BITS Pilani

Pilani | Dubai | Goa | Hyderabad | Mumbai

An Institution of Eminence

Bulletin

2023-24

59 Years in the service of the nation

innovate | achieve | lead

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE PILANI (RAJASTHAN)

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INSTITUTE EMBLEM

The Emblem of the Institute represents a synthesis of Science, Humanities and Engineering with Lotus representing Humanities and Social Sciences, the Structure of Molecule representing Science, and the Figure of Rocket representing Engineering & Technology.

The Motto is –

'Knowledge is power supreme'

BITS VISION

“What do we propose to do here? We want to teach real science whether it is engineering, chemistry, humanities, physics or any other branch. We want to develop a scientific approach in Pilani, which means there would be no dogma. There will be a search for truth. What we propose to do here is to cultivate a scientific mind.”

— The Late Shri G.D. Birla
Founder Chairman, BITS, Pilani

“ … to prepare young men and women to act as leaders for the promotion of the economic and industrial development of the country and to play a creative role in service to humanity.”

— The Late Dr. K.K. Birla
Former Chancellor, BITS, Pilani

“What is it that can empower our nation? The most obvious answer is education. Education that enhances livelihoods but also education that is value-based. Education that gives roots and gives wings as well”.

—Dr. Kumar Mangalam Birla
Chancellor, BITS, Pilani

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HIGHLIGHTS

- Multi-campus University with campuses at Pilani, Dubai, Goa, Hyderabad and Mumbai
- Admission in both semesters
- Admission only on merit through a unique computer based on-line admission test, BITSAT
- 20 – 30 Board toppers join every year
- Scholarship to 30% of students
- Academic flexibilities-Dual Degree-a unique combination of Science and Engineering education
- Modular and flexible academic structure
- Vertical transfer options from First Degree to Higher Degree/ Ph.D.
- Continuous, internal, transparent evaluation system
- Practice School – strong linkages with industries
- Work-Integrated Learning Programmes for employed professionals
- State-of-the-art institutional library with over 2 lac books
- State-of-the-art Campus-wide computer network
- Large number of Alumni in top positions in India and abroad
- Very strong Alumni network
- Collaboration with foreign universities of repute
- Entrepreneurial Leadership Development
- Many societal development projects-Rain Water Harvesting, Desert Development Technologies, Women Empowerment, Healthcare
- Major cultural, academic and sports events-OASIS, APOGEE and BOSM - organized by students
- Privately funded with an affordable fee structure

PART I

GENERAL INFORMATION

HISTORY AND PURPOSE

The Birla Institute of Technology and Science (BITS), Pilani, declared a Deemed to be University in 1964 and an Institution of Eminence in 2020, was established by combining the colleges of Engineering, Arts, and Science, Commerce and Pharmacy, which had originally evolved from a pathshala that was started in 1901. The qualities of innovation, enterprise, commitment to excellence, adherence to merit, and transparency, have characterized the Institute all through its journey towards its eminence. The guiding principles of the Institute, as envisioned by the founding fathers, emphasize on its role "to provide for and otherwise promote education and research in the fields of Technology, Science, Humanities, Industry, Business, Public Administration and to collate and disseminate in such fields effective ideas, methods, techniques and information as are likely to promote the material and industrial welfare of India"; while doing so, the Institute resolves to "train young men and women able and eager to create and put into action such ideas, methods, techniques and information".

The Institute was initially registered as a Society under the Rajasthan Societies Registration Act of 1958 on the 13th May, 1964. Subsequently, by notification published in the Gazette of India dated the 27th June, 1964, the Ministry of Education, Government of India, declared that the Institute being an institution for higher education shall be "deemed to be a University". The Institute started functioning with effect from 1st July, 1964 with late Shri G.D. Birla as its Founder Chairman.

The Institute was initially a small "Pathshala" (village school) in Pilani way back in the year 1901, started by Seth Shiv Narainji Birla with only one teacher, for educating his grandsons, late Shri G.D. Birla and late Shri R.D. Birla. Pilani was then a small isolated desert village in Rajasthan. The Pathshala evolved slowly and steadily into a High School in 1925 and became an Intermediate College in 1929.

The Intermediate College developed into a Degree College in 1943. In 1947, this college was raised to postgraduate level. In 1950, Pharmacy courses were started in this college, and in 1952, it was bifurcated into the College of Arts and the College of Science, Commerce and Pharmacy.

During the World War II, the Government of India established a Technical Training Centre at Pilani for the supply of technicians for Defense Services and industry. In 1946, late Shri G.D. Birla decided to convert it into an engineering college with degree programmes in Electrical and Mechanical Engineering. Master's programme in Electronics was started in 1955. B.E. programmes in Civil Engineering and Chemical Engineering were started later. In 1964 with the inception of the Birla Institute of Technology and Science, the colleges, viz., Birla College of Science, Commerce and Pharmacy, Birla College of Arts and Birla College of Engineering situated at Pilani, as also all properties, movable and immovable, together with educational facilities, hostels, staff quarters, playgrounds, etc., became part of the Institute. During the early years of its inception, i.e., 1964 to 1970, the Institute, with the support of Ford Foundation Grant, collaborated with the Massachusetts Institute of Technology (MIT), USA. It helped the Institute to bring in the semester system, modular structure of courses, continuous and internal evaluation, letter grading, to name a few, thereby making an independent mark in its pedagogy and curriculum design. The proverbial feather in the cap came in the form of institutionalized linkages with the industries. Over a period of time, the Institute also introduced several flexibilities in its curricular structure making it dynamic and orienting it towards student excellence.

Dr. K.K. Birla who took over as the Chairman of BITS in 1983 was deeply involved and closely associated with his visionary father in running both the earlier Birla Colleges and the current institute BITS, since its inception. With his great involvement in all the activities of the Institute, he worked relentlessly to give shape to his father, Late Shri G.D. Birla’s vision. After taking over the responsibility of running the institute, Dr. K.K Birla, who became the Chancellor in 2003, realized the need for a greater number of promising graduates in the field of science and technology in bringing up the nation’s development. Hence, he initiated a gradual

increase in the intake of students at Pilani campus during 1999 which steadily took the total strength from 2500 to 4000. Under his patronage, BITS embarked on a program of expansion, first in Pilani starting in the mid-nineties, and then beyond. The first international campus of any Indian University was established in Dubai, in 2000, followed by campuses in Goa in 2004, in Hyderabad in 2008 and in Mumbai in 2021.

Upon the sad demise of Dr. K.K. Birla on 30 August 2008, Dr. Kumar Mangalam Birla was elected as the Chancellor and Smt. Shobhana Bhartia was appointed as the Pro-Chancellor of the Institute. Under the leadership of a young and dynamic Chancellor, BITS is taking steps to scale greater heights.

BITS Pilani – Accreditations and Ranks.

In its endeavor to attain greater heights in education, research and outreach, BITS Pilani participates in several ranking and accreditation process of repute.

International: 2023 Rankings are as follows.

THE (Times Higher Education): Global University Rank 800-1000. Asia Rank 351-400.

QS (Quacquarelli Symonds). World University Rank 951-1000(2024); Asia 188 (2023); BRICS Rank 96; QS World Graduate Employability Rankings: 251-300 (in top 8 in India). Ranked 344 globally in Engineering with 10 departments in the top 500 and Pharmacy in top 101-150, 2nd in India.

NAAC: In the year 2000, BITS was accredited in its first cycle, by NAAC with the highest possible rank in University accreditation. In 2008-2009, the NAAC peer team visited BITS campuses at Pilani, Goa and Dubai and BITS Pilani, has been reaccredited in its second cycle with CGPA 3.71 on four-point scale with the highest 'A' grade. Again in 2016, the NAAC peer team visited BITS campuses at Pilani, Goa and Hyderabad and BITS Pilani has been reaccredited in its third cycle with a CGPA of 3.45 with 'A' grade.

NIRF: National Institutional Ranking Framework 2023 has ranked BITS Pilani at 20 in University Category and at 3 in Pharmacy.

Institution of Eminence: BITS Pilani was declared as an *institution of eminence* by the Government of India on October 1, 2020.

Other Ranks: Among all the technical institutions of India, in 2022 BITS Pilani has been ranked 1st among the private engineering colleges by India Today, 1st among the private and deemed technical universities by The Week and 7th by the Outlook magazines among all institutes in their recent surveys, and BITS Pilani remains the highest ranked non-government institute consistently in most of these surveys.

BITS Pilani-Strategic Improvement Journey

In the last 15 years, BITS has taken decisive steps to cement its legacy of being an excellent teaching institution, with focus on research. Besides, the institution has substantially expanded its capacity to provide education to more meritorious students from India and abroad. All these can be achieved through a well-planned transformation program that not only ushered major improvements in academics and research, major overhauling of the infrastructure space with remodelling and new construction of several academic blocks, faculty and student housings and other facilities at Pilani, Goa and Hyderabad campuses. An elaborate growth plan, with increased student and faculty intake over the next 12 years, formed the crux of this transformation.

BITS Pilani has transformed from a very eminent teaching-focused institute to a teaching and research intensive institute in a short span of time. Since 2009, through strategic improvement exercises, BITS Pilani has significantly bolstered its research and innovation capabilities with a concerted focus on interdisciplinary research and industry income. The beginning of this strategic transformation was with the launch of Vision 2020 in the year 2009, with an aim to improve BITS Pilani's ranking amongst Science & Technology institutions in India and Asia. The improvement in the rankings was planned through 3-year programs, known as "Mission" programs, with a clear objective of bringing significant transformation in chosen focus areas, known as thrust areas. First such program was called Mission 2012, that saw

over 100 faculty member working with BITS leadership in 6 thrust areas. The major achievements of the Mission 2012 program included a renewed focus on research with launching of schemes like Seed Grant and Research Initiation Grant to motivate faculty members, improved administration through automation, introduction of new people policies in recruitment and performance management, bringing distinct brand identity guidelines, and the most significant of all – the Project "Parivartan".

In November 2011, Chancellor Dr. K M Birla formally announced the Project Parivartan to modernize and expand physical infrastructure in Pilani, which was subsequently extended to Goa and Hyderabad campuses as well. Through this project a number of new facilities have been created and the existing academic blocks, hostels and faculty & staff housing have been renovated and augmented. While the project has been completed in Hyderabad campus, it will take a few more years to complete the same in Pilani and Goa campuses.

After Mission 2012, a follow-up program called Mission 2015 was initiated with focus on seven new thrust areas. Mission 2015 brought further engagement in areas like international student admission, institution-wide innovation and incubation centres and policies, inter-disciplinary centres-of-excellence for research and application, Teaching Learning Centres for research on new age teaching and pedagogy. After two major transformation Missions, the leadership decided to consolidate and review the progress made thus far in the journey towards Vision 2020 and introduced periodic campus and institution reviews. These reviews are now completely institutionalized and are an excellent platform for departments and divisions across BITS to showcase their achievements, and an opportunity to align their objectives and activities with that of the institution. Equipped with several successes and deep learning of implementation of the two strategic programs, followed by periodic institutional reviews, BITS began deliberations for an extended vision, that would prepare the institution well beyond 2020.

In 2017, BITS engaged a leading global strategy consultant for formulating an overall roadmap that would propel it to further heights and help attain leadership position in the coming years. This strategic exercise is named as the Project Lakshya. This exercise focused mainly on five thrust areas: Research, Faculty, Programs & Pedagogy, Industry Engagement and Alumni Relations. The thrust areas, each led by a senior leader, have set themselves goals that would strengthen and enhance BITS' position amongst the global science and technology institutions.

BITS Pilani has always been a leader in providing excellent education – the eminent alumni and stellar faculty who have been part of this institution for the last 59 years are a testimony to this fact. In 2018, Ministry of Human Resources and Development, Government of India, identified BITS Pilani for the *Institution of Eminence* status, concurring and endorsing the faith our student, faculty and alumni have reposed since its inception. BITS Pilani now admits approximately 3100 first degree students, 860 higher degree students and 370 PhD scholars. With a strength of around 930 faculty members and over 1170 staff members across its 4 campuses, BITS is committed to achieve a faculty-student ratio that meet global standards. BITS is also proud to have a network of over 1.7 Lakh alumni spread across the world. "BITSians" are leaders in vastly varied fields ranging from Industry, Academia, Research, Entrepreneurship, Social Sector, Armed Forces, Entertainment, right up to the Government sectors.

Innovation Ecosystem: The innovation ecosystem at BITS is supported through incubators funded by DST, TIDE and BIRAC BioNEST that mentor and support innovative startups both from within and outside of BITS. In 2018, BITS Pilani signed agreements with Rajasthan State Innovation Council to extend its research and innovation facilities for startups. 126 start-ups have incubated in these TBIs and 44 more are under incubation. BITS has been ranked 3rd in the country behind IIT Delhi and IIT Bombay in terms of the number of Indian start-ups founded by graduates of an institute. Presently, there are 14 BITSian Unicorns.

CAMPUSES OF BITS

BITS Pilani - Pilani Campus

BITS Pilani, Pilani Campus is located in the Vidya Vihar campus adjacent to Pilani town in Jhunjhunu district, in Rajasthan. Pilani is the home town of the Birla family and has a population of about 50,000. It is about 200 km west of Delhi and about 220 km north of Jaipur. The temperatures during the year go to extremes like 45°C in summer and 0°C in winter. The climate is generally dry and healthy. Annual rainfall is about 30 cms.

The Institute buildings, hostels and residential quarters for staff with neatly laid out roads, lawns and gardens constitute the BITS Campus of about 240 acres.

Pilani can be reached either by rail or by road. The nearest railway stations are Chirawa on W.R. (16 km) and Loharu on N.R. (24 km). There are connecting buses to Pilani from Loharu and Chirawa railway stations. There are regular bus services between Delhi-Pilani and Jaipur-Pilani. The buses leave Delhi from Inter-State Bus Terminal, Kashmere Gate and Jaipur from Rajasthan State Roadways bus stand, Sindhi Camp. The Pilani campus is very close to the Pilani bus stand.

BITS Pilani, Dubai Campus

BITS Pilani, Dubai Campus (BPDC) was established with the approvals of the Ministry of HRD (Vide Letter No. F.1-8/2000(CM) dated 4th August 2000) and the University Grants Commission (UGC) (Vide Letter No. F.34-18/2000-U.3 dated 6th November 2000) in the year 2000 in response to the growing need for quality engineering education among the residents of the Middle East. The beautiful campus is spread over an area of 14.7 acres in Dubai International Academic City in Dubai, with a built-up area of approximately 5,36,436 sq. ft. It is about 16 kms from Dubai International Airport. All the programs offered at the campus are also approved by Knowledge and Human Development Authority (KHDA), Government of Dubai, UAE. BITS Pilani is the first Indian Higher Educational Institution to set up its campus abroad.

Dubai Campus houses the academic building (main, library and mechanical blocks), hostels for boys and girls, library, sports facilities (playgrounds, indoor play areas, gyms), , grocery and canteen. All classrooms, laboratories, offices, hostels and other indoor areas are centrally air-conditioned. Cisco Telepresence classroom and Cisco meeting rooms, campus-wide Wifi infrastructure are the latest addition to our facilities.

BITS Pilani - K.K. Birla Goa Campus

BITS Pilani - K.K. Birla Goa Campus started functioning in August 2004 and was formally inaugurated by Hon'ble Prime Minister of India, Dr. Manmohan Singh on May 5, 2006.

The Campus is spread over an area of 180 acres and the location on campus is unique with respect to scenic beauty and panoramic view of the picturesque surroundings with Zuari river, hillocks, waterways and forest. The Campus is about 25 km south of Panaji (capital of Goa), 10 km west of Vasco-Da-Gama and 22 km north of Madgaon. It is 5.5 km east of Goa Airport, along National Highway – 17B, bypass road.

BITS Pilani - Hyderabad Campus

BITS Pilani established its fourth Campus in the city of Hyderabad in 200 acres area in Jawahar Nagar, Kapra Mandal in 2008. For the academic session 2022-23, the campus had admitted 1184 students in its fifteenth batch of First Degree programmes, 226 students in Higher Degree programmes and 147 students in PhD programmes.

The campus is located on the Karimnagar highway and is about 25 kms from Secunderabad railway station; 40 kms from Hyderabad (Nampally) railway station; and 70 kms from Hyderabad Rajiv Gandhi International Airport.

The Institute has a Student Activities Centre housed in a separate building where students have their union office and rooms for various activities. This building also has badminton courts, a squash court, a Table tennis room, a Health Club, an open air amphi theatre and a cafeteria.

BITS School of Management, BITSoM, Mumbai

BITSoM is a world-class business school launched under the aegis of BITS Pilani. It aims to redefine the tenets of business education in India to enable fresh graduates and young professionals to ask the relevant questions, handle workplace challenges effectively, align technology with best practices, reinvent strategic goals and most importantly, learn how to deal with change & adversity — all the while keeping human values at their core.

Leadership

Leadership and governance of the institution are critical in realizing our ambition. BITSoM will be led by the Dean who is ably guided by the Governing Council and the Industry Advisory Council in giving strategic direction to the school.

The members of the Governing Council are:

Mr Kumar Mangalam Birla
Chairman of the Aditya Birla Group

Ms Shobhana Bhartia
Chairperson of Hindustan Times Group

Prof V Ramgopal Rao
Vice-Chancellor, BITS Pilani

Prof Ranjan Banerjee
Dean and Professor - Marketing, BITSoM

Mr Dilip Gaur
Director, Aditya Birla Management Corporation Private Ltd

Mr Bharat Puri
Managing Director, Pidilite

Prof Geoffrey Garrett
Dean, USC Marshall School of Business

Mr Hari Menon
CEO, BigBasket.com

Ms Nishi Vasudeva
Former Chairman and MD of HPCL

Mr Preetish Nijhawan
Co-founder and Partner of Cervin Partners

Prof Rajagopal Raghunathan
Professor of Business, University of Texas Austin

Ms Revathi Advaithi
CEO of Flex

Prof SP Kothari
Professor of Accounting and Finance at MIT Sloan School of Management

Ms Tulsi Mirchandaney
MD of Blue Dart Aviation

Faculty

Faculty is the fulcrum of any school of excellence, and we have hand-picked a stellar line-up from among the leading business schools across the world. These are individuals who are widely regarded as thought leaders in their respective fields.

A few of the faculty who will be teaching at BITSoM are:

Prof Ranjan Banerjee
Dean and Professor of Marketing

Prof Leena Chatterjee
Professor of Organization Behavior

Prof Abhijeet Vadera
Singapore Management University

Prof Dan Gode
NYU Stern School of Business

Prof Gerard George
McDonough School of Business

Prof Luis Martins
McCombs School of Business, University of Texas

Prof Mark Finn
Kellogg School of Management

Prof Milind Shrikhande
J. Mack Robinson College of Business, Georgia State University

Prof Nirmalya Kumar
Singapore Management University

Mr Nish Bhutani
Founder & CEO, Indiginus

Prof Rajagopal Raghunathan
McCombs School of Business, University of Texas

Prof Shailendra P Jain
Foster School of Business, University of Washington

Prof Ram Ganeshan
Raymond A. Mason School of Business, College of William and Mary

Prof Soumitra Dutta

Dean, Saïd Business School, University of Oxford

Prof Sudip Gupta
Carey Business School, John Hopkins University

Prof Vera Tilson
Simon Business school, University of Rochester

Prof Kapil Tuli
Lee Kong Chian School of Business, SMU

Curriculum and Pedagogy

The curriculum at BITSoM has been designed with the advantage of a clean slate. We consulted extensively with industry leaders to understand the requirements of the modern workspace, and expectations of organizations in the digital economy. Salient features of the curriculum are as follows:

- A focus on design thinking, analytics and emerging technologies. We have mandatory courses around each of these topics in both the first and second years.
- Students can choose up to two specializations from a set of five that includes new age specializations such as Entrepreneurship and Innovation, and E-commerce and Digital Leadership
- We have a strong focus on soft skills. The Winning at the Workplace (WAW) track will offer students courses to develop their emotional intelligence and people skills, courses in liberal arts and essential workplace skills.
- Each student will have a self-development plan made in discussion with the faculty. The student will work on the plan through the two-year programme with structured feedback from the faculty. We believe this will be an essential feature of the experience that will inculcate the habit of lifelong learning.
- Student are assigned mentors from the industry to guide them on their chosen career path.
- The pedagogy is strongly integrated with industry. Each student will go through an internship at the end of the first year. Additionally, students working in groups are required to take up a minimum of three live projects across the corporate and social sectors.

Admissions and student selection

BITSoM has received a strong response from aspiring students for the two admission cycles in the last two years. We have enrolled two batches of bright young minds. Our students represent a wide range of top-tier undergraduate institutions from across the country.

The admissions process is designed to recruit a diverse set of students, not only in terms of gender but also academic diversity and diversity in work experience. We assess students based on academic excellence, extracurricular activities, work experience, and standardized test scores (CAT, GMAT and GRE).

The Interim Campus

The interim campus has been set up Hiranandani Knowledge Park, Powai, Mumbai. Spread over 50,000 square feet, it has been designed to accommodate all the facilities expected of a top end business school:

- Two stepped classrooms
- Two flat classrooms
- One multipurpose hall
- Library
- Breakout spaces
- Cafeteria
- Digital multimedia studio
- Wellness Centre

Well-equipped and comfortable students housing is provided at a short distance of 1.2 kms from the campus.

The Permanent Campus

Our upcoming permanent campus is spread over a lush 60 acres in the Mumbai Metropolitan Region. We endeavor to make this a highly environmentally friendly campus to truly embody the spirit we hope to inspire in the next generation of leaders.

Designed by the renowned architect Hafeez Contractor, it will be state-of-the-art and pedestrian-friendly, and at par with the best business schools in the world.

Some of the key features of the campus are as follows:

- Campus Location: Approximately 60-acre campus with large green areas and a natural water body, ~1hr 45mins away from Mumbai airport
- World-class infrastructure: Fully residential modern campus equipped at par with the best institutes in the world
- Digitally enabled classrooms: Classrooms will be digitally equipped with tablets as command centers, projectors, telepresence, and smart devices for optimizing learning experience
- Business Incubation Centre: Cutting-edge business incubation center equipped with video conference, computers built for data science, and interactive tables
- Video Studio: Fully equipped video studio open for faculty and students for the creation of multimedia content

The design principles for the campus are:

- Integrated Master Planning
- Environment-Friendly Complex
- Dedicated Zones for Academic /Faculty Housing and Student Housing / Sports
- Optimizing Use of Land Low Rise Buildings
- Pedestrian Friendly Campus
- Courtyard Formations
- Shading Devices and Solar Panels
- Integration of Water Streams with Water Bodies
- Facilities for Students

Institutional address:
8th Floor, Hiranandani Knowledge Park
Powai, Mumbai – 400076
Phone: 8050012004
Homepage: https://www.bitsom.edu.in

International Students Association

The International Students Association at BITS established to bring together the greatly diverse international community. The ISA works to bring elements from our distinct and richly diverse cultural backgrounds to share them with the BITS community at a cultural, academic, and social level. It is a Student advisory board of foreign students studying at BITS with a faculty member as an Advisor. The association organizes cultural activities and extends all possible help to foreign students whenever required.

International Student Admission in Integrated First Degree Programmes

In order to introduce transnational diversity and to embark upon making BITS Pilani a global university, the Senate has approved an alternate merit based mode for admitting international students to the integrated first degree programmes. Any student who is not a citizen of India is eligible to apply through this scheme for which the admission will be based on performance in Scholastic Assessment Test (SAT) conducted by the College Board (USA) in Reading & Writing and Mathematics Test.

BITS BioCyTiH Foundation
(Section 8 not-for-profit company)

BITS BioCyTiH Foundation was established on 10th March 2021 by BITS Pilani as Host Institute, under National Mission for Interdisciplinary Cyber Physical Systems (NMICPS), Department of Science and Technology (DST), GOI with a funding of Rs. 125 crores for a period of 5 years. The domain area of the Foundation is Bio-Cyber Physical Systems (Bio-CPS)

Website: https://biocytih.co.in/

Vision of the Foundation is to foster translational Research, Innovation, Skill Development & Training in Bio-CPS through mentoring and nurturing startups and entrepreneurs, and industry-academia collaborations to undertake cutting edge research and provide affordable solutions in the areas of healthcare, agriculture, water and environment. Bio-CPS combines biological knowledge with the power of computing and physical systems, Bio-CPS cut across the field of biology, artificial intelligence, chemistry, IoT, electrical and electronic engineering, computer science and associated disciplines to solve the problems.

Foundation focuses on four main verticals:

- **Technology Development:** Under the technology development vertical, BITS BioCyTiH Foundation supports translational research and development projects from both academia and industry in the interdisciplinary areas of Bio-CPS focused on translation of R&D results into marketable products and services.

  The Foundation so far has supported 23 strategic projects of the host institution (BITS Pilani) across the Pilani, Goa and Hyderabad campuses. The diversity in strategic projects includes Biosensor for aflatoxin, BPS and pathogens, CPS based portable microfluidics cell culture and diagnostic platform, Acostic sensor networks for coral reef monitoring, IoT, Edge computing and cyber security, Malaria, Cancer, CVD biomarkers, AR/VR based cognition tracking, CRISPER/Cas based molecular diagnostics.

  Foundation has also supported nine projects of the spoke institutions (IIT Dharwad and SASTRA Deemed to be University). Foundation has launched programs such faculty fellowships and chair professorship programs in Bio-CPS.

  SMART Bio-CPS is a unique strategic funding initiative of the Foundation to identify and support mature, market-ready technologies and products in Bio-CPS (TRL 7 and above) from Indian startup and MSME & the program aims to intensely accelerate market advancement within a period of 6-9 months.

  Foundation has supported total of 18 startups under SMART program working in the Bio-CPS area of Anti-microbial resistance; Neonatal critical care; Chronic wound care management; Unmanned aerial vehicle (UAV) based precision Agriculture and crop-infestation control; Waste management systems; Livestock health monitoring; Soil health monitoring etc. The major startups supported by the Foundation which are close

to launch their product in market are BillionCarbon Solutions Private Limited, Proximal Soilsens Technologies Private Limited, Heamac Healthcare Pvt Ltd, Ekosight Technologies Private Limited, Flic Farm Private limited, Adiuvo Diagnostics Private Limited, Sensivision Health Technologies Private Limited etc.

- **Entrepreneurship Development:** The Foundation aims at providing R&D infrastructure, mentoring, business advisory, industry connect, networking opportunities, fundraising support, and skill development opportunities for boosting translation and commercialization of the innovative devices, tools and systems. The Foundation has launched various programs and activities to promote and encourage innovative entrepreneurship in the interdisciplinary area of Bio-CPS. This includes, but is not limited to, Incubation Programs, Entrepreneur-In-Residence (EIR) Program.

  EIR program supports young entrepreneurs in the domain of Bio-CPS. EIR is national call where young research and startups are onboarded for EIR program from Kashmir to Karnataka working on Automated indoor aeroponics cultivation of saffron, Noval peptides based drugs for inflammatory bowel disease, Satellite based AI solution for smart cultivation etc.,

  Bio-CPS VIP is designed to digitally connect and support startups through their early-stage entrepreneurial journey by providing mentoring, networking etc., Some of the startups incubated in VIP program are Cleome Innovations Private Limited, Evoreality Private Limited, Nanobrid Innovations Private Limited, T-3 Molecular Genetics (T-3 MGen) Private Limited.

  The incubates will also be benefitted by the events and activities, such as seminars, webinars, training & skill development programs, workshops, expert panel discussions, etc. organized by the Foundation.

- **Infrastructure Development:** The Foundation is building state-of-the-art infrastructure across the Pilani, Goa and Hyderabad campuses to provide access to innovators, startups and researchers.

Infrastructure at KK Birla Goa Campus

1. IoT Lab
2. Bio Lab Facility
3. Bio-Sensor Lab
4. Bio-CPS Incubator
5. Device Fabrication Lab (under development)

Infrastructure at Pilani Campus

1. Omics/NGS GLP Facility (under development)

Infrastructure at Hyderabad campus

1. Flexible & Printed Electronics Lab & Data and Systems Security Lab

Skill Development: The Foundation focuses on skill development activities to create new talent pool and leaders in the domain of Bio-CPS. This is critical to create a talent pipeline in the Bio-CPS arena.

1. Training Ph.D. fellows across three campuses.
2. Translational Research Internship program (TRIP).
3. Onboarding post-doctoral research fellows in Bio-CPS.
4. Technology translation orientation programs.
5. UG/PG Fellowships and Internships.
6. IP/Regulatory awareness, webinars and workshops.
7. Hands-on training workshops in IoT, Biosensor, Device designing & fabrication, etc.

Foundation has supported total of 33 Researchers including 15 Project fellow, 8 Research Associate (Post Doc), 4 Project Associates, 1 Research Associate, 1 Senior Project Associate, 1 JRF and 3 Technical Assistant.

As a part of the Skill Development activities, the Foundation has organised various workshops and webinars. More than 1048 participants including startups, researchers, scientists,

professors and students from across the country have attended these events.

Industry experts and eminent speakers including Prof Vijay Chandru (Founder Strand Lifesciences), Dr Chandrasekhar Nair (Founder Bigtec & MolBio), Dr Radha Rangarajan (Director CSIR-CDRI), Dr Premnath Venugopalan (Director Venture Center), Mr David Gill (St John's Innovation Centre, Cambridge), Dr Kavita Singh (Director South Asia, DNDi) and Dr Malathi Lakshmikumaran (Executive Director Lakshmikumaran & Sridharan) have visited the Foundation and interacted with its researchers and faculty.

FACILITIES AT CAMPUSES

Pilani Campus and Its Adjoining Facilities

Shiv Ganga and Saraswati Temple

Shiv Ganga is a central beauty spot of the Vidya Vihar Campus with 400 meters circular canal and the Sharda Peeth, a beautiful white marble temple dedicated to Goddess Saraswati.

Guest Accommodation

Limited facilities are available for board and lodging on payment at the VFAST Hostel (Visiting Faculty and Students Hostel) which is near the entrance of the Campus. Other accommodation facilities are also available at (i) Alumni Home (Requests should be addressed to Public Relations Officer, Birla Education Trust, Pilani), (ii) CEERI Guest House (Requests should be addressed to Administrative Officer, CEERI, Pilani) and (iii) Some guest houses and dharamshalas in the city operated by private agencies.

Schools/Colleges

There are several Middle and Primary Schools in Pilani. The Secondary schools are affiliated to Central Board of Secondary Education; prominent being Birla Public School, Birla Senior Secondary School, Birla Balika Vidyapeeth (for Girls upto 10+2) and Birla Shishu Vihar, a Co-educational Secondary School, located in Vidya Vihar Campus. Adjoining the Vidya Vihar Campus, there is Engineering and Technology Institute, Commerce & Arts College and a Polytechnic Institute. These schools and colleges are run by Birla Education Trust and other Educational Societies.

Blossom Kids-zone

The Blossom Kids-Zone (BKZ) is run voluntarily by faculty wives and it takes care of the pre-school training and education of the children in the age group of three to five years. The center primarily caters to the needs of staff children belonging to BITS and the sister organizations.

Bank and P&T Service

Within the Vidya Vihar Campus there is a branch of UCO Bank with ATM facility. In the adjoining CEERI Campus there is a branch of the State Bank of Bikaner and Jaipur, with ATM facility. Vidya Vihar Campus also have ATM facility of Axis & ICICI Bank. Pilani also have ICICI, Axis, SBI, PNB Banks. The Pilani Post office is located within the Campus, while a Telegraph office is situated in the CEERI Campus.

Shopping Centers

AKSHAY, a Supermarket, located in the heart of the campus in an area of 7500 sq.ft. with an elegant modern building is a part of BITS Consumers' Cooperative Stores Ltd. (BITS Coop). Student volunteers of the Institute have worked with management of the BITS Coop in the establishment of the Supermarket. It has various sections for consumable items where the customers can choose and pick-up the items of their choice and pay on the cash counter. General provision, sanitary goods, cosmetics, snacks and other food items, Bakery and Dairy products, books & stationery, fruits & vegetables are made available to the students and staff at reasonable rates.

Birla Museum

The Birla Museum is located adjacent to the Institute Building. It is the first science and technology museum established in the country. Most of the exhibits and models incorporate stimulating animations and visual effects.

Central Electronics Engineering Research Institute (CEERI)

Adjoining the Campus, there is the Central Electronics Engineering Research Institute. It is

one of the National Laboratories under the Council of Scientific & Industrial Research (CSIR).

STUDENT LIFE

Student Housing

The Institute is fully residential and hostel accommodation is provided for all students. There is a hostel for married research scholars. Each room has a separate kitchen and washroom. Permission to become day-scholar may be granted only under exceptional circumstances where student's parents or close relatives are residents of Pilani

There is a central kitchen from where food is served to all messes for every set of two boys' hostels. Each unit of the mess serves vegetarian and non-vegetarian food, and the unit operates under the management of the students' mess committee. The girls' hostel has a separate mess of its own, situated within the boundary of the hostel. Students staying in the hostel have to necessarily take their food in the hostel messes. Every inmate of the hostel is provided with necessary furniture and fixtures in the room. Each hostel is equipped with solar water heating systems. Common room facilities like TT table, carom etc. are available in each hostel. Internet connectivity has been provided in all hostel rooms. Most of the hostel common rooms are equipped with a multi-station gym equipment and Air Conditioned. The badminton/ volley-ball /basketball courts are installed in most of the hostel QTs.

The details of the girls, boys and married research scholar hostels are given below:

S.N	Bhawan	Code	Single Seated Room	Double Seated Room	Total Capa-city
1	Bhagirath	BG	0	0	0
2	Budh	BD	176	96	368
3	Gandhi	GN	174	112	398
4	Krishna	KR	176	108	392
5	Malviya	ML-A	138	0	138
		ML-B	138	0	138
		ML-C	182	0	182
6	Ram	RM	180	110	400
7	Malviya Studio Apartment	MSA	0	60	120
8	Ashok	AK	134	72	278
9	Rana Pratap	RP	138	60	258
10	Shankar	SK	176	112	400
11	Sir C.V. Raman	CVR	201	0	201
12	Srinivas Ramanujam	SR	0	206	412
13	Vyas	VY	176	112	400
14	Vishwakarma	VK	192	39	270
15	Meera	MR-0	108	0	108
		MR-1	49	0	49
		MR-2	49	0	49
		MR-3	49	0	49
		MR-4	49	0	49
		MR-5	0	49	96
		MR-6	72	0	72
		MR-7	40	0	40
		MR-8	40	0	40
		MR-9	0	174	348
16	Research Hostel	RH-A	90	0	90
		RH-B	72	0	72
		RH-C	18	0	18
		RH-D	24	0	24
		RH-E	4	0	4

Student Activities Centre

The Institute has a Student Activities Centre housed in a separate building where students have their union office and rooms for various activities. This building also has badminton courts, a squash court, a Table tennis room, a Health Club, an open-air amphitheater, and three food outlets. The Newest addition to the SAC is the Students' Union Honours Board featuring the list of previous Students' Union Leaders.

Cultural and Recreational Activities

The Institute has the following clubs and societies: Music, Dance, Hindi Drama, English Drama, Hindi Press, English Press, Creative Activities, and Mime clubs; English Language Activity and Hindi Activity societies. These are entirely managed by the students and have been nurturing the creative and cultural talents of the students. In addition, the Institute has a Recreational Activity Forum, Photography Club, Swimming Club, and Health Club whose membership is open to students and staff. The Institute also organizes Theatre and Dance workshops. A classical music group called 'Ragamalika' aims to encourage budding talent

among the students in music and dance. It also arranges performances by leading artists in the field of classical music and dance. In addition, there is also a BITS Pilani Chapter of SPIC-MACAY which organizes programs to promote Indian classical music and culture among youth. In total, there are around 120 organized Student Chapters, Clubs, and communities catering to different student activities and events throughout the year.

Recreational Activity Forum (RAF) regularly organizes film shows for the BITS community. BITS being an all-India Institute, students have also established regional associations representing almost all Indian States conducting several special programs on festive occasions.

Physical Education

Physical Education of the Institute aims at providing a safe atmosphere to enable students and staff members to exercise to their potential whilst achieving their goals. It offers a variety of fitness, wellness, and recreation opportunities, and Fitness Programmes including Yoga and Martial Arts. Physical Education has major facilities that include the Health Club, Swimming Club and Sports Club. The Health Club is equipped with single and multi-stationed machines and weight training facilities to provide students with an opportunity of doing exercise for physical fitness. The Swimming Club has a swimming pool of 25 m in length while the Sports Club has various indoor and outdoor facilities for students to take part in sports and games. The indoor facilities are Badminton, Table Tennis and Squash with synthetic flooring while outdoor facilities are Basketball, Football, Hockey, Volleyball, Cricket, Tennis, Track & Field (400 m) etc. Sports and fitness activities are supervised by the qualified and experienced staff members of the Institute.

Festivals on Campus

Traditionally students organize three festivals during an academic year. BITS Open Sports Meet (BOSM) in September, a sports festival; OASIS, a cultural festival in November and APOGEE (A Professions-Oriented Gathering Over Educational Experience), an Academic Festival in April thus bringing about a beautiful blend of sports, the cultural and academic milieu of the campus. This year saw the revamp of the Oasis and BOSM for the first time after the campus reopening. This year we hosted the 50th edition of the Oasis which featured 96 hours of non-stop events featuring 5 concerts. APOGEE saw the revamp of technical culture on campus with flagship events Robot Wars, Drone Racing League, and many more coming back to the roster. The biggest feature of APOGEE was the Drone Light Show which was hosted at BITS Pilani for the first-ever time. Among the new additions this year, The students also organized the Inter-BITS ELadue featuring students from all BITS campuses competing in various sports events at Pilani.

Students' Participation in Institute Activities

Students actively participate in various continuing and developmental activities of the Institute as follows:

There are four students as members of the Senate – one representing each campus, two students in the Senate-appointed Academic Counselling Board, and two students in the Senate-appointed Standing Committee for Students' Discipline in each campus. In addition, senior students act as mentors to junior students in the registration process. Some students are also associated with the course development activities. Students participate as associate members in the activities of various Divisions of the Institute. Their contribution to the projects and research activities of the Institute has always proved to be very useful. The Students' Union along with the help of its various departments has helped to digitize various functions of the institute including Hostel Allocation, Timetable generator, and notably the vaccination verification portal which eased the process of reopening the campus.

STUDENT SERVICES

Orientation and Counselling

At the time of admission, the Institute organizes an orientation program in order to familiarize the new students with the Academic Programmes at BITS and to give them an idea about their campus life and co-curricular activities. The Vice-Chancellor, Director, PilaniCampus, and senior faculty members

along with the Student leaders meet the parents of freshers at an interaction session organized at the time of admission.

Faculty members act as Advisors and Mentors for groups of students to guide them in the registration process and encourage them to discuss any matter –academic and non-academic with them during their stay at the BITS campus. Students can also approach their wardens for any help or guidance related to academic or personal matters. Each hostel has Resident and Non-resident Wardens who are faculty members of the Institute. To assist the hostel warden in matters related to the upkeep of the hostels and attending to the needs of the students, each hostel has a Hostel Superintendent.

Discipline Associations

Associations formed by students of various academic disciplines organize extension lectures, paper reading seminars, etc. They also arrange symposia in which professionals from industries and other universities participate. These associations organize exhibitions of working models during APOGEE, the academic festival.

NATIONAL SERVICE SCHEME

The Institute's vibrant National Service Scheme (NSS) chapter is a hub of enthusiasm, fostering the spirit of active participation in nation-building through social work. Every year, we welcome around 200 passionate students who are eager to make a positive impact on society. Our NSS volunteers become beacons of change as they immerse themselves in the surrounding villages, igniting joy and hope through various activities. The air is filled with excitement as our NSS volunteers organize lively public awareness camps, health camps, and tree plantation drives. These events not only bring the community together but also create lasting memories of camaraderie and shared purpose. In January 2023, our Blood Donation Camp witnessed an overwhelming response, with an incredible collection of 678 units of life-saving blood. We believe in inclusivity and celebrate the abilities of every individual. That's why every year, we organize "Junoon," a spectacular Sports Day for the specially-abled. Our dedication to making a difference extends beyond the boundaries of Pilani. Every year, we host “Shop for a Smile”, where we partner with various NGOs that support the underprivileged in our community. Additionally, our annual "Conferencia de Youth" provides a platform for dynamic discussions, empowering young minds to shape a brighter future. Within our campus, we have a remarkable NSS school that serves as a beacon of knowledge and inspiration. Every day, more than 100 local students from Pilani gather for engaging tutorials and invigorating personality development classes. Our NSS volunteers go above and beyond, organizing counseling sessions at regular intervals to nurture holistic development. Under the Umang Scholarship Program, NSS BITS Pilani extends financial support to over 100 school students residing in and around Pilani. But that's not all. We also extend our reach to underprivileged children and adults in the surrounding villages, imparting invaluable computer literacy skills. We're bridging the digital divide and opening doors to new opportunities and a brighter future for all.

NIRMAAN

Nirmaan is a bottom-up NGO with the motto, "We have one passion, the rise of a great nation." It all began in 2005 when a passion-driven initiative, "My India" by a group of students from BITS Pilani, grew into "Nirmaan" as a registered Organization aiming to serve the underprivileged. The organization is now spread over all the BITS campuses- Pilani, Hyderabad and Goa, and full-time chapters in Bengaluru and Hyderabad. Nirmaan envisions achieving a knowledge-driven

and economically empowered society. We wish to benefit socioeconomically disadvantaged children, women, youth, and farmers. Currently, the Nirmaan workforce stands at around 1000 across India and corporate chapters in US, UK and Singapore.

With more than 150 active volunteers, the NirmaanPilani chapter impacts the lives of 1100+ beneficiaries across the Pilani areas. We work in the domains of Women Empowerment, Education operations and development, Community Development, Youth Employment, Skill Development & Entrepreneurship and Social Leadership through a highly efficient network to channel the resources with eleven projects as our branches to work for different causes. With activities like Cleanliness drives in various bastis, public toilet construction, menstrual Health awareness, career counselling sessions, Installation of solar street lights, Annual flagship.

Medical Centre (MedC)

Medical centre is providing healthcare services through its team of dedicated specialist doctors. Three doctors, Dr. Guru prasad Burnwal CMO (Physician) and Dr Sanjana R Bhat, Gynaecologist (Dy. CMO) and Dr. Bibin Chandran ,Medical officer are fulltime doctors available at the Medical centre while other specialists visit on different weekdays.ENT specialist Dr. H.S.Sankhla visits the centre on every Monday and Thursday evenings, the paediatrician Dr. Karan Singh Beniwal on all Wednesday evenings, the Dentist Dr.Sanjay Katewa on all Saturday evenings, the Ayurvedic doctor Dr.Ramesh Jaju on all Sunday mornings and the homeopathic doctor Dr. Diwakar Pathak is available on all Tuesday evenings. Besides these specialist doctors, a General Duty Medical Officer from Birla Sarvajanik Hospital visits MedC for evening OPD's.

There is a computerized system for registration, investigations and procurement of medicines from MedC pharmacy thereby making all records available in a digital format and making all transactions cashless. Medicines from the pharmacy are available on prescription only. The pharmacy remains open till 12 midnight on all working days.

MedC has a fully equipped 1 bed emergency observation room equipped with emergency medicines and multi-parametric patient monitor to take care of any medical emergency.Since the lockdown started ,we are running tele consultation at Medical Centre.

Medical centre has a well-equipped clinical laboratory. Besides having fully automated biochemistry and haematology analysers, machines for performing glycosylated - haemoglobin (test for diabetes), serum electrolytes and urine comprehensive examination tests are available.Besides these Medical centre has a tie up with Lal pathological laboratory where almost all the advanced and rare tests are done and sample being collected in Med C only. Computerized ECG machine, a spirometer and a digital dental X-Ray unit are also available at MedC. Installation of a new automated immunoassay analyser, for carrying out the Thyroid function test and Serum 25-hydroxy Vitamin D3 test, Hepatitis-C, has been done.

From 1st April 2022 to 31.01.2023, medical centre recorded a total of 12722 new patient visits and 17066 were old registrations. 3343 patients underwent various haematology and biochemistry tests.

Besides curative services, the doctors at MedC provide preventive services by sending Emails to the students and staff on various topics of public health importance. The topics covered range from adolescent health, anaemia, nutrition and health, obesity, osteoporosis, diabetes, cardio-vascular diseases etc.MedC has also been conducting health camps at various villages adopted by NSS in collaboration with NSS students.

.Medical Centre has been chosen as a primary care centre for BITS employees covered under ESIC scheme since September 2017.Besides the routine outdoor services provided to these patients, special medical camps are being organized for these patients from time to time. The entire process is computerized, the details of which are provided to ESIC on a monthly basis.

New additions at MedC in the year 2022

Upgraded advanced TMT machine

Digital X-ray machine to be installed very soon

M-POWER

The cell was inaugurated by Neerja Birla, founder and chairperson, Mpower, in an endeavour to accelerate the movement to bring about a mind-set change and offer mental well-being in a holistic manner. Mental health challenges among youth is a pressing issue. Mpower works for the Mental Health of students, faculty and staff.

It consists of a Clinical Psychologist- Ms Shikha Joshi, she has an experience of 8 years in various hospitals and schools, a Visiting Psychiatrist- Dr Sandeep Dudy, he has an experience of 13 years, and the admin support is provided by Mr Sachin Soni.

Mpower conducts webinars,/ workshops/ seminars to share the knowledge about Psychological issues experienced by many.

Mpower also provided Youth Mental Health First Aid program twice a year to train the youth, so that the youth can act as a first aid provider and help the person reach the professionals.

PLACEMENT AND CAMPUS INTERVIEWS

A separate unit deals with this important activity. Around 280 companies have visited the institute this year to interview students who are about to graduate. The number of such interviews has actually grown considerably over the years. As the student population in the final year is divided into two batches, one going to practice school in the first semester and the other in the second semester, only one half of the final year students will be available for campus interviews during a particular semester. Hence many organizations find it worthwhile to conduct the campus interviews in both semesters so that they can interview both the batches on campus itself. The institute also tries to arrange interviews for practice school students in and around their own practice school centers. The impressions given by the representatives of industries about students are continuously fed back to the concerned divisions and departments. Organizations that have visited campus for interviews, are shown in the following table.

Organizations conducting Campus Interviews

S.No.	Name of the Company
1.	1 K Kirana Bazaar
2.	Aakash Byjus
3.	AbInbev
4.	Accenture
5.	Accenture AEH
6.	Accenture Strategy & Consulting
7.	Acuvon
8.	Addverb
9.	Aditya Birla Capital
10.	Aditya Birla Group
11.	Adobe
12.	Aerchain
13.	Airbnb
14.	Amadeus Labs
15.	Amazon
16.	AMD
17.	Amdocs
18.	American Express
19.	Ampluss Solar
20.	Anand Group
21.	Andromeda
22.	Andromeda Security Inc.
23.	App Dynamics
24.	Arcesium
25.	Arista Networks
26.	Arup
27.	Asian Paints
28.	Aspect Ratio
29.	Awign
30.	Axis Bank
31.	Axtria
32.	Axxela Advisory
33.	Bain
34.	Bajaj Auto
35.	Barclays
36.	Barco
37.	Baxter
38.	BCG
39.	BharatX
40.	Biocon
41.	Biocon Biologics
42.	Biz2credit
43.	Blackrock
44.	Bloomberg

S.No.	Name of the Company
45.	Bloomreach Technologies
46.	Cairn India
47.	Capital One
48.	Carscan.ai
49.	Ceremorphic
50.	Chubb
51.	Cirel Systems
52.	Cisco
53.	Citi Bank
54.	Citrix
55.	Cleanmax
56.	Cogoport
57.	Coinswitch
58.	Color Tokens
59.	Coutour.ai
60.	Credit Suisse
61.	CRIF
62.	Cyient
63.	DE Shaw
64.	Deal Share
65.	Deccan Chemicals
66.	Dell
67.	Deloitte India
68.	Deloitte USI
69.	Devrev
70.	Dolcera
71.	Dover
72.	Dr. Reddy's Lab
73.	Draup
74.	EdgeQ
75.	EDIIIE
76.	Eltropy
77.	ESRI
78.	Essar Power
79.	Ethiquant
80.	Euler Motors
81.	EXL
82.	Expedia
83.	Exxon Mobil
84.	EY
85.	EY GBS
86.	Finova
87.	Fischer jordan
88.	Flipkart SDE
89.	Flipkart APM
90.	Fortanix
91.	FP Labs
92.	Games 24*7

S.No.	Name of the Company
93.	GAN Studio
94.	GE India
95.	Genpact
96.	Godrej Capital
97.	Gokwik
98.	Goldman Sachs
99.	Goodera
100.	Google HW
101.	Google SW
102.	Grey Orange
103.	Growth Jockey Pvt Ltd.
104.	Groww
105.	Happay
106.	HCL
107.	HDFC Bank
108.	Headout
109.	Here Technologies
110.	Hero Fincorp
111.	Hevo
112.	Hilti
113.	Hourglass
114.	HSBC
115.	HUL
116.	Hyundai
117.	IBM
118.	ICICI Bank
119.	Incedo
120.	Incture
121.	Indeed
122.	Indus Insights
123.	Infoedge
124.	Infosys
125.	Innomagine
126.	Intel
127.	IQVIA
128.	Jacobs
129.	Jio
130.	JPMC
131.	JSW
132.	Just Dial
133.	Kanerika Software
134.	KBR Technologies
135.	Kirana Kart
136.	Kognitiv Inc
137.	Komprise
138.	kore.ai
139.	Kotak Bank
140.	KPIT

S.No.	Name of the Company
141.	KPMG
142.	KPMG GS
143.	L&T Infra
144.	L&T Ltd.
145.	Lea Associates
146.	Life sciences Consultants
147.	Lilly
148.	Lime
149.	Lohia Corp
150.	Lummus Technology
151.	Markets & Markets
152.	Mashreq Bank
153.	Mathworks
154.	Matter Motor Works
155.	Mavenir
156.	Maxlinear
157.	Maybank
158.	Mckinsey
159.	Media.net
160.	Mediatek
161.	Medibuddy
162.	Merilytics
163.	Mewt
164.	Microchip
165.	Micron
166.	Microsoft
167.	Mindgate
168.	Mondelez
169.	Morgan Stanley
170.	Moveworks
171.	Mudrex
172.	MyHQ
173.	NAMO
174.	Navi
175.	Netapp
176.	Nirman
177.	Nirsan connect
178.	NoBroker
179.	Nomura
180.	Nutanix
181.	Nvidia
182.	NXP
183.	Nykaa
184.	OfBusiness
185.	Online Sales
186.	Palo Alto Networks
187.	Payu
188.	Pernod Ricard

S.No.	Name of the Company
189.	Petasense
190.	Pfizer
191.	Pharmaace Analytics
192.	Philip Capital
193.	PhonePe
194.	Pienza
195.	Piramal Group
196.	Porter
197.	Proclink
198.	Protean Tecs
199.	Publicis Sapient
200.	PWC
201.	Q3 Tech
202.	Qualcomm
203.	Qure.ai
204.	RetainIQ
205.	Rodic
206.	Rupify
207.	Saas Lab
208.	Salesforce
209.	Samsung Delhi
210.	Samsung R&D Bangalore (SRI-B),
211.	Samsung SSR
212.	Sandvine
213.	SAP Labs
214.	Schlumberger
215.	Searce
216.	Secureworks
217.	Sedemac
218.	Shipsy
219.	Sigmoid
220.	Silicon Labs
221.	SmartCube
222.	SocGen
223.	Society Generale
224.	Solutionec
225.	Spectrum
226.	Spiralyze LLC
227.	Sprinklr
228.	SRF
229.	Standard Chartered Bank
230.	Steradian Semi
231.	Suki
232.	Sundial Systems Pvt. Ltd.
233.	Synchrony
234.	Syneos Health
235.	Systra
236.	Tally Solutions

S.No.	Name of the Company
237.	Tata AIG
238.	Tata Communications
239.	Tata Motors
240.	Tata Power
241.	Tata Technologies
242.	Telus International
243.	Teradata
244.	Texas Instruments
245.	Thornton Tomasetti
246.	Transorg Analytics
247.	Trilogy Innovations
248.	Trinity Life Sciences
249.	Truminds Software Systems
250.	Tvarit
251.	Uber
252.	UBS
253.	Udaan
254.	Ugrow Capital
255.	urban Health
256.	Urban Ladder
257.	Vantage Research
258.	VECV
259.	Vedanta
260.	Veritas
261.	Viacom
262.	Visa
263.	Vodafone Idea
264.	VVF Ltd.
265.	Walmart
266.	WCB Robotics
267.	Wells Fargo
268.	Western Digital Corp
269.	Whatfix
270.	Winzo Games
271.	WNS
272.	Wooqer
273.	Yokohama
274.	Yubi
275.	Yugabyte
276.	Yulu
277.	Zenon
278.	Zeptonow
279.	ZoomRx
280.	Zydus

Alumni Relations Division

BITS Alumni (called as BITSians) are spread across the globe. The BITSians have done their alma mater proud by taking top position in every sphere of life – corporate, entrepreneurship, academia, civil services, literature, performing arts, defense, social services and so on. Congratulations on becoming the newest member of this ever growing family of highly accomplished individuals.

The BITS Alumni Association (BITSAA) at Pilani was functioning from 1989 as a nodal agency for maintaining liaison with Alumni all over the world and to involve them with the development of the institute. A new division, Alumni Affairs (BITSAA) Division, was created in 2010 to give distinct thrust to the activities related to Alumni and to connect and engage students, alumni, friends and well-wishers for a long-term relationship with BITS Pilani. It focused on development of alumni support to the continuing development of the Institute's academic, research, and off-campus programs, expansion and renewal of its facilities, and providing scholarships and financial aid to students through annual fundraising campaigns.

To manage and provide alumni a single window interface to their alma mater, Alumni Relations Division was formed in 2017. The key objective of the division is to connect and engage with alumni on a range of programs. The division organizes many such programs such as reunions, research talks, lectures, webinars, amongst other on-campus events. The alumni are also offered teaching engagement in the form of adjunct / visiting professorships and can avail of sabbatical scheme to teach a semester at BITS campuses.

The role of Alumni Relations Division includes the following:

- Constantly connect with alumni, and conceptualize, develop and organize various alumni led initiatives.
- Plan, implement and promote alumni programs that support the BITS Pilani strategic initiatives.
- Establish and build relationships with local, regional, national and international alumni chapters.

- Maintain regular communication with alumni.
- Educate graduating students about alumni benefits and engage them in various programs.
- Partner with various offices of the institute to spearhead the introduction of alumni involvement in the growth and continued leadership of the University.
- Seek alumni involvement for placements of graduating students and for promotion of entrepreneurship amongst students.

The division also makes it convenient to help alumni contribute funds towards advancement of their beloved institution. Some of the key areas in which the alumni have contributed are Scholarships. Student and Faculty Awards, Chair Professorship, Research Labs, Sports Infrastructure etc. The division is also responsible for raising funds through the Corporate Social Responsibility (CSR) for institutional development activities.

Student Alumni Relations Cell (SARC), a student-led body is formed at each campus that furthers the aims of enhancing and improving our connect and engagement with the alumni.

BITSAA - International

BITSAA International is a global association formed and managed by BITS Alumni. BITSAA operates through city-based chapters in India and abroad with its headquarter in New Jersey, USA. BITSAA undertakes a number of events, such as BITSian Day (celebrated every first Friday of August), get together events, and welfare programs for alumni in distress. The Alumni Relations Division works in close coordination with BITSAA for its objectives.

For more details on the activities of the division, please visit bits-pilani.ac.in/alumni.

Alumni Lifetime Membership Fee

All graduating students automatically become Alumni Member and a Lifetime membership fee of Rs 2000 is charged across three Indian campuses and AED 100 at the Dubai Campus.

CENTRAL FACILITIES

Central Library

The BITS Pilani library is housed in a state-of-the-art new building, covering about 65000 sq.ft area and is located close to all academic blocks of the Institute. Built-in about 2.5 acres of land in the north-East corner of the campus, the library indeed is an architectural marvel with attractive palatial interiors high ceilings adequate natural lighting, and ventilation with several series of courtyards, with each used for different activities. Inside the library, there is a layout of natural green plants that are soothing for the eyes a seating capacity for 950 students. Two vaults in the main atrium have a theme-based painting on "Guru Shishya parampara". with minute derails and mirror work. The big 8M dis-exposed brick arch becomes the gateway to the main entrance. Small green areas with nicely designed floor pattern and overlooking Jharokas makes one feel as if they are in a big lobby of an old palace. The thick walls and high ceilings keep the actual interiors of the library as cool as possible. In fact, the whole building is divided into two equal parts by a series of courtyards around which all the other areas of the library are placed. The skylights are devised to bring in the maximum amount of natural light throughout the day - ensuring adequate light for the reading areas even when the power goes off during the day. Lofty ceiling - 32 feet high - in the courtyard areas reduce the heat transfer to the ground. All the outer walls are constructed as cavity walls with deep-set windows to reduce the temperature indoors. The most impressive part of the library is the dome in the center of the building - seven meters in diameter. in echo to the historic ambiance of Rajasthan with expensive work in Dholpur stone, by creating stone jali railing, arches, and column cladding. The ambience of the central court was to make one feel as if one was inside some palace and the softness of the light and the greenery enhance this feel. It also has a floral pattern in the flooring by using white and green marble along with Jaisalmer stone. The space is attractively designed so that the students and staff can relax with garden benches and subtle lighting and can enjoy the cool of the night. While the touches of are

Rajasthani style are reflected throughout the interiors, in the stonework, jharokhas and painting, practicalities have also been carefully thought out. The administration services, cloakrooms, Information Counter, E-Zones, and staircase to the first floor are all conveniently accessed from the atrium. The library has well-lit reading halls, stacks, display areas, e-library zones, audio-visual library, and study carrels. There are a couple of air-conditioned reading halls. BITS Pilani Library aims to support the teaching, learning, scholarship and research activities of the institute using the state-of-the-art library and information services. Its mission is to achieve excellence and professionalism in library services and help its users to achieve their goals by providing innovative world-class information services. The library is equipped with unique facilities like, Group discussion rooms, brainstorming room, ideation and innovation zone, interview carrels, ResearchZone for research scholars and faculty members, MakerSpace for designing, and other IOT borrowing facilities. In the year 2021, a unique space has been developed in the library known as “Birla Heritage Gallery” which is one of the best photo gallery presents the historical journey of BITS Pilani from Pathashala to the present Institute of Eminence (IoE).

The library provides a vibrant ambiance to the students, faculties, staff, alumni, and other users for study, research, and access to library resources. The efficient and courteous staff backs the services of the library. It holds a vast collection of a hybrid collection of books, rare books, the back volume of journals, monographs, standards, reports, thesis/ dissertations, and current journals/magazines, etc., in the varied areas of engineering, sciences, technology, humanities, and social sciences both in print and electronic format. The library has a collection of over 2.5 Lakhs books, manuscripts, a good collection of rare books with bound volumes of journals since the 1920s. The library has developed a strong collection of Career Resources that help students to prepare for interviews in various industry sectors and appear in various competitive examinations and campus recruitments. In 2021, the library has opened a new section for competitive examination materials which is stocked with the latest collection of materials for various examinations like GATE, SAT, NET, IAS, UPSC, etc. The library subscribes to over 100+ printed National and International journals. The library continues to provide access to 49 research databases, 11000+ subscribed access to e-journals, and 2.38 Lakhs ebook titles and has added over 2000 print books, 200+ awarded theses in 2023. All the library collections can be accessed from anywhere at any time through the OpenAthens Remote access platform implemented with the help of INFLIBNET eSS team.

The library functions are automated using Koha Integrated Library Management System and it is RFID technology complaints along with Self issue/return/reissue KIOSK. The library has developed an institutional digital repository using DSpace software for archiving Thesis, dissertations, digitized rare books, Sri G. D. Birla’s personal collection, and institutional knowledge assets and faculty publications.

In September 2021, a Patron traffic counter for monitoring the physical footfall of the library has been installed at the entrance for monitoring the record of the physical footfall of library patrons.

In 2017 BITS Library has implemented Google-like single-window search facility named as “OneSearch” for the entire collection both print and electronic using Web-scale discovery services from anywhere anytime. This saves the time of users as they need not go to various links. One Search is an online discovery tool that “pulls together” BITS Pilani Library resources so that they can be explored using a single search box. In other words, instead of searching individually the different resources such as WebOPAC, databases, E-books, Institutional Repository users can use One Search and get the most relevant results.

Also, BITS is using OpenAthens SSO, which is among the most widely deployed identity management software in the world for providing access to subscribed e-resources to authorized users from outside the campus. This has helped the library to provide access to all the subscribed digital content to all the users to

access from anywhere. Since March 2022, library is providing online access to ebooks and e-resources to over 32000 WILP registered students and 6000+ regular students, PhD scholars and faculty members.

BITS Pilani library has recently upgraded the interactive Library portal in 2022. This is one of the dynamic library portal known as “infoBITS” connects with users and makes library services more relevant, visible and helps in quickly meeting the teaching and learning needs as well as for marketing and promotion of library services. The objective is to build a relationship with users, get them engaged with the library to recommend, share, suggest, complain, compliment, and give feedback in addition to using online resources and services so that it becomes a one stop shop for their information needs. At the same time, it is intended to provide opportunities for library staff, faculty members, and students to interact with each other and to put the resources and services to active use and also make it as a marketing and promotional tool.

InfoBITS mobile library apps play vital roles in providing the mobile services of the library which not only integrate the library’s basic functions comprehensively but also demonstrate the features of mobile communication technology, such as QR code scanning. Now Mobile Apps have been regarded as an important tool for libraries to promote and enhance both resources and services of the library. In this respect, libraries can not only satisfy users’ personalized information demands but also make them carry the library in their pockets. Library has also launched EBSCO Mobile App for getting access to all e-resources from anywhere at any time using a smart phone.

The library also renders user services like reference, consultation, document delivery services, book lending, arranging materials. from other libraries through inter-library loan, and organizing the user-awareness programs to enhance their awareness about library resources, services, and activities. The library allows users to self-checkout books as well as renew borrowed books online. It facilitates inter-library-loan facilities of books and other informational documents for its members as and when required. It handled over 32000 circulation transactions of books and other documents for its members and 8.23 Lakhs of online access during the year. During the lockdown, the library remained open, mostly to safeguard the library’s collection and technology and for providing uninterrupted online service to the user community. Also, during the lockdown period with the help of publishers millions of resources were made available to the students to support them.

Services of the Library

1. Reference Service
2. Current Awareness Service
3. Circulation
4. Online Public Access Catalogue
5. Photocopying
6. Inter-Library Loan
7. Plagiarism checking
8. Reference Management
9. Document Delivery Service

The library has the institutional membership of three national-level organisations:

eShodhSindhu Consortium - The library is part of eShodhSindhu Consortium, a national level consortium of higher educational institutions affiliated with University Grants Commissions.

DELNET, New Delhi - The library has an institutional membership of Developing Library Network (DELNET). In addition to other services, it facilitates the interlibrary document delivery service amongst its institutional library members.

ShodhGanga - ShodhGanga a national level initiative of Information Library Network (INFLIBNET), Ahmedabad offers centralized online theses hosting facilities to higher education institutions of India. Education institutions can deposit a copy of PhD theses produced in these institutions in ShodhGanga to showcase and enhance the visibility of their respective research activities.

In December 2022, a MOU has been signed between INFLIBNET and BITS Pilani for participating a Research Life Cycle Management System called Shodh-Chakra.

In 2021, the BITS Pilani Library in collaboration with INFLIBNET (An Inter-University Centre of University Grants Commission) has developed IRINS (Indian Research Information Network System) which is web-based Research Information Management (RIM) system. The IRINS portal is serving as a premier database of research profiles of scientists/researchers and faculty members working in our institutions.

Central Workshop

The Central Workshop of the Institute has shifted to the 2600 sqm new building. The new workshop; in addition to imparting training to the students and catering to the maintenance and research needs of the Institute; is also designed for the 'design to test' concept. When fully functional, any student having an idea can design, prototype and test the part/product in the workshop. CNC machining, Reconfigurable Mini CNC machining, Foundry, Forming, Welding, Carpentry, Advanced Metrology, Learning Factory, Sustainable Manufacturing & Life Cycle Engineering are fully functional. Major equipment added during the year are: coordinate measuring machine (CMM), contour measuring system, vision measuring system, surface roundness tester, profile projector, microscope, micro hardness tester, 4 CNC turning and milling centres, 63 tonne power press, power tools, TIG & MIG welding and dynamometer. The workshop is equipped with state of the art metrology lab and dustless carpentry shop. Students' training consists of training all integrated first degree students through the course 'Workshop Practice' by imparting skills in various manufacturing processes. In addition, students are imparted training for other courses like 'Production Techniques', 'Metal Forming and Machining', 'Casting and Welding', 'Computer Aided Manufacturing', and 'Flexible Manufacturing Systems'. Apart from routine maintenance, fabrication and training, the workshop also accepts jobs on precision fabrication of project work of students, staff and research scholars.

Instrumentation

The instrumentation unit undertakes regular and annual maintenance of laboratory instruments across the Institute. Instrumentation provides an LCD projection facility for regular class-work in classrooms, workshops, conferences, symposiums, and other academic and cultural activities across the institute and also performs preventive maintenance for these projectors. The instrumentation unit facilitates all the institute programs with high-quality public address systems, digital mixers, loudspeakers, and Lighting equipment to make the events more effective and lively. The instrumentation unit also takes care of digital TV installation and recharges in all the hostel's common rooms.

All classes have been equipped with a projection and microphone facility supported by UPS. Unit has procured some state of art instruments like Kramer switch, multiplayer, Logitech presentation remote, 4 Unit x LED par 64 LED stage par cans light, 36x3W RGB DMX RGB Infinite color mixing with Control mode: Work Auto, Sound Active, Master/Slave, DMX512, LED control panel, Irradiant SRC-146 Lighting Controller, 24 Channel Lighting Controller and also providing Videography using Panasonic memory card camera-recorder.

The instrumentation unit also provides mobile and a cellular connection to faculty and staff members. The instrumentation unit also provides an announcement system in MB Hostel and periodic bell system for classrooms and offices in the institute.

Reprography Services

The Reprography Section takes care of all the in-house printing, binding, and photocopying work (e.g. printing of institute bulletin, annual report, various information brochures, time table, academic regulation, answer booklets and project reports for submission to various Government and other funding agencies). The printing and binding sections have been fully equipped with facilities like off-set B/W printing, heavy-duty photocopier machines, cutting, laminating, stitching, spiral binding, etc. Reprography

has a separate question paper printing/copying facility where the scripts related to assignments, tutorials, quizzes, test and comprehensive examination for all courses offered in on-campus or off-campus programs are printed.

Apart from Institute work, the reprography section also caters to the printing and publishing needs of staff and students. Services like photocopying of journal articles, laser printing, binding and lamination of project reports are available. Reprography also supports printing requirements of various student activities like OASIS, APOGEE, BOSM and other activities undertaken by various clubs and associations. The printing and publication requirement of conferences and workshops organized in the Institute is also supported by the reprography.

The following facilities are available for the benefit of students and staff members.

1. Dispatch facility: All the Institute dispatch requirements are catered through reprography either through ordinary/ speed post facility available at the VidyaVihar Post Office, Pilani or through private courier and cargo carriers for both domestic and international destinations as per needs.
2. Photocopying and allied facilities: Photocopying, printing, word processing, binding and laminating facilities are available for students and staff on chargeable basis at the Reprography section. Photocopying service is also available at the BITS Library.
3. Photography facility: Nikon Camera and Flashlight (Set 1: D7000 & SPEEDLIGHT SB-910; Set 2: D7500 & SPEEDLIGHT SB-5000), Umbrella Light (Problitz 300D), Tripod (Manfrotto, 498RC2) and Photo editing

Document Designing: Notification poster and advertisements of BITSAT, ME & Ph.D. admissions, faculty recruitment; Cover page designing of Annual report, Bulletin, Research at BITS, BITScan, BITS in the News, News in Alumni, etc.; Greeting card designing; Digital advertisement preparation, All the above-mentioned designing as per BITS Brand guidelines using Adobe creative cloud software.

Computing Facilities

Information Processing Centre (IPC) provides computing facility for students and staff of the Institute. The Centre is responsible for planning, need forecasting and maintenance of computing resources across the Institute. The Centre has signed campus agreement with Microsoft and MATLAB for licensing their product & tools.

With a view to upgrade the computing resources, across the Institute, 50 desktop machines, 180 Laptops, 05 servers, network equipment and a few printers & peripherals were purchased. During the year, Centre has been involved in setting up of Wi-Fi based 800 node network in girls and boys hostel, implementation of identity based access control, deployment of biometric attendance systems, and implementation of second phase of campus wide surveillance system using more than 120 CCTV cameras. The Centre has also successfully completed the deployment of 250 port Giga bit network for faculty housing.

The Centre is responsible for maintaining and upgrading the campus wide 5000 data port wired and Wi-Fi network. With the augmentation of existing facilities, the Centre has been able to support the conduct of online examinations, structured and unstructured labs for more than 30 courses offered by Computer Science and other departments. The Centre has also been involved in supporting the number of workshops and training programmes conducted in the Institute. The IPC is open on all days throughout the academic session from 08:00 A.M. to midnight and it is closed only for 3 days in every semester. The details of existing facilities in the IPC are given below.

IPC has setup a centralized Data backup solution to backup the server data across the institute.

The Center also offers number of high-end computer servers to its users currently it has 16 node HPC cluster, 5 GPU servers with Nvidia

tesla cards, and 15 numbers of Intel based SMP servers. These servers offer, variety of operating systems and development tools to the faculty and students. In addition to the servers, the center has 7 labs equipped with 350 latest desktop machines. These systems operate under Linux and Windows environment and support variety of compilers database and software tools such as C, C++, Java, and Microsoft Visual tools, MATLAB, and Rational Rose etc. The central computing facility specifically takes care of the bulk computing needs of under graduate, masters and Ph.D students.

The BITS Intranet

IntraBITS is a collaboration-category intranet portal deployed and supported by the Software Development and Educational Technology Unit (through its Centre for Software Development) since 1999. Its principal objective has been to enable the faculty and students to leverage appropriate software technologies in the On-Campus educational (teaching, learning, sharing) process. The followings are some of the highlights of the BITS Intranet. This portal has gradually expanded to multiple independent sites linked to it.

- An On-line Learning Management System (Nalanda) built in 2010, atop LAMP and Moodle platforms provides a complementary globally accessible service that aims to serve the entire community, both students and faculty members.
- An online IPC Complaint Management System that provides facility for registering network connectivity related queries of the campus community.
- BITS Notice Board has been deployed where all BITS Notices can be seen at one place by all faculty, staff and students.

The BITS Intranet is serving as a vibrant medium for exchange of academic and other ideas among students and faculty.

Campus-wide Computer Network

The campus hosts a state-of-the-art, completely switched, voice-enabled local area network. The network has more than 5000 wired data ports and provides connectivity to Instructional/ Administrative buildings, Hostels, Guest House, Library and Staff residences. More than 800 access points have been deployed across campus to support wi-fi based connectivity. The campus backbone is a 10Gbps fiber optic cable on a dual ring configuration. The external (Internet) connectivity is supported through 3 Gbps of leased line. The network support team maintains the network facility and resolves the issues through online portal.

CENTRES OF RESEARCH AND DEVELOPMENT

The Institute has established the following centres of Research and Development:

Software Development and Educational Technology

The Software Development & Educational Technology Unit (SDET Unit) incorporates the Centre for Software Development (CSD) as well as the Centre for Educational Technology (CET). The Unit has the mandate to include identification, establishment, deployment, and evolution of appropriate educational technology to support effective resource utilization of expertise (teaching/mentoring/collaboration) available at various campuses (both existing and upcoming) as well as enable students and faculty involved in various off-campus work-integrated learning programs of the Institute. Research, development, and consultancy in those areas of computing with expertise and interest amongst its nucleus members remain the other important areas of the work for the SDET Unit.

The SDET Unit has four specific sets of activities handled by its two wings: CSD and CET. These wings focus on multimedia, E-learning, web services, and live and stored video streaming as current thrust areas. Its CET wing has its mandate to identify suitable educational technology solutions for on and off-campus operations of the Institute and help in their deployment.

The SDET Unit is involved in the Open-source Moodle Learning Management System (LMS) deployment for the requirements of the Institute in the form of the Nalanda portal. Recently, this

portal has been upgraded and deployed over the cloud for better scalability and performance. For quite some time now, it has added the live interactive (bi-directional audio/video/text-based) classroom feature to value add its on-campus student population.

The SDET Unit has played the leading role in designing and establishing a University-wide, Integrated, immersive Telepresence (TP) Infrastructure with seamless support for high-quality eye-to-eye contact-based video conferencing. The TP facility enables meetings between people present in four telepresence rooms across campuses of the Institute and integrated multi-campus interactive lecture delivery and recording support. Apart from this, SDET facilitates the other video /audio conferencing requirement of the Institute for academic and non-academic purposes.

The SDET Unit is the official enabler for the BITS-BITSAA joint venture, Project Embryo. It is aimed at joint efforts by current students, alums, and faculty to deliver live lectures by specialist alums and joint collaborative research guidance by alums and faculty to on-campus students.

Centre for Education Technology (CET)

The Centre for Education Technology (CET) is responsible for identifying and deploying the new and upcoming technology to support instruction delivery. The centre manages the Telepresence facility based classroom which is used for running inter campus courses. It is involved in the Open-source Moodle LMS based *deployment for requirements of the Institute* in the form of the *Nalanda portal* on a regular basis. The centre also provides technical support for managing class room lecture recording system, deployed in four classrooms of Lecture Theater Complex (LTC). It is involved in the research, development and deployment specific to the next-generation Education Technology solutions.

Central Animal Facility (Pharmacy)

Central Animal Facility at BITS Pilani, Pilani campus is a CPCSEA approved facility with a total floor area of 5330 sq. ft. The facility is also approved for in-house breeding of small animals. The facility maintains the animal species like Rats, Mice, Guinea Pigs, Rabbits, and Hamsters. It was build up in accordance with guidelines issued by CPCSEA and other regulatory bodies. It is also equipped with an incinerator (electrically operated) facility for the disposal of biological and other biomedical waste. The air-conditioned facility is maintained by well-trained personnel, with a full-time veterinarian to take care of the various requirements of the animals. Central Animal Facility caters to the needs of the various research departments like Pharmacy, Biological Sciences, and Chemistry, etc. The facility also incorporates Pharmacokinetics,Pharmacodynamics, and Pharmacology research laboratory for carrying out advanced research in the areas of pre-clinical pharmacokinetics, bioavailability studies, pharmacological screening of various synthetic/natural origin drugs. The laboratory has sophisticated instruments such as two chambers automated organ bath, laser doppler, noninvasive blood pressure recorder, semi-dry transfer apparatus, microtome, RT-PCR, electroconvulsiometer, actophotometer, analgesiometer, light-dark apparatus, rotarod, etc. Equipment such as surgical anesthesia machine, electrical cautery, deep freezers (-20 and -80°C) and spare air-conditioners are also utilized. The laboratory is upgraded with a video documentation system for various animal behavioral studies and Individual Ventilated Cages (IVCs). The facility is geared to take up various industrial or governmental funded projects in various pre-clinical areas. Recently Air Handling Units and Large Scale Autoclave have been installed.

Centre For Innovation, Incubation and Entrepreneurship (CIIE), Center For Entrepreneurial Leadership (CEL)

CIIE Portion for BITS Pilani Bulletin 2023-24

Activities and Initiatives launched by CIIE since January 2023:

1. **How to Start a Startup – A workshop jointly organized with Sleepwell Foundation and MacLead Certifications (Jan 20-22, 2023):** A three-day Workshop module for youths aspiring to start own

business. The objective of this workshop is to provide a comprehensive knowledge to start up a business and to run it successfully. Workshop witnessed presence of 50 participant's and graced by the expert speakers from Maclead Education.

2. **BIRAC Sensitization Workshop (February 8, 2023)**: a one-day workshop on **"Bio entrepreneurship and Intellectual Property & Technology Management in Life Sciences"** for Faculty, Research Scientists and Research Scholars in Biological sciences and those who are working at an interface of biological science/ Pharmacy and other disciplines. Workshop witnessed expert speaker's from BIRAC, Govt of India and a participation of 50 faculty and student members of BITS Pilani.

3. **Mantra Awards 21-22: The Center for Entrepreneurial Leadership (CEL)**, in association with **BITSAA International**, is proudly appreciated the Mantra Awardees for the year 2021-22. Through these awards, CEL seeks to recognize and celebrate students' achievements in the fields of Leadership, Innovation, Social Leadership, and Entrepreneurship.

4. **Why you are never too young to start up (March 2, 2023):** Hosted – Entrepreneur First on the Pilani campus, an amazing opportunity for the students, entrepreneurship enthusiasts and budding entrepreneurs to network with startup founders and India's top talent investors. The fireside chat session witnessed Matt Clifford, CEO & Co- Founder – Entrepreneur First, Rahul Samat, Partner and Head- Entrepreneur First India and cheered BITS Alumni - Rathin Shah, CEO-Spenny.

5. **Conquest 2023 Launch Program: The India Portfolio Summit 23, (April 17, 2023):** the second edition of The India Portfolio Summit by Conquest. The summit received incredible response for its inaugural edition in 2022, where we covered the history of the startup ecosystem through the eyes of founders such as **Aadit Palicha (Co-founder, Zepto), Harsh Jain (Co-founder, Groww), Sumit Maniyar (Founder, Rupeek), Vibhor Jain (President, ONDC) etc**.

   This year, we seek to pick up where we left off, turning our attention to the possibilities that India's rapid innovation brings for our future, with technologies like the 'Indian Stack' revolutionizing the Indian Startup Ecosystem. With massive increases in India's public infrastructure, and groundbreaking innovation across sectors like Web3, AI, FinTech, and FMCG, India has seen massive innovation, leading to the ecosystem growing at a breakneck pace. Now, we see this leading to radical changes on a timescale shorter than 'India 2050', forming our grand narrative for **The India Portfolio 2023 - 'Blitzscaling India'**. The India Portfolio 2023 aims to cover the limitless possibilities of the Indian startup ecosystem in the next decade, through the eyes of founders such as **Amit Jain (Co-founder, CarDekho and Shark on Shark Tank India), Divya Gokulnath (Co-founder, BYJU's), Naiyya Saggi (Co-founder, Good Glamm Group), Sandeep Aggarwal (Founder, Droom and Shopclues) etc.**

6. **The Conquest Communiqué:** dreaming of being a part of the next big thing in the startup world? Are you curious about the latest innovations and technologies driving the entrepreneurial ecosystem in India? CEL's flagship startup accelerator, Conquest proudly launched its newest initiative, The Conquest Communiqué. Our weekly newsletter is dedicated to all things related to the Indian startup ecosystem. It is packed with top-quality analyses, thought-provoking articles, and the latest industry news and trends to help you navigate the complexities of entrepreneurship with ease. And the best part? It's delivered straight to your inbox every Sunday free!

7. **World Intellectual Property Day (April 26, 2023):** A one day celebration event to appreciate the value of intellectual property

rights and its role in protection of innovation and innovators original work. The workshop was graced by notable IP experts, **Ms. Maninder K Maniktala, Founder of Guarding Genius** and **Ms. Bhawna Sharma, Founder & Head IP Practice, Lexradar,** who shared a detailed overview of IPR's and how it can benefit academic researchers in their research domains. The workshop witnessed a participation of 50 members.

8. **Workshop on Design Thinking with Mr. Vineet Raj Kapoor (April 29, 2023):** A one day workshop focused to inculcate practises and approach of design thinking in students to benefit them in their innovation and entrepreneurial endeavours. The workshop witnessed a presence of 35 student members and graced by **Mr. Vineet Raj Kapoor, Founder and Director of SXILL and Chandigarh Design School.**

9. **AMA session with Phanindra Sama & Richa Bajpai | CEL x Campus Funds: (April 29, 2023):** A session with cheered **BITS Alumni Phanindra Sama**, **Founder, RedBus** and **Richa Bajpai, Co-Founder Goodera and Head, Campus Funds.** Enthusiastic budding entrepreneurs cheered the opportunity to learn from the experience of their startup journey and an interaction to clear their doubts in their own endeavors.

Teaching Learning Centre (TLC)

The Institute has set up Teaching Learning Centre (TLC). It will be involved in improving the overall teaching - learning environment at BITS Pilani and headed by a Professor-in-charge, who will be supported by Faculty-in-charges from all the four campuses of BITS Pilani. There will be a few nucleus members in each campus to support the Faculty-in-charge. The Centre will carry out research on innovative teaching pedagogy, collection of good practices of teaching learning from all over the world and disseminate among the faculty, conduct intensive teaching workshops and invite experts from India and abroad to deliver lectures on relevant topics.

According to the notification issued by the Office of the Registrar of the Birla Institute of Technology and Science, Pilani dated 10 June 2015 (Ref. No. N/3), the Teaching-Learning Centre (hereinafter referred to by the acronym TLC) "will be involved in improving the overall teaching-learning environment at BITS Pilani".

The TLC is mandated with the specific tasks of

- collecting the best teaching-learning practices from around the world towards disseminating these amongst the teaching-learning community at BITS Pilani
- conducting teaching-learning workshops
- enhancing scholarship on the teaching-learning processes

Centre for Robotics and Intelligent Systems

The objective of the Centre for Robotics and Intelligent Systems (CRIS) is to develop prototypes that provide greater intelligence and higher versatility for robotic tasks under ever-changing constraints of the environment. This objective is set forth to make Indian industry competitive by developing indigenous technical skills, manpower and innovative spirit. Each prototype is developed in four different stages viz. (i) Conceptualization, (ii) Algorithmic development and verification in simulated environment, (iii) Real-time testing and (iv) Integration of automated system. The Centre is well equipped with excellent computational facilities; advanced software packages for circuit design, image processing and mechanical design; micro controller and DSP based driver card for real-time experimentation; experimental bed, CRS-Plus robot manipulator, 4-DOF SCARA manipulator, 6-DOF ABB-1410 Industrial Robot, Allen Bradley PLC Micro Logix 1500, PLC based Hydraulic and Pneumatic Trainers and many other facilities.

The center is geared to provide research facilities in areas such as intelligent robotics and system design, intelligent control, neural and fuzzy neural based system modeling and control, evolutionary computation, robotic vision and virtual reality. Earlier BITSUMO, which is an autonomous assistant robot, was developed to work in restaurant/ library. In addition to these, an autonomous glider, an autonomous

hovercraft, a 14-DOF robotic arm, an intelligent mechatronics ball, a micro-mouse platform and a micro-mouse testing base were developed at CRIS. The center is engaged with the development of humanoid robots. The first breakthrough is in terms of Acyut-1 and Acyut-2 (humanoid). Acyut-I is a dancing robot and which has won several laurels even at international competitive events (Rob games 2008 held at San Francisco, USA and INDEEN Expo, Germany etc.), Acyut-II is much larger and far more capable. It has far better control and using remote command by way of hand movements etc, it can be moved synchronously. These models were demonstrated for their capabilities at Korea, USA, Germany and Japan. The students are currently working on further developments related to Acyut-2 robot with added features Acyut-III had participated in FIRA-2010, Bangalore and created a world record in weight lifting (2.4Kg.) in year 2010.

In same year a mobile Robot (named SHAURYA) participated in Annual student contest organized by DRDO, India and received recognition. Team Acyut have showcased their technologies at in the Tech fest of BITS Pilani Dubai campus and IIT Kanpur, Robotics symposium of RDE Pune (DRDO) and Tech test of NIT Calicut. For their effort the team has been appreciated by scientists of BARC Mumbai and DIT New Delhi. Acyut-IV had been invited to participate in ROBOCUP-2013. AcYut was redesigned completely and a novel system of parallel links is introduced. It stood 2nd in Robocup Iran Open 2013 and stood 4th in Robocup Netherlands 2013. Based on the progress in the area of humanoid robotics, Department of Information Technology (DIT) sponsored a project worth 45 Lacs in year 2013-2015, to develop a humanoid which is capable of stable walking and navigate in a structured environment.

The team has continually improved the software for the robot to incorporate artificial intelligence and computer vision. Acyut V can now play autonomous soccer against another robot and score goals. In February 2015 team AcYut demonstrated humanoid walking and image processing technology in HiSens Workshop at IIT Delhi. In July 2015 the team participated in RoboCup China in Teen Size humanoid league. Continuing the good work the team developed software modules with better algorithms for cognition. Other improvements include up gradation of the camera sensor to new Fish Eye lenses and implementation of feedback system for more stable gait. Team AcYut, BITS Pilani's humanoid robotics team, participated in the RoboCup 2017 held at Nagoya, Japan. Team AcYut had been the only participant from India. They participated in the Humanoid Soccer League and the Humanoid Soccer Drop-in league, where they finished fifth and third, respectively, out of a total of 8 teams.

In March 2018, a student team developed Buddy Bot for DRDO competition and became west zone topper. The team participated in the National Level finals competition and won a prize worth Rs. 60,000. Currently the same team is in the process of developing a driverless car with the developed technology and have achieved the autonomy level II so far and working for autonomy level III. The student team is known as Sally Robotics and has been engaged in research based innovations in the above area. The team aims to develop an AI model based on the spatial cognitive abilities of the Indian driver, which can make vehicles demonstrate autonomous capabilities on highly unstructured Indian roads.

The research at CRIS involves all aspects of creating and controlling robots such as Mechanical design, Dynamics, Perception, Vision, Navigation, Control and Decision making. Current faculty research includes projects in the areas of Humanoid, Autonomous Car, and use of computer vision, motion planning and control, Machine learning Algorithms.

Embedded Controller Application Centre

This Centre was set up in Collaboration with Motorola India Ltd. The objective of the Centre is to impart detailed understanding of important features of embedded controller architectures and familiarization of advanced concepts in the field of embedded controllers through students projects/Industrial projects, Imparting training to the industry professionals and running short

term courses in the field of Embedded System design, developing course modules. The infrastructure of the Centre includes High quality computing facilities, Microcontroller Modular Evaluation Systems, Microcontroller Development Systems, Emulators, Assemblers and Cross compilers for various microcontroller families (ARM, ATMEL, Microchip, Cypress, ST Microelectronics, etc.) DSP processors, logic analyzer and other bench equipments. We have received hardware and software license support under the ARM University program and Texas Instruments University Collaboration.

Centre for Renewable Energy and Environment Development (CREED)

CREED is an interdisciplinary Centre that co-ordinates educational and research activities in the active areas of renewable energy and environment. The objectives of the Centre are (i) to conceive, develop and implement renewable energy applications and environment protection projects, (ii) to develop courses and organize awareness programmes, and (iii) to collaborate with external organizations in the areas of renewable energy education, training and technology development. Some of the existing facilities at CREED include an experimental set up for solar water heating, solar air-heating system, solar stills, and solar photovoltaic power pack with storage battery bank, SPV lighting systems, fluidized bed combustor with gasifier and various instruments related to energy audit and solar resource assessment.

Currently, active research areas of CREED include concentrated solar power and photovoltaic power based policy analysis, emissions and environmental impact of thermal power plants, planning and economics of renewable energy systems, real time operation and control of renewable systems, industrial cogeneration, integrated renewable systems, demand side management, clean development management integrated resource planning, CO_2 based refrigeration, biomass based fluidized bed combustion, biomass pyrolysis etc. The faculty members and research scholars of the center have also visited University of South Florida, USA and TU Braunschweig, Germany for the research purpose under institute's schemes.

The Renewable Energy Club is an exclusively a student managed body that operates under CREED. The Club has undertaken active work in organizing competitions, quizzes, carbon footprint analysis and carbon credits. Commercial organizations in these areas have evolved out of this club, and are currently owned and operated by BITS alumni.

Centre for Biotechnology (Department of Biological Sciences)

The Centre has in-house facilities of Genetic Engineering and Recombinant-DNA Technology. The objectives of the Centre are to take up research and development projects from various sponsoring organizations, establishments of University-Industry linkage through various R&D contract projects and conduct periodic Workshops and hands on training for faculty members, industry personnel and students in the area of advanced molecular biology/biotechnology and bioinformatics. Some of the key facilities available are Gel Documentation System, PCR Machines, Real Time PCR, Hybridization oven, Gel electrophoresis equipment, UV-Cross linker, HPLC, FPLC, Nanodrop Spectrophotometer, Vacuum concentrator, Temperature Controlled Water Bath Shaker, Refrigerated Centrifuge, Ultracentrifuge, Cell counter, Plant growth chamber, Fluorescent Microscopes, Apotome Microscope, Gene Gun, ICP-OES, Cold Room, Tissue Culture Room, Plant Biotechnology facility, Semi-automated Green House, Victor-3 Multichannel counter, Inverted microscope with camera attachment, –80°C/-20°C Deep Freezers, Biological Safety Cabinets and CO_2/ Humidity Chambers, Cell and Tissue Culture facility. We have Insectory to facilitate research on mosquito-borne diseases, and a *Drosophila* lab for studying human genetic disorders as well. We also have an active bioinformatics lab with advanced computational facility.

Centre for Materials Science and Technology (Mechanical Engineering)

The objective of the Centre for Materials Science and Technology is to develop and implement projects related to modern

materials such as smart materials, biomaterials, fibre-reinforced plastic composites and also related to conventional materials such as metals, ceramics and polymers. The Centre undertakes mechanical and non-destructive testing of various engineering materials and products for evaluating their mechanical properties and for evaluating defects such as cracks, voids, delamination, inclusions etc. Other activities include providing consultancy related to materials aspects and testing/development and analysis in the field of materials science and technology in general. The testing facilities available at the Centre include a conventional Universal Testing Machine of 50 Tons capacity, as well as, a fully computerized microprocessor based Electronic Universal Testing Machine of 100 kN capacity, Heating Chamber for UTM for High Temperature Testing, Hounsfield Tenso-meter, various hardness testing machines such as Brinell, Rockwell, and Vickers Hardness Testers, Rotating Bending Fatigue Testing Machine, Combined Bending and Torsion Fatigue Testing Machine, Strain-gauge testing facility, Izod Impact Testing Machines, Digital impact testing machine, Double disk polisher, Inverted Metallurgy Microscope, Erichsen cupping tester, Circular and plane Polari-scope for photoelastic stress measurement, Single Screw Extruder with Calendering and Pelleti-zation Facilities, Ultrasonic Flaw Detectors, Liquid Penetrant Test kit, Magnetic Crack Detector, Eddy Current Tester, Acoustic Emission Testing equipment, Acoustoultrasonic pocket hand-held AU scanner etc. Wet-lab facility and fume hood for polymer fabrication section. Basic Mechanical fault simulator, Data acquisition system for vibration measurement, Tribometer.

Centre for Desert Development Technologies (CDDT)

Established with the financial support from BITS Alumni, C-DDT functions with the primary objective of developing world-class desert development technologies for making the desert bloom. It has joined hands with the Jacob Blustein Institute for Desert Research (BIDR) of Ben Gurion University, Negev, Israel to work in the area of desert development. The activities of the centre revolve around developing affordable and technically less esoteric technologies and integrating them with the existing practices of the desert areas of Rajasthan for economic upliftment, employment generation and poverty alleviation of the people of Rajasthan. Last four years research has been focused on the energy efficient houses. For the purpose four rooms were constructed with different architectural elements. Last two years three International papers are published in International reputed journals and two reputed International conferences and one Ph.D. scholar has completed her doctorate along with some first-degree projects at centre this year. Last year the solar house was integrated with rain water harvesting scheme and tank was covered, extended roof is fabricated to harness more rainwater and some roof tops were connected. This year ground is cleaned and leveled to apply contour irrigation system. Downward slope is made to flow the water in one direction.

BITS Astronomical Observatory (Physics): BITS Pilani houses an astronomical observatory that is equipped with two telescopes, a 6” refracting telescope, and an 11" Celestron's Schmidt-Cassegrain telescope which is completely computerized. The observatory has recently procured a CCD camera which can be used with the 11" telescope to obtain long-exposure, high quality images, of nebulae and star-clusters. The observatory is maintained by the Physics Department of the institute. A group of 20 students, known as, Astro Club, makes a regular use of the telescopes to observe celestial objects on a fortnightly basis. In addition, the club conducts regular astronomical observation sessions as well as workshops for

general public, i.e. entire BITS community of students and staff, several times during a semester. Moreover, students registered in the elective course on Introduction to Astronomy and Astrophysics, offered by the physics department faculty, also make use of the observatory on a regular basis to augment their understanding of celestial objects.

Pilani Meteorological Observatory (Physics)

The Institute runs and maintains Pilani Meteorological Observatory on behalf of the Meteorological Department of the Government of India. Daily meteorological data regarding the weather at Pilani are recorded and transmitted by the observer, under the supervision of a professor in-charge, appointed by the Institute. The observatory has an automated weather station.

SPECIALISED LABORATORIES

Apart from the Centers described above, the following specialized laboratories have been established with a view to strengthen research and development in the respective areas:

Process Dynamics and Control Laboratory (Chemical Engineering)

Infrastructure includes Universal Process Control Trainer, Multiprocessor Trainer and Computer Control of process variables such as temperature, pressure, level, flow and pH in Chemical Engineering Processes

Environmental Engineering Laboratory (Chemical Engineering)

Infrastructure of this laboratory includes BOD Incubator Shaker, several gas and water pollutant sampling and analysis equipment such as air and water analysis kits, underground water sampling kit, pH meter , conductivity meter, Total Dissolved Solid, Salinity, Dissolved Oxygen meter, BOD incubator, Digital BOD analyzer, Digital COD apparatus, Temperature Controlled Shaker Bath, Laminar Hood Chamber, Orsat Apparatus, Refractometer, AutoClave, Fermenter, Distilled Water Setup, Peristaltic Pump, Compressor, Muffle Furnace, Calony Counter, Electronic Balance, Ion Meter, Fluoride Electrode, Hot Plate, Vertex Mixture, Deep Freezer, Oven, Hot Air Oven, Vacuum Oven, Remi Centrifuge, High Speed Centrifuge, Refrigerator. Data Logging Thermometer, 4-Channel Thermometer, etc.

Petroleum Engineering Laboratory (Chemical Engineering)

Infrastructure of this laboratory includes setups for ASTM Distillation, Flash point and fire point, Cloud point and pour point, Reid vapor pressure, Saybolt viscometer, Copper-strip corrosion, Conradson carbon residue, Redwood viscometer-1 & 2, Engler viscometer, Penetrometer, Bomb calorimeter, Drop point of grease, Melting point apparatus, Smoke point apparatus, Gum content testing apparatus, Oxidation stability tester, Sulfur analyzer etc.

Research (Setup) Laboratory (Chemical Engineering)

Continuous Adsorption Set-up, Biofiltration Column Set-up, Downdraft Biomass Gasifier, Pyrolysis Unit, Reactive Distillation Setup, Air-Lift Bioreactor, CSTR Unit, Fluidized Bed Reactor, Fixed Bed Catalytic Reactor, Re-circulating Fluidized Bed Bench-scale Riser, Loop reactor, Particle Imaging Velocimetry, Flow Sense Camera, Isokinetic Tar sampling Setup, Digital Steam Rotameter, Ventury Scrubber, Sand Bed Filter, Glass Fiber Candle Filter, Fixed Bed Pyrolysis Unit, Fluidized bed Pyrolysis unit, Biomass Coke Stove, etc.

Analytical Laboratory (Chemical Engineering)

UV-VIS Spectrophotometer, pH/Ion Meter, Thermal Gravimetric analyser (TGA), High Performance Liquid Chromatograph (HPLC), Digital Scanning Calorimeter (DSC), Automatic Potentiometric Titrator with KF Attachment, Atomic Absorption Spectrophotometer (AAS), Gas Chromatograph (GC), Fourier Transform Infrared Spectrometer (FTIR), Flue Gas Analyser, Surface Area Analyser, Dynamic Foam Analyser, Multi Syringe Pump,Volumetric Analyser (VA), Cooling Micro Centrifuge, Rota Vapour, Digital Viscometer, Ultrasonic Cleaner, Auto Vacuum Desiccators, Ultrasonic Liquid Processor, HPLC Pump, Freeze Dryer (Lifolizer), Nan-contact Infrared Thermometer, Spin Coating Machine, DTG, Contact Angle

Meter, Continuous Gas Chromatograph, Weighing Balance,CO_2 Analyser, etc.

Flexible Manufacturing Systems Laboratory (Central Workshop)

The Flexible Manufacturing Systems (FMS) Laboratory conducts hands on training to first degree & higher degree students and cutting edge research in manufacturing science. This laboratory is a center for carrying out practical experiments for various on campus courses such as Flexible Manufacturing Systems (EA C412/BITS F431), Computer Aided Manufacturing (ME F432), Production Techniques-II (ME F313), Metal Forming and Machining (MF 313), etc. This laboratory has been designed and configured to assist the Indian industry to become globally competitive in CNC manufacturing, CAD/CAM and machine tool sectors. The aim of the laboratory is to conduct fundamental as well as integrated research in order to achieve appropriate skill in CNC machining, in-depth knowledge in metal cutting, designing of manufacturing systems, developing manufacturing management techniques/strategies/practices for revitalization of Indian industries. The FMS lab aims to be foremost research center in CNC manufacturing, design of manufacturing systems and manufacturing excellence practices.

The following facilities are available in the FMS Lab.

- **Hardware:**
  - KODI-40 KLIEN Vertical Machining Center (Industrial)
  - Renishaw Probing System attached to KODI 40 VMC
  - Taylor Hobson Talysurf
  - FLIR Thermal Image System T250
  - MTAB STARRTURN CNC Lathe and Milling Trainer
  - MTAB FMS Cell
  - ROBOT
  - Rapid Prototyping Machines
    - ✓ Dimension Elite 3D Printer
    - ✓ FMD 200mc
  - IBM Intelli Workstations and High Computing Facility
- **Software Tools**
  - Umberto Life Cycle Assessment Tool
  - CATIA-PLM Tool
  - QUEST-3D Simulation Tool
  - ARENA-2D Simulation Tool
  - SIMUFACT Software
  - MINITAB-Quality Control Tool
  - DFMA-Product Design Tool
  - LINDO/LINGO-Optimization Tool
  - Multi-Attribute Decision Models

Oysters Lab-VLSI DESIGN Laboratory (EEE) This laboratory has been established to support the Micro-electronics program and to carry out projects in the field of VLSI design. The facilities in the Lab, with a seating capacity of forty students, include the centralized IBM x3650 M4 servers, Sun Fire X2200, Ultra 20 with RHEL operating system and DELL Optiplex desktops as clients. The servers operate on High Availability platform with parallel computing and cluster configuration. The lab is equipped with the complete set of front-end and back-end EDA (Electronic Design Automation) tools from the top vendors including Cadence, Synopsys and Mentor Graphics for ASIC design, Symica custom IC design Tool kit, Altera for FPGA design, and Silvaco for device & process simulation.

The lab has collaboration with Europractice to obtain design kits for ASIC design including UMC 90 nm, 130nm, and 180nm, TSMC 180nm and 250nm and the Altera FPGA kits include 40 UP3 kits, 10 DSP development kits and 10 NIOS-II development kits. The lab also has a Mixed Signal Oscilloscope and a Function generator, from Tektronix, to test the fabricated chips

Instrumentation Technology and Virtual Instrumentation Laboratory (EEE): The facility in the laboratory includes general purpose and specialized bench equipment, transducers and signal conditioning kits, PC based data acquisition and control cards, Virtual Instrumentation software (LabView) and

data acquisition & signal conditioning modules, ELVIS boards, Green Engineering, bioengineering kits, wireless sensor network kits, Programmable Logic Controllers with I/O modules and interfaces.

Optical Communication Laboratory (EEE)

The infrastructure in the laboratory includes facilities for study and characterization of optical waveguides, fibers, Optoelectronic sources and detectors. Facilities are available for fabrication and calibration of fiber optic sensors. Training kits to study, design and simulate fiber optic communication & network systems with additional computational facilities to characterize them.

Sensor Networks and IoT (EEE)

The Internet of Things (IoT) lab provides various equipment and facilities to conduct research and develop prototypes for IoT and several allied areas such as Security, Drones, Brain Computer Interface (BCI), 5G, Blockchain and Vehicular Ad Hoc Networks (VANETS). It also hosts laboratory activities for the related courses. Humanoid robots, BCI and FPGA kits, Quadcopters, FPGAs, and a variety of microcontrollers, sensors and actuators are available in this laboratory for research and development activities.

Advanced Structural Engineering Lab (Civil Engineering)

This lab has well-equipped testing facilities for structures and materials. The lab supports various equipment such as Loading frame with Servo-Hydraulic Actuator of 400 kN capacity, 100 kN Dynamic Universal Testing Machine, 1000 kN Static Universal Testing Machine, 1000 N Shake Table, Beam Torsion Testing Machine, Acid Resistance chamber, Digital Hot Air oven. These facilities are available to students, academicians, and researchers for their class and project work, and to outside agencies.

Structural Engineering Lab (Civil Engineering)

Portal Frame Apparatus, Redundant Joint Apparatus, Elastically Couple Beam Apparatus, Deflection of Truss Apparatus, Elastic Properties of Deflected Beam Apparatus, 3-Hinged Arch Apparatus, Column and Strut Apparatus, Unsymmetrical Bending Apparatus, Digital Switching Power Amplifier etc., etc. These facilities are available to students for their class and project work.

Highway/Transportation Engineering Laboratory (Civil Engineering)

The highway / transportation engineering laboratory is equipped with state-of-the-art devices that are used for the testing of pavement materials, conducting traffic engineering studies and to design safe flexible and rigid pavements. The equipment housed in the laboratory includes, among others, Los Angeles Abrasion Testing Machine, Light Weight Deflectometer (LWD), Dynamic Cone Penetrometer (DCP), MERLIN, Bump Integrator, Portable Skid Resistance Tester, Centrifuge Extractor, Viscosity Bath Test Apparatus, Digital Ductility Testing Machine, Speed Radar Gun, Auto Exhaust Multi- gas Analyzer, Global Positioning System (GPS) units, Digital California Bearing Ratio Test Machine, and Marshall Stability Test Apparatus, Buoyancy Balance equipment. In addition, the laboratory also hosts several software packages that include VISSIM, ArcGIS, AutoCAD, MX Road, Trazer, Automatic Marshall compactor, Asphalt Mixer Density Meter, Two Handycams – Sony Make with tripods, Datalogger, Uniframe automatic compression testing machine etc. These facilities are available to students, academicians, and researchers for their class and project work, and to outside agencies for consulting work.

Survey Lab (Civil Engineering)

The survey lab is equipped with both basic and advanced instruments such as Total station, Digital Theodolite, Tacheometer, Prismatic compass, Auto Level, Tilting Level, DGPS Setup, Digital Planimeter, GPS etc., These instruments are predominantly used for the undergraduate lab work for the surveying course and also for project work for post-graduate students.

Soil Mechanics and Foundation Engineering Lab (Civil Engineering):

This lab has state-of-the art facilities for both teaching and research purpose and has wide range on instruments such as Digital Direct Shear Test Apparatus, Manual Direct Shear Test Apparatus, Triaxial Test Apparatus, Relative Density Test Apparatus, Unconfined Compressive Test Apparatus, Hot Air Oven, Consolidation Test Apparatus, Permeability Test Apparatus, Field Density Test Apparatus, IS Sieves, Hydrometer, CBR Test Apparatus, SPT Apparatus, Direct Shear APP. Large Motorized, DCPT Apparatus and Casagrande Apparatus, 4-Channel Digital Vibration Meter, Rock Drilling Machine, Rock Cutting Machine, Point Load Tester, Direct Shear Apparatus, Hydraulic Extruder, Hand Operated Machine, Automatic Soil Compactor, Digital Indicator with Data Acquisition System, Plate bearing Test Apparatus, Load Truss Apparatus, Colorimeter Apparatus, Harvard Miniature Compactor, Humidity Chamber, PH 700 Meter, Digital weighing balance, Automatic Triaxial Test Apparatus,. These facilities are available to students, academicians, and researchers for their class and project work, and to outside agencies

Hydraulics Lab (Civil Engineering)

This lab has state-of-the art facilities for both teaching and research purpose and has wide range on instruments such as Stoke's Apparatus, Discharge Measuring Apparatus (V-Notch), Osborne Reynolds Apparatus, Hydraulic Jump Measuring Apparatus. Jet Impact Measurement Apparatus, Centrifugal Pump Francis Turbine Kaplan Turbine, Heleshaw Apparatus, Geophysical Resistivity Meter Electrical Resistance, Water Filter Chamber and Hydraulic machine, Metacentric Height Measurement Apparatus (Ship Model), Fixed Bed Flume, Multi-Purpose Flume, Tilting Flume Apparatus, Constant Head Apparatus, Varying Head Apparatus, Anemometer Viscometer, AGS RES2DINV with RES#DINV starter.

Concrete Lab (Civil Engineering

The concrete lab has state-of-the art facilities for both teaching and research purpose and has wide range on instruments such as.Self Compacting Concrete Mixer, Slump Cone, Compression Testing Machine(2000kN), Compaction Factor Apparatus, Cement Tensile Testing Apparatus, Hobart Mixer, Cube Cutter, Flexural Strength Measuring Apparatus (Beam), 4-Point Loading Apparatus, Core Cutter, Vicat Apparatus, Vibrator Table, Vee Bee Test, Hot Air Oven**,** Muffle Furnace, Freeze-Thaw Chamber, Carbonation Chamber, Hydraulic Trolley (5000 kg capacity), Calorimeter, Motorized Sieve Shaker, Humidity Environmental Chamber, Cement autoclave, Automatic Blaine apparatus, Rebound hammer, concrete cube cutter apparatus, brick making machine, humidity chamber, environment chamber, RCPT Apparatus Vacuum desiccators with port value & the vacuum pump, Water permeability test apparatus, Air compressor with accessories, Load Feame for 300 Ton,Mortar Mixer , Servo Power Pack for 3000Kn, Data Logger, Data Acquisition & Multimeter System, Automatic pace rate control Power pack Machine, Stand Mixer, Digital weighing balance. These facilities are available to students, academicians, and researchers for their class and project work, and to outside agencies.

Environmental Engineering Lab (Civil Engineering):

The Environmental Engineering Lab has state-of-the art facilities for both teaching and research purpose and has wide range on instruments such as.Orbital Shaker, Hot Air Oven, Deep Refrigerator, Vertical Autoclave, UV Spectrophotometer, Jar Test Apparatus, Incubator, Oxy Top Bottles, Nephlometer, COD Digester, DR Spectrophotometer, Digital DO/pH Meter, Centrifuge, Primary Clarifier/Setting tank apparatus, Rapid Sand Filtration Process Apparatus, Ambient Air Monitoring Kit For PM_{10}, PM_{25}, PM_1, So_x, O_3, NH_3, Digital Clinical Flame Photometer, , Fume Hood with special blower, Ninja Drone along with Drone data processing software, Digital water and soil analysis kit,YSIPRO DSS, Multipara meter Photometer,

with COD Test. These facilities are available to students, academicians, and researchers for their class and project work, and to outside agencies.

Computer Center and GIS (Civil Engineering)

The computer center and GIS Lab has state-of-the art facilities for both teaching and research purpose such as VISSIM, ArcGIS, ANSYS 14.5, CivilFEM, Abaqus 6.13, ETABS 2013, SAP2000 16, GEO5 15, AUTOCAD 2014, Lahey-fujitsu Fortran 7.5, RAM Concept V8i, STAAD Foundation Advance V8i, Structural Synchronizer V8i, MX V8i, Bentley Maps V8i, Bentley PowerCivil V8i,Projectwise V8i, STAAD Beava Module, Bentley Products, Pipe flow expert, ROLTA Geomatica suite, STAAD Pro V8i, STAAD Foundation V8i, DigitiZeIT, CIVILGEO ENGINEERING SOFTWARE, AMPL Software, Plaxis 3D, Microsoft Visual Studio License

Composite Lab (Civil Engineering): This lab is dedicated for research purpose, especially in the area of composites. Many equipments such as, Vacuum system for composites equipment, AE Win, Waveform equipment, Probe Sonicater are available for research purpose. Composite plates are being manufactured and tested in this lab for the research purpose.

AREL- FMS LAB: The AREL - FMS Lab has state-of-the art facilities for both teaching and research purpose and has wide range on instruments such as Bomb Calorimeter, EPSILON 1 Academia, Benchtop, Viscometer for Wastewater Analysis Apparatus, Microwave Digestion System Apparatus, Milli –Q water setup Apparatus, Turbidity Meter with Fast Tracker Technology Apparatus, TOC_L and TN Apparatus.

Language Laboratory (HSS)

A language laboratory with 40 booths is functioning to conduct practice sessions pertaining to the various courses offered by the department and to provide adequate practice to the students in different communication skills in English. The computer assisted lab facilitates the teacher to instruct and take responses from students through a computer network. Students and faculty across the institute also use these labs for the self-practice and self-assessment of their language and communication skills. The lab has a good collection of audio visual teaching materials in the form of Audio/Video CDs, Audio cassettes and Learning software which are used to enhance the linguistic competence and interpersonal skills of the students. The Department has procured an advanced language lab software system named Orell Digital Language Lab (ODLL) which offers cutting edge software solutions and delivers language teaching – learning solutions integrating two – way communication and incognito individual student monitoring. The Lab also houses a 2D Classical Animation Desk for students to practice and do assignment for the course Mass Media Content and Design.

Creative Media Lab (HSS): The Department is equipped with a studio-cum-lab for meeting the requirements of asset of courses in the area of Media and Communication. It is primarily designed to support the course Short Film and Video Production. The lab is equipped with DSLR and video cameras, colour video monitor, Microphones, basic lighting equipment and other accessories. For editing films, the lab has acquired a Mac –Pro 2.4 GHz Quad –core Intel XEON.

Music Lab (HSS): The Music lab is used for offering the various courses, theoretical as well as practical, i.e.- Appreciation of Indian Music, Musicology-An Introduction, Indian Classical Music- (Instrumental-1) and Indian Classical Music (Instrumental-2), with different course plans of Indian and worldwide music, along with the musical practices and rehearsals for different institutional events taking place throughout the academic year. It houses various instruments like Tanpura, Tabla, Harmonium, Sitar, Guitar, Synthesizer, Violin, etc. for the class room practices for the practical courses and performances.

DUBAI CAMPUS AND ITS FACILITIES

Student Housing

The Campus has segregated, conveniently located, singly occupied, and air-conditioned hostel accommodation for more than 900 boys and girls, furnished to suit the student's requirement. Wifi Internet connectivity and provisions for maintaining a small fridge are also provided. The hostels provide a safe and secure learning environment to students. Hostels have televisions, microwave ovens, gymnasium, laundromat, first aid kits and recreation rooms with indoor games, magazines and newspapers.

STUDENT ACTIVITIES

Cultural and Sports activities

The Campus provides facilities and services that encourage the personality development of every student in the social, cultural and interpersonal domains to produce self-reliant young professionals. Students organize various academic activities, social activities, and cultural and sports festivals. A variety of extracurricular activities such as drama, public speaking, debate, poetry and story writing, painting, sketching, singing, dancing, quizzing, gaming, digital art, face painting, rangoli, henna, photography, fashion show, activities on financial literacy etc. have become a regular feature of the Campus calendar. Students also participate and win several laurels in various inter university events organized by other universities.

Student Clubs

Student clubs formed around academics and themes add to the rich mosaics of student life. The list of clubs includes Dance Club, Music Club, Art Club, Photography Club, Drama Club, Public speaking and Literary Club, Design Club, Fashion Club, Social and Environment Club, Astronomy Club, Quiz club, Wall Street Club and Sports Club. These clubs enrich the social and cultural life on the campus by organizing a number of inter and intra campus events. The Sports Club is committed to the health and wellbeing of the student community and encourages students and faculty to be involved in recreational sports through intramural, extramural competitions and tournaments.

Social Activities

The Social and Environment club organizes events with the aim of sensitizing students about their responsibility towards environment and community**.** Activities taken up by the club includes awareness programme like , tree plantation, organic farming , Earth hour ,Earth Day, Preventable Cancer Awareness,Mental Health etc. Blood Donation Camp and Platelet Donations are organized regularly.Clean up drive, English classes for the support staff, recycling of paper, cans and tetra packs, fundraising events for charity,Volunteering work with local charities are facilitated. Goodie bags for the support staff. Spectrum, a cultural program for special needs children is an annual event. Students are involved in continuous activities to make the campus more sustainable.

Student Professional Bodies

Dubai Campus has student branches of leading professional bodies and Department Technical associations such as IEEE, AIChE, ASHRAE, ASME, SAE, ACM, ACM-W, SKYLINE, CHIMERA, Linux Group, Microsoft Tech club, LINUX users' group and CIIE. Students actively engage themselves in the activities of these professional bodies and avail the opportunities provided by the professional bodies and their UAE chapters/sections. Department Technical Associations provide platforms for organizing co- curricular events at different levels

IEEE

The IEEE Student Branch of Dubai Campus has been one of the largest IEEE student branches in UAE Section. It organizes competitions, invited lectures from eminent scholars and successful entrepreneurs for the benefit of students of all disciplines. IEEE Power Engineering Society has also been formed on the campus and is active. Students from the Campus also participate in IEEE Xtreme which is a 24 hour online International Programming Competition held every year. The IEEE Student Branch of Dubai Campus is one of the largest IEEE student branches in UAE Section.

AIChE

AIChE (American Institute of Chemical Engineers)- the students' chapter (started in 2013) at the department of Chemical Engineering, BITS Pilani, Dubai Campus is one of the first AIChE Student Chapters set up in the region. The students' chapter comprises a subchapter active in organizing industrial field trips, interactive sessions with professionals, and workshops which equip our chemical engineering graduates with hands-on experiences to excel in their careers. Many technical and non-technical events have been organized by the students in the past few years which includes talks by professionals from reputed organizations like Henkel, Exxon Mobil, Beckers, TUV Nord etc. The club also organizes hand-on workshops to improve skills of the students in Excel, Python, Matlab, Aspen from time to time. AIChE student chapter is also involved with networking, mentoring opportunities, and essential educational/career guidelines. Over the last several years, they have been interacting with students from AIChE chapters at the University of Utah and Brigham Young University, UC Berkeley, Institute of Chemical Technology (ICT-IOCB), Rajiv Gandhi Institute of Petroleum Technology, and Universidad Nacional de Colombia. Over the last several years, our students have been selected at various leadership positions such as regional liaisons in AIChE executive student committee, and chair of the sister chapter subcommittee. In 2018, our students were the first team from UAE to participate in the Chem-E-Car competition held in Bahrain

ASHRAE

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) student branch fosters students interested in pursuing a career in the field of heating, ventilating, air conditioning, and refrigeration. Student Branch offers the opportunity to interact and "network" with members of the ASHRAE Chapter, to participate in technical tours, invite guest speakers, and to interact with other students with the same career interests.

ASME

Students participate in several District level and Global level competitions and brought laurels to the institute. The ASME Chapter of the Campus in association with the Pinnacle Knowledge Group held its first ever and the biggest Student Professional Development Conference (SPDC). SPDC is an initiative of ASME to enhance and develop the technical and leadership skills amongst the engineers worldwide. This Student section also organizes various student competitions every year in which many local universities participate.

SAE

SAE Student chapter is very active in participating in various competitions like FSAE BAJA SAE etc in USA / ITALY / INDIA. The students form into teams and register for these competitions, and they design, fabricate, and build the cars in college workshops and team Gear shifters also won many laurels in various competitions.

ACM

With over 100 enthusiastic student members the ACM is a vibrant and technology focused association. Founded on March 1, 2011, the association has grown from strength to strength over the past couple of years. The association regularly holds coding workshops, bootcamps, hackathons and invited talks. The idea being to introduce students to the latest technologies and for students to share their knowledge and upskill their fellow students. There are three Special Interest Groups for students with a focus in a specific area .ACM-CP, ACM-HEX and ACM AI for Competitive Programming, Security and AI. ACM BPDC was awarded the excellence award for outstanding chapter activities by ACM headquarters in New York in April 2020.

ACM-W

ACM-W BPDC is the women in tech chapter of ACM at BITS Pilani, Dubai Campus. Founded in 2019, it aims to inspire and lead women in tech by offering services and programs for professional and career development. In 2020, ACM-W continued to contribute to a community of women in tech, through webinars, hands-on sessions and social media. This year was met with challenges and obstacles because of the pandemic. However, ACM-W continued to progress through testing times. A number of Tech related activities, seminars, workshops and hackathons were conducted over the last two years.

LINUX Users Group

The Linux Users group was started in Oct. 2005. The registrations are free and open to all interested BPDC students. The group also provided resource material on UNIX Commands and Editor for first year students and Installation related assistance for UBUNTU OS for interested Project students. The group conducted a short-term course on LINUX Concepts and Applications during 12th July 2020 – 25th July 2020, for ten school students of grade 12 in UAE.

CHIMERA

Chimera, BITS Dubai Biotechnology association, was inaugurated in 2010 with the hope of being more than just a college club for biotech students, rather it would act as a voice, providing the students with a platform to grow and learn. Chimera provides students with opportunities to participate in fun activities like Agar Painting, Crime Scene Investigation, Poster making Competition and many more. Guest lectures and talks are held by professionals in the field which keep students updated with recent discoveries and developments and provides them with industry exposure. It gives students the real feel of truly being a biotech engineer and gives students a chance to further enhance their knowledge and skills.

CIIE

The Center for Innovation, Incubation and Entrepreneurial (CIIE) [formally Centre for Entrepreneurial Leadership (CEL)] was established in 2012, to foster entrepreneurship among students and provide support to translate ideas into successful ventures. CIIE strives to create events and initiatives to bring together the young minds to “Ideate, Innovate and Implement”. CIIE is an initiative of Birla Institute of Technology and Science, Pilani established in all four campuses (Pilani, Hyderabad, Goa and Dubai) in alignment with BITS Pilani’s VISION 2020. The CEL was inaugurated on 8 September 2012 by Dr. Kumar Mangalam Birla, Chancellor in the presence of several dignitaries including Prof. B.N. Jain, the Vice Chancellor. Currently there are about 50 students enrolled as members with 10 students on its Executive Board. CIIE joined the Dubai Incubator Network powered by Dubai SME and Hamdan Innovation Incubator. The BITS Pilani Business Incubator was inaugurated on 27th September2021 jointly by H.E. Abdelbaset Al Janahi, CEO, Dubai SME and H.E. Dr. Aman Puri, Consul General of India at Dubai. The inaugural ceremony was also graced by Mr. AbdelAziz Al Maazmi, Director, Hamdan Innovation Incubator, Mr. Dilip Chenoy, Secretary General, FICCI and Mr. Merzi Sodawaterwala, Chairman, WSBF and Founder, IFIICC.

Microsoft Tech Club

Microsoft Tech Club is the tech club at BITS Pilani, Dubai Campus, associated with Microsoft Gulf, DIC. Is run by Microsoft Student Partners, and students of the Microsoft Student Community under the guidance of the faculty advisor. The club was established in 2009 and continues to be very active on our campus. Every year the club carries out training programs for students beginning from 1st year onwards in emerging technologies using the software tools supplied by Microsoft. Senior members of the club (MSP) used to undergo training at Microsoft Gulf in Dubai and they then teach the other members of the club about emerging technologies happening in Computer science with the support of Microsoft tools whose keys are shared free of cost from Microsoft. MSPS are involved in building apps, training others and social media. They are social, friendly students who enjoy creating global connections. They attend seminars, workshops and developer camps at the Microsoft Dubai office. Further, Evangelists from Microsoft used to visit and conduct workshops for the members of the club on cutting edge technologies delivered by Microsoft. The training offered by the club prepares the students to undergo PS-II program effectively where Microsoft software tools are widely used. Every year the tech club used to conduct various activities like Boot camps, Hackathons, Technical quiz, workshop, code Blitz ,coder of the year etc; During the current academic year the club has conducted 13 events virtually due to covid-19 restrictions.

SKYLINE

Student's led association SKYLINE of the Department of Civil Engineering was established in 2016 with the mission to educate and empower students for what lies beyond

academics. SKYLINE students have membership in the American Society of Civil Engineers (ASCE) since the initiation of the association. Guest lectures and invited talks by eminent personnel from the construction industry and site visits to leading companies in the industry such as Shapoorji Pallonji LLC, Emirates Filigran LLC Precast Factory and organizing workshops that offer hands-on experiences on popular concepts such as GIS and modern methods of surveying dominate the major activities of the association. Skyline conducted an event titled 'Constructo' at the institute's Technofest to focus on the gamification of concepts related to the structural design of bridges, soil and transport engineering to give students of all departments a taste of civil engineering.

GDSC

Google Developer Student Clubs are university based community groups for students interested in Google developer technologies. Students from all undergraduate or graduate programs with an interest in growing as a developer are welcome. By joining a GDSC, students grow their knowledge in a peer-to-peer learning environment and build solutions for local businesses and their community.

SWE

BITS Pilani, Dubai Campus is an affiliate campus of the US-based Society of Women Engineers (SWE), the largest advocacy organization for women in engineering and technology. We are the first dedicated Engineering & Technology Institute in the UAE to partner with SWE.

SWE is a global organization with 80+ global affiliates worldwide, dedicated to giving women engineers a unique place and voice within the engineering industry. Through this new global affiliate BITS Pilani, Dubai Campus seeks to further SWE's vision of a world with gender parity and equality in engineering and technology.

BPDC SWE aims to further encourage participation of women in the field of Science, Technology, Engineering and Math (STEM) by supporting them with the proliferation of their vision and mission and by providing them with the necessary skill sets to tackle the outside world whether it be pursuing masters or being part of the engineering workforce. Through SWE various events will be held locally in BPDC wherein the female students will be empowered by conducting public speaking and leadership workshops, industrial visits, projects mentored by professionals, working on elevator pitches and networking with other women in leadership roles.

AOEE

Association of Electronic Engineers (AOEE) has student members form Electrical and Electronic Engineering & Electronic and Communication Engineering. The objective of this body is to conduct Workshops and Guest lectures in the advancement happening in the core engineering field. Apart from these activities, it also takes part in STEM ,Enginuity and Technofest events.

IEI

The Institution of Engineers (India), abbreviated as IEI, was established in 1920 in Kolkata, India, and incorporated by Royal Charter in 1935. Currently, IEI has more than one million members across the world in 15 different disciplines, and offers various research and publication opportunities to its members. IEI BPDC chapter is the first International Student chapter, and was established in 2017, with the aim of providing students with a platform to learn, experience, share, and showcase their skills through technical talks, invited seminars, lecture series on niche areas, and discipline-specific intra- and inter-university competitions

FESTIVALS ON CAMPUS

Cultural and Sports Festivals

B-quizzed

B-quizzed, conducted at the Campus, is the largest quizzing competition held in UAE where many universities and schools take part every year.

JASHN

JASHN is an annual inter university cultural festival where universities from all over UAE participate in drama, dance, music, fashion, quizzing, art, literary, photography and many other competitions. Its mission is to mark the beginning of a new generation of cultural uprising in UAE, and give a platform to all the untapped sources of talent in the ocean of

cultural ripples. Its a four day event and every day a celibrity artist performs to enthrall the crowd. On the day of the grand finale a DJ is invited, enticing people to have fun.

ARTEX

ARTEX is an annual intra College art, craft and photography event conducted by Shades –Art Club of BPDC, every year at the Campus. It's main event is Kalakriti - an Art exhibition, a showcase of various forms of art like Oil painting, Acrylic painting, Water Color painting , Poster Colour painting, Digital Art, Classroom art, Pencil Sketching, Oil pastels, Pen/ink art, Pencil color shading, Glass painting, Fabric painting, Embroidery, Pot designs, Best out of Waste (Junk Art) etc. Artwork entries by the students, Faculty and Staff of BPDC are put on display during Artex. Competitions like Rangoli making, Face painting, Henna designing, Nail-Art,Origami, Clay modeling, Beg-borrow-steal, Blind art, Doodle god, Make-up contest etc along with fun filled games are conducted for the students during Artex.Prizes and Certificates are given to the winners. The club has been part of various College events such as Convocation, Technofest, Enginuity, Jashn, Diro's Tea Party, Dandiya Night, Holi Milan,Gandhi Jayanthi celebrations, Stem Teacher's award ceremony etc in joining hands for decoration/art work**.**

Sparks

Sparks is an annual cultural intra university event organized every year at BPDC. Various competitions in dance, drama, literature, fashion show, quiz and music etc are held. Competitions in Duet and Group Dancing are conducted in both Eastern and Western categories. For Music, Solo and Duet singing is conducted in both Eastern and Western categories along with Battle of Bands. Drama events like Histrionics, Ad making etc are popular events. The Fashion club members thrive to entertain the crowd and to teach those who are interested a sense of fashion and style. Two events are quite popular one being Drape which is a fashion designer's show where participants brainstorm and come up with innovative designs to portray their ideology. The other event being Mr & Ms. Sparks. A large number of students participate in Sparks.

BSF

BITS Sports Festival (BSF) is the annual event interuniversity event where more than 36 universities and colleges participate from all over UAE in the tournaments that include basketball, throwball, football, cricket, table tennis, chess, volleyball, athletics, archery, boxing, swimming and badminton. BITS Pilani, Dubai Campus was the first institution to introduce badminton, archery and boxing as an inter university sport event in UAE for both boys and girls. BPDC was also the first university to introduce boxing as a sport at the inter-university level. Now BSF is also being organized for school children.

BITS Sports Festivals has been graced with the presence of sports stars like Diego Maradona, Mohammed Azheruddin,Mary Kom ,Virendra Sehwag, DJ Bravo, Pullella Gopichand, Sania Mirza, Sushil Kumar, Sania Nehwal, Madan Lal, Koneru Humpy, Vijender Singh and Piyush Chawla. The sports event witnesses' crowds of around 6000 student, it is considered as the largest inter- University /college sports festival in the United Arab Emirates.

RECHARGE

Recharge is an annual event hosted every year specially for the hostel students. This 4 to 5 day event has various sports activities like Gully Cricket, Super 6s, Volleyball, Foot Volley, Throwball, Badminton, Table Tennis, Chess, Basketball, Pitthu, Handball, Football etc. Students also have various fun activities for cultural events. There is also a special menu each day from the hostel mess to celebrate RECHARGE. On the final day, committee members felicitate winners of sports and cultural activities and gifts and vouchers are given to the hostel staff.

ETHNIC DAY

Every year, 5th November is celebrated as the founder's day. All Students, staff and faculty come in their Ethnic wear to celebrate this occasion. There is also a special function where students and faculty showcase their talent. A special fashion show is held for the students who are beautifully dressed and top 2 contestants (One Boy and one Girl) are selected as Mr. Ethnic and Ms. Ethnic.

Ice Breakers

Fresh to college and ready to embark on this journey the freshers are given a glimpse of activities conducted by various clubs and associations through a presentation. Each club and association sets up stalls which not only give a glimpse of the activities but they also recruit the freshers to their clubs and associations. There are conversations with culture and loads of artistic performances are held which lets the freshers embrace the colorful and vibrant culture of BPDC.There is a batch tree plantation and ice is literally broken by freshers and seniors.

Farewell Party - DIRO's Tea Party

The 'DIROS Tea Party, a farewell party to the passing batch is organized by the Student Welfare division. The event begins with Department photographs being clicked with the respective department faculty. A program is then organized to give farewell to the graduating students. The graduating batch, faculty and staff members attend the ceremony. A dance performance by the Dance Club and music performance by the music club entertains the gathering. A lot of fun games are arranged and gifts are awarded to the winners of the games. A DJ sets the tempo high. The farewell ends with dinner and on an emotional note. The Party is indeed a memorable one. Students arrive dressed at their very best to the Diros Tea Party.

Technical Festivals

Technofest

Technofest is an annual intra-university technical festival. There are many interesting and innovative events organized by various clubs and associations under Technofest. The various events include: Mechathlon, Float, Capture the Flag, Puzzled, Frynapse, Tech Fiesta, Debate, What is the good word, Business Quiz, Code Blitz, MindSpark, Big Split, Consumer Product, Pass the Buck, Rings of Fire, RC Football, Play2Code, TrashPanic and Hackathon. There are separate sessions for Paper Presentations and Exhibits for Working and Non-Working Models. The events help our university students to exhibit their skills and generate a lot of interest and enthusiasm among them.

ENGINuity

ENGINuity, the annual inter-university techno-managerial and innovation festival held at BITS Pilani, Dubai Campus, is one of the most prestigious platforms to showcase one's technical affinity. The word ENGINuity is a word play on the phrase "An Engineer's Ingenuity" and the event caters to this philosophy by encouraging innovation and creativity amongst its participants. Since its inception, ENGINuity has metamorphosed into an ideal melting pot of the country's synergic talent resonating with unmatched frequencies of fierce competition. It aims at forming a conglomerate of students who share a mutual passion for science, technology and management in a synthesis of enthusiasm and jubilation. The broad categories of events include: Technical, Business, and Literary. The various events under them are BQuizzed, Treasure Hunt, Code Blitz, Hackathon, Art Carnival, Gaming, Model Designing, Azure Workshop, Infographic, Talk on Sustainability and so on. From this year Enginuity is inviting participation from school too. One full day is dedicated for that.

Students Participation in Institutional Activities

The campus has a Student Council, the office bearers of which are President, Vice President, General Secretary and an Ex-Officio. Other members of the Student Council include a hostel and day scholar representative from each year. Students are also part of many committees like senate, discipline, event management, corroboration and review, library, academic counseling board, anti aging committee, grievance cell etc.

STUDENT SERVICES

Orientation and Counselling

The Institute organizes an orientation programme at the time of admission of freshmen, to familiarize them with various aspects of BITS, Pilani education system and academic system, infrastructural facilities, hostel facilities and various other policies and procedures at BITS Pilani, Dubai Campus. The Director and the Institute Officers of other units such as Academic -Undergraduate Studies, Practice School and Placement, Student Welfare, Library, Information Technology, etc., meet the parents of freshmen at an interactive session at the time of admission. Students also receive important information about the Student

Services, Learning Resources, Financial Aid, Student Activities, Career Counseling, Academic Advising, and Industry Internship, etc. It is a week long event.

Academic Advising

Academic Advising is carried out through the faculty members as academic advisors to students. The academic advisors interact with their advisors on a regular basis and discuss their performance and progress. Students are advised to contact the academic advisors periodically. The goal is to help the students reduce their program-related stress and maximize opportunities for academic performance improvements leading to a high quality professional life.

Student Counseling

Campus has a dedicated professional Counselor. This is to foster well being on campus and to help students actualize both personal and career goals. The sessions are individual and confidential. The counselor interacts with students discussing all issues which affect their academic performance and help students in resolving their psychological issues, if any. Students are advised to contact the counselor directly. The goal is to help students reduce their stress, maximize academic and personal success, enhance personal development and quality of life. Students are also free to meet the faculty for counseling services and many students approach the faculty for the same.

Grievance Cell

The Students Grievances Cell, addresses the students' grievances, if any, and works to maintain the well-being of the student community in general. The SGC addresses the issues, investigates and recommends feasible solutions for resolving issues for the mutual benefit of the students and the Institution.

Earn-while-you-learn

Students can earn while learning under the Earn-while-you-learn scheme. Students are given the opportunity to work as Professional Assistants in laboratories and/or assist the faculty and departments in other academic and professional tasks. They are paid an honorarium based on the work done and a certificate of appreciation is also provided.

Placement and Campus Interviews

The Campus offers a Placement Program to all its graduating students. Reputed multinationals and local conglomerates from UAE, Middle East Countries, and India participate in Campus placement. Some of the recent organizations that conducted campus placement are given in Table 1. Many graduating students prefer to go for higher education as well. The Campus also facilitates admissions to reputed Universities. A sample list of Universities where students have got admissions for Masters or Ph. D. is given in Table 2

Table 1: Organizations participated in Campus Placement/conducted Campus Interviews	
KPMG Lower Gulf, UAE	Noon.Com, Dubai, UAE
Schindler, Dubai, UAE	L'Oreal, Dubai, UAE
Lipton Tea Arabia, UAE	KPMG Lower Gulf, Dubai, UAE
PwC, Dubai, UAE	Citibank, India
Al Shirawi Group, UAE	Emerson, Dubai, UAE
Dubbizle (OLX Group), Dubai, UAE	Jacky's Group, UAE
Telr, Dubai, UAE	Sharaf DG, Dubai, UAE
Emirates Group, Dubai, UAE	Beckers Group, Dubai, UAE
Weidmuller Middle East, Dubai, UAE	Deriv, Dubai, UAE
Zomato, Dubai, UAE	Alderely, Dubai, UAE
Landmark Group, Dubai, UAE	Help AG, Dubai, UAE
LEWA Middle East, UAE	National Oilwell Varco, Dubai, UAE
WIO, Abu Dhabi, UAE	IFFCO, Dubai, UAE
NEST Scientefic MENA, UAE	Al Tayer Group, Dubai, UAE
Alokozay, Dubai, UAE	Emirates NBD, Dubai, UAE
Schneider Electric, Dubai, UAE	Dabur International, Dubai, UAE
UltraTech Cement, UAE	Sobha Group, Dubai, UAE
Torrecid, Dubai, UAE	Lamprell, Sharjah, UAE

Table 2: List of Universities where students secured admissions for Masters or Ph. D	
Aalborg University, Denmark	Technical University of Delft, Netherlands
Alabama State University	Hong Kong University of Science and Technology, Hong Kong
Anna University, India	The University of Sydney, Australia
BITS Pilani Dubai Campus, UAE	The University of York, UK
California Institute of Technology (Caltech), USA	University of California San Diego, USA
Carnegie Mellon University, Pennsylvania, USA	University College Dublin, Ireland
Collège De L'Estrie Inc., Qubec, Canada	University of Adelaide, Australia
Columbia University, NY, USA	University of Alberta, Canada
Cornell University, NY, USA	University of Central Florida, USA
Coventry University, UK	University of Copenhagan Denmark
Duke University, North Carolina, USA	University of Glasgow, UK
Ecole Polytechnique, France	University of Groningen, Netherlands
Embry Riddle Aeronautical University, USA	University of Kent, UK
George Washington University, USA	University of Leeds, UK
Georgia Institute of Technology, USA	University of Maryland, USA
Harvard Medical School, USA	University of Michigan, Ann Arbor, USA
Heriot Watt University, UK	University of New South Wales, Australia
Illinois Institute of Technology, USA	University of Nottingham, UK
Indian Institute of Management, India	University of Pennsylvania, USA
Indiana University–Purdue University, USA	University of Sheffield, UK
Johns Hopkins University, USA	University of Southern California, USA
Karolinska institute, Sweden	University of Toronto, Canada
Lamar University, USA	University of Washington, Seattle, USA
Ludwig Maximilians Universität Munich, Germany	University of Waterloo, Canada
Lund University, Sweden	University of Windsor, UK
National University of Singapore, Singapore	University of Wrocław, Poland
NIT Surathkal, India	The University of Texas at Dallas, USA
Northeastern University, Massachusetts, USA	Vision Concept Aviation Training Institute, Dubai, UAE
Santa Clara University, USA	Washington University
Stevens Institute Of Technology, USA	Western University, Canada
Symbiosis Institute of Business Management, Pune (Symbiosis International University), India	Worcester Polytechnic Institute, USA

Alumni Relations

The BITS Pilani, Dubai Campus Alumni Cell fosters long term relationships among alumni through various programs. Its mission is to enable the alumni, students, faculty and friends to maintain their connectivity with the Institute and each other for shared benefit. The website is periodically updated to enable the alumni to have an access to the information. The Alumni Relations at the campus uses various platform to connect with the alumni such as emails, Linkedin, Instagram, Facebook and Almaconnect. The Alumni Relations team consisting of faculty and students actively engaged in maintaining the up-to-date information of the passed-out students as it provides a great strength to institution building and, engages with alumni for various events such as startup mentoring, organizing workshops and informative talks and social get-togethers.

The students team comprises of:

Post	Name/ ID no	Email
President	Durwa Thakur (2020A7PS0241U)	f20200241@dubai.bits-pilani.ac.in
Vice President &	Rishin Mashoom Shah (2020A9PS0007U)	f20200007@dubai.bits-pilani.ac.in
General Secretary & Head-Mentorship	Avani Kottalgi (2021A7PS0049U)	f20200049@dubai.bits-pilani.ac.in
Head-Content Writing	Maryam Naseer Khan (2020A9TS0187U)	f20200187@dubai.bits-pilani.ac.in
Head- Campus Relations	Ved Vijay Uplenchwar (2021A7PS0285U)	f20210285@dubai.bits-pilani.ac.in
Head- Graphic Designing	Jayantra Thulasidas Andal (2020A4PS0153U)	f20200153@dubai.bits-pilani.ac.in
Head-Event Management	Hitansh Tuli (2021AAPS0167U)	f20210167@dubai.bits-pilani.ac.in
Head - Data Collection	Akash Rajasekar (2021A7PS0007U)	f20210007@dubai.bits-pilani.ac.in
Marketing	Rishabh Somani (2021A1PS0288U)	f20210288@dubai.bits-pilani.ac.in

CENTRAL FACILITIES

Auditorium

The Campus has a large auditorium with a seating capacity of 1100. It has movable partitions to bifurcate the hall as per the requirements, acoustic paneling and carpeted floor and is equipped with five projectors with remote controlled screens, Bose speakers, a professional grade audio mixer and a carpeted wooden stage with stage focus lights.

Food Outlets

A canteen and a grocery shop are there for the students, staff and faculty. Vending machines are also available in the Campus and Hostels.

Sporting Facility

Campus has huge indoor and outdoor sports fields for games - Badminton, Carom, Table Tennis, Volley ball, Basket Ball, throw ball and Tennis. Athletic track was made to facilitate marathons, relays and races. One main turf cricket pitch and three turf net practicing pitches and two cemented net practicing pitches are available at the facility. The football and Cricket pitches are equipped with the flood lights for the day and night matches and events.

SECURITY

The complete campus and hostel is monitored through a CCTV system. Also round a clock security is available in the premises for the safety and the security of the students and property. Automated barrier system is

introduced in the main gate to restrict the access of the outside vehicles to enter the premises.

HOSTEL FACILITIES

Mess

Hostels have independent mess facility with separate dining facility for boys and girls. Vegetarian and non-vegetarian food is being served in the hostel mess.

Laundry & Gym

For the ease of students, hostels have separate laundry and gym facility for boys and girls.

Library

BITS Pilani, Dubai Campus Library, a gateway to knowledge resources, is located in a separate building with two floors and total area of about 29,680 sq. ft.

The mission of the Library is to collect, organize, preserve and provide access to the information necessary for the institute, to achieve its educational, research and service goals and to enhance access to information in all forms, using innovative technology thereby having a broad-based collection, to assist in meeting the needs of students, faculty and staff.

Library has a contemporary design with reading halls, reference section, stacking area, faculty and staff reading room, discussion rooms and digital library with 21 computers, internet browsing centre with 22 computers, 71 individual study carrels, and exclusive 8 (ground and first floors) systems to browse Library resources and online catalogue. Library has a seating capacity of more than 325 members. CCTV cameras are installed. LED display panel for displaying information about library and its resources and services has been installed.

The Library operations are completely automated using the AUTOLIB Library Management Software and all the resources are RFID tagged and bar-coded for quick and easy service to the user community. The RFID security system has been implemented. Self Service Kiosk has been installed for issue, return and renewal of books. The Online Public Access Catalogue (OPAC) is web enabled which can be accessed from anywhere at any time. Users can search the resources and check their accounts. The Library renders standard services such as circulation, reference, referral services and reprographic services such as networked printing, photocopying, scanning and binding facilities.

At present, the library has a collection of around 24,028 books. The collection of the library is growing continuously on a regular basis. Around 428 new volumes of books are added to the existing collection in major disciplines of Engineering, Management and Sciences. The Library has a separate collection of Textbooks under Book Bank Scheme for students to borrow. The Library procures a good number of general aptitude books such as TOEFL, GRE, SAT, IELTS, GATE etc. Fictions and books on Islam and Arabic are also added every year. Library procures latest editions of reference books and handbooks on core disciplines of Engineering, Technology, General Sciences, Management and General Knowledge.

The Library caters the users' needs with the collection of 2343 e-journals from the following e-databases: IEEE Xplore Digital Library, Science Direct (Engineering, Computer Science, Material Science and Biochemistry, Genetics and Molecular Biology), and JSTOR (Mathematics & Statistics, Life Sciences, Sustainability, Business & Economics, Arts & Sciences and Engineering). The e-databases have full text of e-journals with back issues, conference proceedings, e-books and reports. The Library has 7610 e-books (including BPDC Course Text and Reference Books) from IEEE/MIT Press, IEEE-Wiley, Springer, Elsevier, Taylor & Francis and etc. 7000+ e-magazines and e-newspapers were subscribed through Press reader. The past year question papers of campus courses have been digitized and made available for students to access through the library web OPAC from anywhere at any time. An e-Library portal provides a one-point search and access to all the subscribed e-databases from anywhere, anytime at any device.

Library subscribes to UAE based 4 print newspapers. The Library has 918 back volumes of print journals. Library has 1609 CD-ROMs on

engineering courses. Library has more than 3237 practice school reports and project reports and 495 theses submitted by students and PhD scholars. Library subscribes research supporting tools such as Typeset, Quill Bot, Turnitin and Microsoft Visio.

The Library provides alert services of conference, competition for students, higher education scholarship and latest arrival service to the patrons and users. The Library also offers Inter Library Loan (ILL) facilities to the users. Library has Wi-Fi facility which enables the users to use their laptops for internet browsing / project / thesis work. The Library also provides the necessary training and information literacy sessions to users. The Library has an MOU with the Al Ain University of Science and Technology in UAE for the mutual benefit of both the institutions to facilitate the users to avail Inter Library Loan (ILL) of resources. The Library remains open from 7.15 AM to 7.00 PM on all working days, Sunday from 1.00 PM to 6.00 PM and closed on national holidays. The Library services are extended till Midnight during Mid-semester and comprehensive examinations.

To ensure the safety precautions of library users from Covid-19 and renewed the confidence in library access, an Ultra-Violet (UV) Book sterilization machine has been procured for the Library and sterilized the returned and used books before replacing the books on the shelves.

To assure the safety of library users, “New Guidelines to use the Library, Resources and Services” has been followed and arranged the safety signages and reorganized the seating with reference to social distancing as per the Protocols given by Knowledge and Human Development Authority, Government of Dubai, Dubai.

The Library team consistently organizes webinars, online training sessions, library virtual orientation and provides e-resources trial access to the users.

FICT Facilities

The Campus and the hostels are covered with the latest Cisco network Infrastructure of both wired and wireless hotspot environment which provides the internal and external connectivity to fulfill the computing needs of the students.

Our data centre equipped with the following servers and Network components.

Servers

Nutanix Hyper converged Infrastructure

HP DL 380 series new generation

HP Storage serve (SAN)

QNAP NAS for Backup

Dell Blade Centre

Dell Rackmount RX740xD GPU Server

Network Components

Fortinet Firewalls

Cisco Core switches Nexus series

Cisco Edge switches

Cisco Firewall

Cisco Prime system

Cisco Wireless controller

Cisco Network admission control and access control system

Cisco IP Telephony system

Panasonic IP camera setup

Ucopia Internet Hotspot Appliance

Sonicwall Unified Threat Management System

Most of our key critical applications are configured in Virtualized environment with load balancing and cluster mode. We have Business continuity and disaster recovery plan in place and we have a disaster recovery site is configured in different location to continue our operation in case of any unforeseen scenario. Periodic backup is scheduled by disk to disk method to backup the data as snapshots.

CISCO Telepresence Systems

Cisco Telepresense system (under BITS Connect 2.0 project) is implemented in the campus which is interconnected to all BITS’ campuses in India. The Cisco Telepresense

classroom, capacity of 160 seating will help the students to participate in the online classroom sessions.

CISCO Telepresence Meeting Room: The Telepresence Systems (Model: IX5200 – CISCO) is the 1st device of its kind in the entire CCG installed by CISCO in BITS Pilani, Dubai Campus. This model incorporates an elegant triple 4K Ultra High Definition camera cluster, three high-definition 70 inch LCD screens and theater quality audio to bring people together as if they were just across the table. Other meeting rooms are equipped with Model No.: EX-90 & SX-10 used for a smaller group members or individual can have one to one interaction across all the campuses. These technologies make it possible for users to communicate as naturally as they would in person.

CISCO Telepresence Classroom: Is equipped with C90 system with 160 seating capacity used for inter campus meetings and lectures. The benefits of this technology will be easy to connect with management across all three campuses, offering more specialized electives to students, knowledge exchange between students from the other three campuses, helping students to attend guest lecture sessions from a remote location, expediting the recruitment process.

E-Campus Solution: As an initiative and creative vision from the Director of BITS Pilani, Dubai Campus to make the Institute a smart campus, E-campus solution is adopted to achieve the Smart University environment. E-campus involves cashless transactions using a single card solution for all institute facilities. The faculty members, staff and students can access all the services and facilities in the University campus by using E-Campus smart card. It reduces the administrative overheads, automates the workflow efficiently for a complete university lifecycle of students.

Online Learning and evaluation platform:

Institute has adopted online platforms such as Impartus, Webex, googleMeet, Zoom, Google classroom and Microsoft Teams to continue the education and make the learning uninterrupted to the students during the pandemic situation. Online evaluation platforms such as CodeTantra, Socrative, googleclassroom, WebEx and googleMeet are being used for conducting examination. Lab and lab comprehensive examination are conducted by using the virtual labs such as Platify, Cisco WebEx hands on lab and physical labs by remote lab component. All the classrooms are equipped with Interactive screens .Moodle Learning management system (LMS)is implemented for faculty members and students which enables educators to build, share content, conduct assessment and communicate with the students.

BITS Service Desk portal

Online service desk portal is implemented to all the users in the campus. Initial phase it is rolled out for It services. Every support request is assigned a unique ticket number which the users can track the progress and response online. It will streamline the support request and provide a effective service to the users

Medical Facilities

We have appointed a Part time doctor and one nurse for our in-house clinic from Prime Medical Center. The nurse is available on the campus round the clock to provide first aid and emergency care. Vehicles are available for taking students to the hospital in case of emergency. Institute ensures that all students are vaccinated for chicken pox, flu or any other such contagious diseases. From time to time free medical camps are organized for faculty and staff.

Transport Facilities

We are providing air-conditioned buses from Famous Transport for the day scholar students. During this pandemic inside the buses the protocols are strictly being followed and around 216 day scholar students are using the transport facility. Arrangement made for the hostel students for their weekly City tour trip. We are providing complete free transport service for the Practice school students to their PS stations.

Sports Facilities

The Campus has sports facilities for boys and girls. The indoor Sports Complex consists of

Badminton courts, Table Tennis, Boxing training room, Carrom Board, Foosball and Gym. In addition, the outdoor games facilities consist of grounds for Football, Turf Cricket ground, Basketball, Volleyball, Throw ball, Tennis and Handball courts. Separate gyms of international standards are there for girls and boys in the institute and in hostels. Four Cricket Turf practicing nets of sizes 20m x 3m are also there. Athletic track was made to facilitate marathons, relays and races. Grass football ground with floodlights was installed.

RECREATION ROOM

Two Recreation Rooms with well-equipped equipment for both boys and girls have been setup in the hostel blocks for the students to wind down and relax. There are Pool table, Foosball, Table Tennis, Carom Board, TV and Video Games for the students to enjoy.

University Store – Maha Mall

University has its own store which merchandise items for BITS Students, Staff & Faculty

Centre For Satellite Communication

Institute has established Centre for Satellite Communication in the campus. Which built and launched PICO satellite in UAE and its working to build a Ground Station and working in a project for launching CubeSAT (MAHASAT).

Quiet Zone

As a happiness and wellbeing initiative Quiet Zone has been created separately for Male & Female Staff/Faculty.

Communication Division

The Communications division at BITS Pilani, Dubai Campus takes charge of marketing and communications efforts. They play a role in fostering effective communication within the university and extending outreach to potential regions for attracting prospective students and enhancing the institute's brand visibility. This department offers comprehensive expertise in various areas of marketing including media relations, print media, merchandising, social media management, digital presence, website management, branding, networking sponsorships and partnerships, along with production of creativities such as design, video production, photography, short reels, etc,

Communication Division is dedicated to effectively communicating the university's value, engaging with various stakeholders, and enhancing the institution's positive reputation and impactful presence in the education sector and the broader community.

Central Workshop

The central workshop imparts training to the students in workshop practice, manufacturing process and, advanced manufacturing process courses and caters to the needs of maintenance work of the campus. It also caters to the fabrication needs of students working on experimental setups and various projects. The workshop comprises of Machine shop, Welding, Smithy, Carpentry, Foundry, Tool room, Metrology, Sheet metal forming, CNC , tool crib and stock room.

The major equipment include all conventional lathes and shapers, surface grinding machine, universal milling machine, radial drilling machine, wood turning lathe, and smithy hearth furnace, AC & DC welding machines. In addition to these facilities, there is provision for sheet cutting & bending, wood planning, sawing, casting and heat treatment. The workshop has numerical controlled machines CNC Milling Machine, CNC Lathe, CNC Router, Plastic Injection Moulding Machine, Optical microscope with Image analysis software, Microhardness tester, Potentiostat for corrosion testing, Servo hydraulic Fatigue testing machine, Ultrasonic Testing, Vacuum Hot press, TIG Welding, Tool dynamometer, Acoustic Emission tester and Surface roughness tester.

Laboratories

The Campus has well equipped engineering and sciences laboratories with latest instruments and software tools for students, faculty and research scholars. Viz., Chemistry Lab 1 & 2, Physics Lab, Patroleum Lab, Communication Systems Lab, Instrumentation & Process Control Lab, Power Electronics Lab, Signals & Simulation Lab, Analog/Digital Electronics Lab, Electricals Machine Lab, EG and CAD Lab, Composite Manufacturing Lab, Workshop, Fluid Mechanics

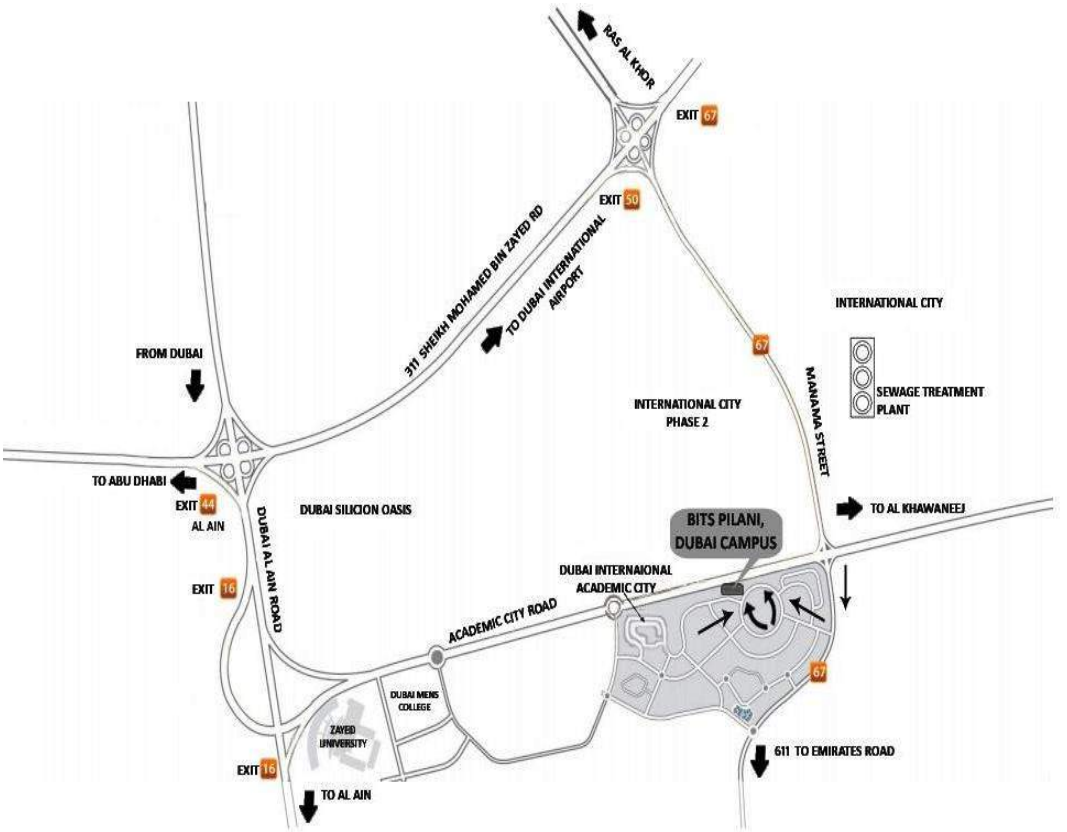
Lab, Material Testing Lab, Heat Transfer Lab, Prime Movers & Fluid Machines Lab, Mechatronics & Automation Lab, Microbiology Lab, IMA Lab, Advanced Molecular Biology Lab, Microscopy and Imaging Facility, Cell Culture Facility, Microalgal Culture Lab, Biotechnology Research Lab, Computer Programming Lab, Software Systems Lab, Algorithm & Computational Engineering Lab, Networking & Multimedia Lab, Centre for Intelligent Computing, Microprocessor Lab, Concrete Lab

Soil Mechanics Lab, Transportation Lab, Surveying Lab and CAD Lab.

For more details, please visit:

http://universe.bits-pilani.ac.in/Dubai

ROUTE MAP BITS PILANI, DUBAI CAMPUS



K.K. BIRLA GOA CAMPUS AND ITS FACILITIES

The facilities available at BITS Pilani - K.K. Birla Goa campus include:

Student Housing

The institute is fully residential. There are separate hostels for boys and girls. First year they will be provided double-seated shared accommodation. Separate private room will be provided from second year onwards. There is a 'hostel attendant' stationed in each hostel.

Each room of the hostel is provided with modern furniture and Internet connectivity. Hostel common rooms are equipped with recreational facilities like Table Tennis, Carom & Chess along with LED TV with Dish connection, newspaper and telephones. Badminton court illuminated with solar lights inside the hostel lawn. Hostels are provided with Aqua guard purified drinking water facility with water coolers, and solar/electric geyser hot water for bathing. Each hostel is fitted with a CCTV camera and a security guard is posted for the security of students & hostel. The external housekeeping agency maintains the cleanliness of common areas of hostel & its surroundings daily.

There are three student dining to cater the food for the students which are run by outsourced mess contractors. There are three large sized Dining Halls with a seating capacity of 1200 students at a time. Each dining hall is well equipped with modern equipment and furniture.

Guest Accommodation

Excellent facilities are available for boarding and lodging on payment at Visitor's Guest House built in the southern corner of the campus. The guest house facilities include 11 AC rooms with modern amenities, a AC lounge, a AC dining hall and a level grass lawn.

Central Library

Spread over 3512 sqmts. area, the central library has a seating capacity of 550+ and includes several reading halls and a large area for book storage. It has a good collection of over 43,460 books in print and 1755 e-books on a wide range of subjects. The library subscribes to 46 print journals. Subscription to important digital libraries and databases like IEEE Xplore online, Science Direct, Scopus, ASME, ProQuest and ACM DL etc. provide full access to thousands of online journals to faculty, students and researchers.

Educational CDs, audio/video cassettes and question bank are also available. The textbook section keeps copies of all prescribed text books and reference books. A digital repository of resources curated from these as well as from the publications and dissertations of the Campus' faculty members and students is being built up.

A new initiative for making the Library a "Happening Place", taking a cue from the NAAC recommendations, is evolving through the leadership of the Library Committee. New comfortable and aesthetically pleasing furniture has been procured; spaces like lounge area and exhibition area and peripheral utility infrastructure have been developed to make the 'reading space library' experience more comfortable and enjoyable for the users.

The library has been provided with a wireless network whereby users can access the internet using laptops. The library transactions and search are managed using the (FLOSS) KOHA Library Management Software to automate its entire housekeeping activities. In this, the Campus is among leading campuses in the country. The bibliographic and holdings databases of books and e-journals can be accessed from anywhere in the campus through a Local Area Network. Using Shibboleth platform the library members can now access e-journals from anywere Indigenous projects are afoot to harness the same to a mobile phone-based social network

Computer Centre

Computer Centre (CC) has a central computing lab having 316 workstations (DELL and Lenovo) connected through LAN. The CC lab has been divided in three zones for the optimal use of the lab. These workstations operate under LINUX and Windows environments and support a variety of software tools such as C, C++, Java, Python, Microsoft visual studio,

MySQL, Xilinx, ModelSim, Adobe Photoshop, OpenCV, Pro-Engineer, ANSYS, COMSOL, Matlab, AutoDesk etc. CC supports all Departments for their software, hardware and storage requirements. CC provides computing and storage facilities for students, staff and faculties of the Institute. Presently, with the existing facilities, the CC provides support for conducting online examinations for several courses viz. Computer Programming, Data Structure and Algorithms, Operating Systems, Computer Networks, Creative Multimedia, Computer Architecture, Database Systems, Engineering Graphics, Control Systems, etc. BITSAT Admissions, student elections and other online events are also conducted in the central computing lab. Apart from the computing facilities, CC supports a LAN of 10000 nodes and Wi-Fi with intranet and internet facilities in the entire campus. There are two internet lines: 300 Mbps from GWave for hostel rooms, 250 Mbps from Vodafone for academic block and staff quarters. 50Mbps dedicated internet bandwidth is provided for WILP classes. The 45 Mbps MPLS line is provided for video conferencing applications in Telepresence rooms. In the academic block multiple display units are installed for information of the campus activities. The centralized email solution is supported by Google. This solution is an integrated solution covering email with 30 GB space, file storage with 5 GB space, collaboration tool, file sharing, personal web pages, calendaring system, etc. CC also provides technical support to all the CCTV installed in the campus.

Voice and Video Communication

All faculty members have been provided with a laptop and IP phone facility in their chambers. The IP phone facilitates receiving incoming calls directly from anywhere and can make intranet calls.

Multi-point video conferencing facility is made available using POLYCOM HDX machine. This facility is utilized for online meetings of research groups and faculties interviews in India as well as across the world apart from the administrative meetings.

Virtual Classroom

Virtual classroom (BITS Connect 2.0) is set up at K K BIRLA Goa campus. This facility enables faculty to deliver lectures to all four BITS campuses, alumni and experts to remotely deliver lectures and conduct workshops or panel discussions to multiple BITS campuses in real time, with recording and streaming of lectures.

Telepresence Conferencing Room

A 34 seat CISCO Telepresence conference room (BITS Connect 2.0) allows an impressive multipoint tele-conferencing facility among all the BITS campuses. Also, a 180 seat Telepresence classroom is provided for delivering and receiving interactive lectures between all the BITS campuses in real time. These facilities are used for cross campus courses, guest lectures, administrative meetings and online meetings of research groups in India as well as across the world. Telepresence at K K BIRLA Goa campus facilitates virtual meetings for academic and administrative decisions at University level. Licenses for WebEx (web conferencing software) have been provided to all the faculty to facilitate discussions related to coursework and research. This facility also provides avenues for multimedia collaboration with anybody outside the campus.

Open Source Software Development Lab and Bring Your Own Device

As a part of an effort to make CC lab enhancement, a Open Source Software (OSS) Development Lab can be used by students and faculties to study and develop OSS/Apps, especially for Linux and Android based systems. Also, a collaborative learning with students own personal digital devices on campus, bring your own device (BYOD) area has been designed in the CC lab. It is created with the purpose of encouraging students to use technology to support their academic learning and research. Students are permitted to bring devices that can connect to campus Wired/Wi-Fi networks for any accessible digital content.

Auditorium and Seminar Hall

A centrally air-conditioned digital auditorium with a seating capacity for 2141 persons with a project area of 714 Sq. ft. is available for Workshops, Seminars, Cultural Events, Orientation Programs, Movie Screenings and

specific live events. All the significant events of the Institute and student fests are also conducted in the auditorium. The auditorium has EB-PU2216B 16,000-lumen large venue laser projector with 4K Enhancement Technology (1920 x 1200 x 2) for display. Also, it has a very powerful audio system with live mixing powered by NEXO with a digital mixer, which allows multiple mics connections (8 Corded mics, 4 Handheld wireless mics, 2 Podiums with mics and 2 Lapel mics).

The recently constructed smart seminar hall has a built-in area of 2500 sq. ft. with 178 seating capacity and is an excellent venue for all kinds of national\ international seminars, conferences and workshops. The seminar hall has 8500 lumens projection with 120 sq. ft. screen size and stage area of 680 sq. ft. The audio-visual setup with live mixing capabilities in the seminar hall delivers an unmatched video and audio experience. Also, enables even smarter online conferencing tools and smarter presentation capabilities. The seminar hall is connected with a high internet bandwidth (250 Mbps) to conduct virtual seminars globally. Also, wireless connectivity is established for live interaction, feedback, polling etc.

Workshop

The workshop is spread over 24,800 sq. Ft. area and encompasses four main sections such as machining, casting, carpentry and welding. In addition, workshop also houses metrology lab, polymer & forming lab, pneumatic / electro pneumatic lab, 3D printing, material testing lab and electroplating lab.

The machining section is well equipped with metal cutting machine tools like lathes, milling machines, drilling machines, shapers, pedestal grinders, tool cutter grinders, Bandsaw Machine, etc. A Piezo Electric Cutting force Dynamometer is used for force measurement. There is also a separate CNC machining segment with production machines like CNC lathe and CNC Milling centers (3-Axis & 5-Axis). The casting section includes Electric melting furnace and Sand testing laboratory to test the sand properties like sand grains, strength, moisture, permeability etc. The carpentry section has the facilities of wood working lathe, planning machines, Jig saw machine and band saw machine. The welding section has facilities for Arc, Gas, TIG and MIG welding in the workshop.

A separate Metrology laboratory is also well equipped with measuring instruments like sine bar, dial gauge indicators, gauges, Vernier Height Gauge, etc. Advanced measurements such as Co-ordinate Measuring Machine (CMM) and Surface Roughness Tester is also available. The Non-destructive testing (NDT) equipment's like Ultrasonic Flaw Detector, Magnetic Particle Testing device is housed to introduce the concepts of NDT.

An Electric Discharge Machine is used to introduce the students for Non-conventional machining & the concept of layer manufacturing is introduced using Polymer 3D Printer.

Pneumatic section with pneumatics and electro pneumatics set ups (Make Festo Controls) and a pick & place pneumatic manipulator is used to teach the concepts of Low Cost Automation using Pneumatics.

Workshop houses a well-equipped polymer and composite lab with equipment's like screw extruder, Hydraulic Press, Density and Melt flow index tester, Dynamic Mechanical Analyzer (DMA), HDT & VSP tester, UTM, Izod Charpy impact tester, Creep testing of Polymer & Rubber etc. Rheometer with accessories for measuring the viscous flow behavior and an Injection Moulding Machine is also being installed.

The Material Science Lab is equipped with Low Force Test System (UTM) (2KN), BISS, UTM - 100KN, Acoustic Emission System, Cryogenic Treatment Equipment, etc. It also has machines like pipe bending machine, Compression Moulding Press and Muffle Furnace.

There exists an electroplating section where Zinc plating is carried out on the workpieces produced

Laboratories

The Institute provides labs equipped with sophisticated instruments and apparatus for students, faculty and research scholars.

Optics Lab, Spintronics Lab, Semiconducting materials and Devices Lab, Nanomaterials and Optoelectronics Lab, Soft condensed matter lab, Wet lab for material preparation and Central Physics lab for material

characterization. Undergraduate Physics Teaching Labs are Mechanics, Electromagnetism and Optics Modern Physics and Advanced Physics Lab.

The department also has a newly constructed Astronomical Observatory Measurement Techniques (Biology) Lab, Biotechnology Lab, Genetic Engineering Lab, Animal Cell & Tissue Culture Lab, Microbiology Lab, Applied & Environmental Biotechnology Lab, Advance Bio Lab, Cognitive Neuroscience Lab, Faecal Sludge Management Laboratory, Vector Biology Laboratory, Proteomics Lab, Water Sanitation and Hygiene Laboratory , Marine Biology and Therapeutics Laboratory , Animal Cell and Tissue Culture Laboratory , Microbial Biotechnology and Vector Biology Laboratory, Environmental Surveillance laboratory, RNA lab, Animal House, Green House Computational Biology Laboratory,

Computational and Theoretical Chemistry Lab, Inorganic Chemistry Lab, Biosensors Lab, Nanomaterials Lab, Applied Chemistry Research Lab, IMA Chemistry Advanced Instrumentation Lab I, Chemistry Advanced Instrumentation Lab II, Energy and Environmental Chemistry Lab, Green and Supramolecular Chemistry (GC-SC) Lab, General Chemistry Lab I, General Chemistry Lab II.

Digital Communication Lab, Embedded Systems Lab, Electric Machines Lab, Instrumentation Lab, Microelectronics Lab, Power Electronics Lab, Reconfigurable Computing Lab, Network Embedded Systems Lab, Remote Embedded Lab, Advance Communication Lab, Sponsored Research Lab. Labs of the Department of EEE are equipped with the following Major Facilities for higher education and research work: Anechoic Chamber, Vector Network Analyzer - Keysight, USA, Logic Analyzer - Tektronix, USA, Arbitrary Waveform Generator – Tabor Electronics, Israel, USRP (Universal Software Radio Peripheral) - National Instruments, IRNSS + GPS Receiver, Cadence EDA Tools, Mentor Graphics (HEP) EDA Tools, TCAD Tools and Xilinx Vivado System Edition Measurement Techniques Lab, Proteus Simulation Software, Keil Micro-Vision Software, IBM Rational Rhapsody, Snapdragon Development boards, Keithley Source Meter.

The Language lab (Media Lab CC-122) is located at the Computer Center which is equipped with 12 cubicles for research scholars for their research studies, 2 cupboards for storage of books and equipment's, 2 high end system for video editing, 3 DSLR cameras with lens,2 Speaker, 1 tripod ,1 Zoom audio recorder, 19 Plastic chairs, 8 office chairs, 1 Studio table, 1 Camera Stabilization, 1 Gimbal tripod for camera, 5 Studio lights. This lab is also used for conducting the practical classes for Introduction to Contemporary Arts (HSS F313) and for Art Exhibitions. Short Film and Video Production (GS F343).

Advanced Robotics Lab, 3D printing and image processing Lab, Thermal Systems Lab, Laser materials Processing Lab, Dynamics and Vibration Lab, Coating Lab, Computational Lab, Optical Microscope Lab, Thermal science Laboratory, Prime Movers & Fluid Machines Lab, Heat Transfer Lab, Material Testing Lab, IC Engines Lab with Low Speed Wind Tunnel Polymer Processing Lab, Plastic Testing Lab, Material Science Lab, Microfluidics Lab, High Speed Aerodynamics Lab, etc. Robotics & Automation Lab, MEMS Design Center, Thermal Science Lab, Prime Movers & Fluid Machines Lab, Heat Transfer & Fluid Mechanics Lab, IC Engines Lab with Low Speed Wind Tunnel Facility, Dynamics & Vibration Lab, Polymer & Composite Lab, Material Science Lab, Material Testing Lab, Advance Research Lab, Tribology Lab, High Speed Aerodynamics Lab, etc.

Chemical Engineering Lab-1 with facilities related to Process Control and Heat Transfer. Chemical Engineering Lab-2 which caters to Reaction Engineering and Engineering Chemistry. Chemical Engineering Lab-3 which caters to Mass Transfer, Selected Chemical Engineering Operations and Fluid Mechanics. Computational Chemical Engineering Lab, Sophisticated Instrumentation Lab, DST-FIST Lab. Research Lab 1 to 13 caters to Process Engineering Technology, Gas Hydrate, Material Synthesis, Environment & Energy Lab, Biochemical Engineering Lab. Scientific Computing Lab and Media Lab equipped with Two SLR Cameras – Canon 80 D and 1300D

(with Lens Kit), Boom Microphone, Zoom Voice Recorder, Editing Suite, and Adobe Kit.

In addition to computer center facility, the Computer Science department has a data center and an additional lab with following facilities, for higher degree and research work. In the data center, we have an HiPC Server (For University-wide Computation Service) with two master nodes from and nine compute nodes. The later have 200 CPUs in total. We have 128 TB of storage managed by a Dell server. The HiPC setup used MPI on IB backbone and ethernet connectivity. 650 MFLOPS tested nominal 1TFLOPS. There are two NVIDIA DGX servers for carrying out research in Artificial Intelligence. One DGX station is with eight NVIDIA® Tesla® V100 Tensor Core GPUs and 256 GB GPU memory. The another is with four NVIDIA® Tesla® V100 Tensor Core GPUs and 32 GB GPU memory. The stations are integrated with a fully-connected four-way NVIDIA NVLinkTM architecture. The additional lab has 150 state-of-the-art computers with the necessary software.

In the CS conference room, there is Senses 75-inch Interactive Intelligent Panel for Smart Presentations, Remote Teaching, and Teleconferencing. In the additional CS labs, we have Cloud computing facility, Monosek Network Analyzer, Pervasive devices for applications in wireless sensor device, FPGA Kits for Hardware reconfiguration, Multimedia Equipment, Real Time Operating Systems like VxWorks and QnX. The Scientific Computing Lab of the Department of Mathematics equipped with 24 Laptops, multimedia equipment, interacting projector, and the following software facilities for higher education and research work: MATLAB (Institute wide user's license), MATHEMATICA (30 user's license), Scilab (Free Open Source Software), FreeFem++ (Free Open Source Software) ,FEniCS (Free Open Source Software),Tora and Statistical Software R, SAGE.

HCI server for our computational server facility to accommodate virtualized workload. Xilinx network card to support fast network connectivity to the servers. People Link Bluetooth Mics to cover the voice of the conference room adequately. Installed a Biometric reader to our research lab to ease the coordination of the key with staff, faculty and students and also for proper movement of users can be monitored in the lab for safety and record management concern.

The DST-FIST Scientific Computing Lab of the Department of Mathematics equipped with 24 Laptops, multimedia equipment, interacting projector, and the following software facilities for higher education and research work: MATLAB (Institute-wide user's license), MATHEMATICA (30 user's license), Minitab (5 licenses) Scilab (Free Open Source Software), FreeFem++ (Free Open Source Software) ,FEniCS (Free Open Source Software),Tora and Statistical Software R, SAGE.

Incubator

BITS Goa Innovation Incubation & Entrepreneurship Society (BGIIES) supported bio-incubator BITS BIRAC BioNEST facility is set up with the objective of 'Enabling innovation in health care and environment for a better tomorrow.

The incubator has a state-of-the-art innovation lab for supporting experiments in Microbiology, Biotechnology and Environmental Engineering to develop technologies and startups that can provide solutions for societal challenges.

The incubator is spread over 3500 sq. ft. of office and lab spaces, surrounded by beautiful green landscape; it has the capacity to support more than 20 startups. Currently supporting about 26 incubates; in different areas like assistive devices, grey water recycling, healthcare, nutraceuticals, waste management, etc.

Networks and collaborations, legal, accounting and market research services, along with access to funding opportunities are provided to support the growth of incubated startups.

BGIIES is set up with an aim to promote, encourage, and sustain activities and programs contributing to innovation, incubation & entrepreneurship education and development. BGIIES will help to grow the incubation and overall startup ecosystem.

The Society is funding startups under Startup India Seed Fund scheme. Currently 11 startups have been supported under Grants/ Compulsory Convertible Debenture (CCD)

scheme. Key domain areas of these startups are ed-tech, EV charging, healthcare, renewable energy and waste management.

Students Activity Centre (SAC)

“Sound thoughts it’s the philosophy that become based on and BITS Goa campus too swears with the aid of using it. Sports play a pivotal position in shaping one’s character and preserving precise health. BITS Goa specifically advanced sports activities surroundings that suits global requirements and offers a honestly worldwide revel in to all our students. All the sports activities sports at BITS Goa campus are performed below the supervision of the SAC/SWD headed with the aid of using the Physical Education Officer. In addition to this, there's sports activities secretary from the scholar council. The foremost feature of the SAC is to sell sports activities culture, offer global magnificence sports activities helps for each day carrying sports, prepare sports activities in diverse sports activities disciplines and construct institute groups for the participation and Further pick out the first-rate amongst them for the National and different stage tournaments. SAC additionally organizes personnel sports activities occasions annually.

BITS Goa has various games facilities to its individuals with the chance to encounter sport either for relaxation and amusement or to a tip top cutthroat level utilizing best in class gear and a wide-scope of sports facilities.

Activities - Games and Sports

The Student Activity Centre (SAC) of BITS Pilani Goa Campus is constructed in an area of 37,000 square feet with state-of-the-art sports facilities. BITS Goa has different games offices to its individuals with the chance to encounter sport either for relaxation and entertainment or to a first-class serious level utilizing cutting edge gear and a wide-scope of sports offices. It is outfitted with indoor games offices of International standard like Table Tennis corridor, wooden badminton and squash courts. In open air sports the grounds have a BCCI endorsed very much kept up cricket ground, an AIFF supported football ground, standard volleyball courts, additionally global standard all climate manufactured tennis courts, engineered Basketball courts, with LED flood lights.

Every one of the games exercises at BITS Goa grounds are led under the oversight of the SAC/SWD headed by the Physical Education Officer. Furthermore, there is sports secretary from the understudy chamber. The principle capacity of the SAC is to advance games culture, give top notch sports works with to day by day brandishing exercises, arrange sports in different games trains and construct foundation groups for the cooperation and Further select the best among them for the National and other level competitions. SAC likewise arranges yearly games celebration of organization "SPREE". It is the greatest All India Inter-Collegiate Sports and Entertainment celebration of India, coordinated with the sole point of advancing games and social collaboration among schools from India and abroad.

Indoor Sports facilities

The Student Activity Center (SAC) of BITS Pilani Goa Campus is built in a space of 37,000 square feet with best in class sports facilities. It is outfitted with indoor games offices like wooden Badminton courts, Table Tennis lobby, Billiards room, and wooden Squash court with review display, Carom room, and a Dance room. It likewise has a music room with both eastern and western instruments, and furthermore a Prayer room. An advanced Gym fitness center, with every one of the most recent contraptions has been set up, it gives a wide assortment of wellness classes and fun exercises over time for the BITS people group.

Outdoor sports facilities

BITS Goa has a BCCI supported all around kept up cricket ground, cricket training net field 2 cement pitch and 2 turf pitches for Cricket practice, an AIFF endorsed football ground, standard volleyball courts with floodlight system, additionally worldwide standard all climate engineered tennis courts, 2 concrete and 2 synthetic Basketball courts,2 Synthetic Lawn Tennis courts with LED flood lights. All our outdoor sports offices are available to understudies, staff and employees their children and the BITS graduated class. The Institute has investigated every possibility in urging understudies to partake in sports and sporting exercises.

Shopping Center & Bank

The Shopping center is a complex of shops including a supermarket, stationery shops with printing and photocopying facility, vegetable and fruit shops, gent's saloon, ladies beauty parlor, laundry and tailor shop. There is a restaurant and a juice corner as well. The BITS Goa branch of State Bank of India is also in the complex for all banking requirements of the students and residents of the campus along with ATM. The ATM facility by HDFC bank is also in the Shopping center. All the shops have cashless transaction facility through credit/debit cards as well as money transaction apps.

Medical Centre

Medical Centre offers **primary medical care** as Out-patient Care, Emergency Room (ER) care, Specialty clinics, M Power - Rehabilitation & Counselling unit, Dental Clinic, Collection center for Laboratory service through dedicated medical & paramedical team. ER room is equipped with modern medical equipment's / facilities like - Multi channel Cardiart 8108 R ECG recorder, Ambulatory BP recorder, Multi parameters monitors, Automatic Non-invasive BP monitors (A&D Medical), Defibrillator, Nebulization machine, Infusion Pumps, Ultrasonic Therapy unit.

Specialty clinics are operational during week days in various specialties like *Orthopaedics* / *Paediatrics* / *Obstetrics & Gynaecology* / *Dermatology* / *ENT* / *Dentistry* / *Counselling* / *Physiotherapy*. These services can be utilized on prior appointment basis. In house Pharmacy is available. The institute is utilising tertiary care centres like Goa Medical College for the higher level of care in need.

Child Care Centre

The Institute runs a Child Care Centre to provide a safe, nurturing and creative environment where the children of faculty and staff can spend quality time while their parents are at work. The Centre runs a play school for kids in the age group of 2-4years in the morning and a Day Care in the afternoon for children who are more than 2 years old. Activities like sand play, water play, story time, celebration of festivals and special days and nature walks are carried out along with play-based learning activities. Children also learn creative art and craft activities. Day Care Centre is equipped with all necessary facilities such as toys, outdoor play equipment's, educational material and required infrastructure.

Parks

There are two parks available which provides greenery and space for the children to play. One of these is in the center of the residential complex and is equipped with outdoor play stations, swings, merry-go-rounds and benches, as well as a newly-setup outdoor gym facility for adults equipped with wide varieties of exercise equipment. The park is lit by solar lighting. Other smaller park is near the E-type quarters and is also equipped with swings and play stations.

Campus Placements

"The Placement Unit organizes campus placements, providing students in the final year with career opportunities for their first jobs. A large number of companies offering a variety of profiles in different sectors are contacted and hosted on campus during the recruitment cycle in both the semesters. Inviting the companies takes place for the University as a whole and is not Campus specific; however, the recruiting company chooses the campus they intend to visit. We also make use of the Cisco Tele-presence facility and the Ex 90 systems for inter-campus interviews i.e Any company visiting one of the Campuses can interview students from other Campuses using this facility" and thus students are given large number of opportunities.

The end to end placement processes is fully automated from sending invites to the companies till receiving feedback from the companies about the performance of the students. The feedback is shared to the respective departments on regular intervals.

Mentioned below is the list of companies that visited the Campus:

S.NO	COMPANY VISITED / RECRUITED
1	ACCENTURE
2	ADDVERB TECHNOLOGIES
3	ADITYA BIRLA CAPITAL
4	ADITYA BIRLA MANAGEMENT CORP-GRASIM
5	ADITYA BIRLA SCIENCE &

S.NO	COMPANY VISITED / RECRUITED
	TECHNOLOGY (ABST)
6	ADLOID TECHNOLOGIES PVT LTD
7	ADOBE
8	AEQUS GROUP
9	ALPHAGREP
10	ALTRUISTA (HEALTHEDGE)
11	AMAZON
12	AMDOCS
13	AMERICAN EXPRESS
14	ANALOG DEVICES
15	ANALYTICS QUAD4
16	ANAND GROUP
17	APPBRODA
18	APPLIED DATA FINANCE
19	ARAGEN LIFE SCIENCES
20	ARCESIUM
21	ARUP
22	ASIAN PAINTS
23	ASTROME
24	AVAAMO
25	AXTRIA
26	BAIN CAPABILITY NETWORK (BCN)
27	BARCLAYS
28	BEKAERT INDUSTRIES PVT.LTD.
29	BIG BASKET
30	BINANI - 3B FIBRE GLASS LIMITED
31	BIOCON BIOLOGIES
32	BLUE YONDER
33	BLUEJEANS (VERIZON)
34	BOSTON CONSULTING GROUP (BCG)
35	BRIGHT CHAMPS
36	BROWSER STACK
37	BUNDLE TECHNOLOGY (SWIGGY)
38	BYJU'S
39	CAMBIUM NETWORKS
40	CAPGEMINI
41	CAPILLARY TECHNOLOGIES
42	CAPITAL ONE
43	CASHE
44	CASHFREE
45	CEREMORPHIC
46	CIPHER RESEARCH GROUP
47	CISCO
48	CITYMALL
49	CLASSPLUS
50	COFFEE BEANS

S.NO	COMPANY VISITED / RECRUITED
51	COHESITY
52	COINDCX
53	COMMERCE IQ
54	COUPA SOFTWARE
55	CRED
56	CROPIN
57	CUBASTION
58	CYIENT
59	D.E SHAW INDIA
60	DALBERG
61	DARWINBOX
62	DECCAN FINE CHEMICALS INDIA PVT LTD.
63	DELL
64	DELOITTE
65	DEUTSCHE BANK OPERATIONS INTERNATIONAL (DBOI)
66	DEVREV.AI
67	DEZERV INVESTMENTS
68	DIRECT-I(MEDIA.NET)
69	DOUBTNUT
70	DREMIO
71	ECOM EXPRESS
72	EDGEVERVE-INFOSYS
73	EIGHTFOLD.AI
74	ELTROPY
75	ENZENE
76	ERNST & YOUNG (EY)
77	ESPRESSIF SYSTEMS
78	EVERWELL HEALTH
79	EXL SERVICES
80	EXPRESS STORES
81	EXXONMOBIL
82	FAMPAY
83	FAURECIA (FORVIA)
84	FICO
85	FLIPKART
86	FRACTAL ANALYTICS
87	FT CASH
88	FUTURES FIRST INFO SERVICES (PVT) LIMITED
89	GALAXY EYE SPACE
90	GALYTIX
91	GE HEALTHCARE
92	GE INDIA (AVAITION & GAS POWER)
93	GENPACT

S.NO	COMPANY VISITED / RECRUITED
94	GOLDMAN SACHS
95	GOODERA
96	GOOGLE
97	GREY ORANGE
98	GROWW
99	HACKERRANK
100	HCL
101	HDFC LIFE
102	HEAD DIGITAL WORKS
103	HERO MOTOCORP
104	HETRO DRUGS
105	HONEYWELL
106	HOURGLASS RESEARCH LLC
107	IBM
108	ICICI SECURITIES
109	IFB INDUSTRIES
110	INCEDO
111	INDEED
112	INDUS INSIGHTS
113	INFINEON
114	INFOWORKS
115	INNOMINDS
116	INNOVACER
117	INSTITUTIONAL SHAREHOLDER SERVICES (ISS)
118	INTAS PHARMA
119	INTEL
120	INTUIT
121	IQVIA
122	JIVOX SOFTWARE INDIA PVT LTD
123	JP MORGAN & CHASE (JPMC)
124	KHEL GROUP
125	KITABELI PTE LTD
126	KOMPRISE
127	KORE.AI
128	KPMG INDIA
129	KRYPT INC
130	KUHOO
131	L&T INFOTECH
132	L&T(LIMITED & ECC)
133	LAM RESEARCH
134	LATENT VIEW ANALYTICS
135	LICIOUS (DELIGHTFUL GOURMET PVT.LTD)
136	LIFESIGHT
137	LINECRAFT AI

S.NO	COMPANY VISITED / RECRUITED
138	LUPIN
139	MAIL MODO
140	MAN ENERGY SOLUTIONS
141	MARUTI SUZUKI
142	MATHWORKS
143	MAYBANK (MBB LABS)
144	MEDIATEK
145	MEDIBUDDY
146	MEESHO
147	MERCEDES BENZ R&D
148	MERILYTICS
149	MICROCHIP-MICROSEMI
150	MICRON
151	MICROSOFT CORPORATION
152	MIKO.AI
153	MISSCALLPAY
154	MOBILE PREMIER LEAGUE (MPL)
155	MORGAN STANLEY
156	NATIONAL INSTRUMENTS
157	NATWEST GROUP
158	NAVI
159	NETCRACKER
160	NIYO
161	NOMURA GLOBAL MARKETS
162	NOVARTIS
163	NURTURE FARM
164	NUTANIX
165	NVIDIA CORPORATION
166	NXP SEMICONDUCTORS
167	O9 SOLUTIONS
168	ODE HOLDINGS
169	OFBUSINESS
170	OKCREDIT
171	ONEIRIX
172	ORACLE
173	ORBEES
174	OYO ROOMS
175	PAYPAL
176	PAYU
177	PEGASYSTEMS
178	PENSANDO SYSTEMS
179	PHARMEASY
180	PHONEPE
181	PIRAMAL GROUP
182	PIXIS

S.NO	COMPANY VISITED / RECRUITED
183	PORTER
184	POSTMAN
185	PRAJ INDUSTRIES
186	PRICE WATERHOUSE COOPERS (PWC)
187	PUBLICIS SAPIENT
188	PYSIS ONE
189	Q2EBANKING
190	QUALCOMM
191	QUANTIPHI
192	QUEST GLOBAL
193	QURE.AI
194	RAZORPAY
195	REGOLOGY INC
196	RELIANCE INDUSTRIES LIMITED (RIL)
197	RENAULT NISSAN
198	RETAIN IQ
199	REVOS
200	RIPPLING
201	RUPEEK FINTECH
202	RUPIFI TECH
203	SAAVN MEDIA
204	SAMSUNG SEMICONDUCTOR INDIA RESEARCH
205	SBI MUTUAL FUND
206	SCIENAPTIC SYSTEMS PRIVATE LIMITED
207	SEARCE
208	SECUREWORKS
209	SEDEMAC
210	SELEC CONTROLS PVT. LTD.
211	SERVICENOW
212	SIEMENS DIGITAL INDUSTRIES
213	SIEMENS EDA
214	SIGMOID ANALYTICS
215	SILICON LABS
216	SIMPL
217	SKF INDIA LTD.
218	SLICE
219	SONA COMSTAR
220	SPRINKLR
221	STELLANTIS
222	STRAND LIFE SCIENCES
223	SUPERSET
224	TATA ADVANCED SYSTEMS LIMITED(TASL)
225	TATA CONSULTING SERVICES (TCS)
226	TBV TECHNOLOGIES

S.NO	COMPANY VISITED / RECRUITED
227	TEJAS NETWORKS
228	TEKION
229	TEKTRONIX
230	TENSTORRENT
231	TERADATA
232	TEXAS INSTRUMENTS INDIA PVT. LTD.
233	THERMAX
234	THOROGOOD ASSOCIATES
235	TIGER ANALYTICS
236	TOSHIBA
237	TREDENCE ANALYTICS (US)
238	TRESVISTA
239	TRILOGY INNOVATIONS
240	TRUKKER
241	TRUMINDS
242	TURVO
243	TWILIO
244	UBER
245	UBS
246	UDAAN
247	UNI
248	UNITED HEALTH GROUP (OPTUM)
249	UPGRAD
250	UTC-CARRIER CORPORATION
251	VIACOM 18
252	VISA
253	VMWARE
254	WALMART GLOBAL TECH INDIA
255	WCB ROBOTICS
256	WELLS FARGO
257	WESTERN DIGITAL (WDC)- SANDISK
258	WIPRO
259	WOODSTOCK FUNDS
260	WORKSPOT
261	XILINX-AMD
262	YUGABYTEDB
263	ZENDRIVE
264	ZEST MONEY
265	ZF WABCO
266	ZINNOV (DRAUP)
267	ZLURI
268	ZOMATO
269	ZS ASSOCIATES
270	ZYNGA GAMES NETWORK PVT LTD

Practice School

While the practice school (PS) is a centralized activity for the university, the Practice School (PS) division coordinates the PS-I and PS-II activities for student of the campus. Apart from performing several functions required to conduct this centralized activity, on campus faculties are deputed by PSD for different PS-I stations across the country. These faculties mentor the students in PS-I activities along with the mentor from the industry. PSD also is involved in expansion of industry base that partner BITS in the practice school activities.

During SEM I and SEM II, 2022-23 974 first degree students and 152 higher degree students undergone the PS-II program from the campus. During summer term 2022, a total of 841 students undergone PS-1 program in 217 stations from the campus.

Cultural and Recreational Activities

Students have cultural clubs to cater to interests such as photography, music, foreign languages, cinema, painting, arts, dance, literary, debate and drama to name a few. There are multiple technical clubs in the topics of Robotics, Aerodynamics, Block Chain, Astronomy, Auto-mobile building as well. Along with all the conventional sports club, BITS Goa also has one of the best Ultimate Frisbee Club in the country. All these clubs enrich the quality of campus life at Goa.

Students organize various inter-institute national festivals: “Waves” is the Annual Cultural Festival and “Quark” the Annual Technical Festival. An inter-institutional sports festival “Spree” draws enthusiastic participation from young sportspersons. Along the national festivals, students also organize inter-hostel festival called “Zephyr” for all students on campus.

Students also organize TEDx under which talented individuals from across the country and the globe are invited to present their innovative ideas.

Major Indian festivals such as Makar Sankranti, Lohri, Holi, Ganesh Chaturthi, Onam, Durga Puja, Diwali, Jagannath Yatra and Christmas are celebrated by the entire campus community.

Classical Music, Dance and performing arts have a strong presence supported by classes held on campus for students, staff and children. The student group “Srutilaya” organizes concerts and workshops by eminent artists.

The campus Film Screen Club organizes screenings of latest release movies, as well as educational films with interactive sessions with the directors.

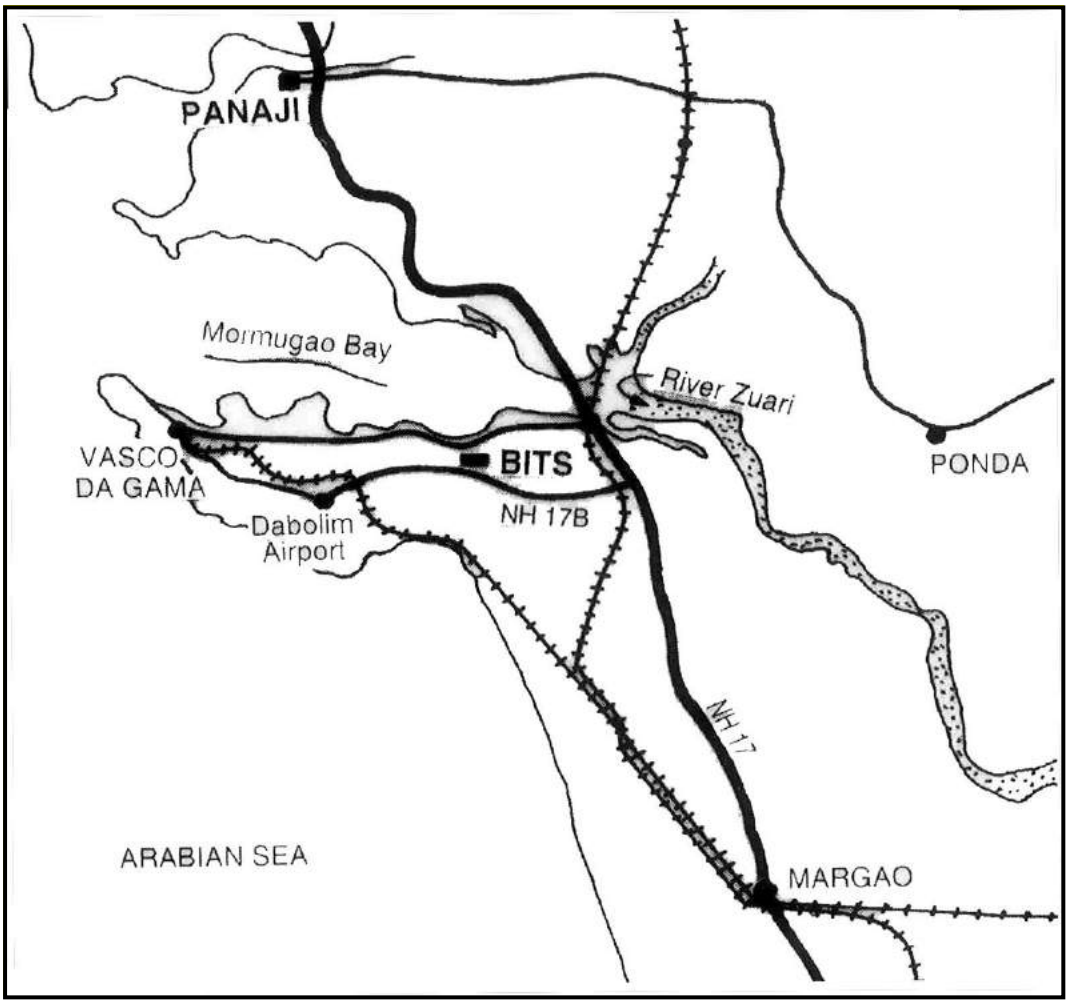
The Staff Cultural Association brings the staff members and their families together and organizes annual events such as SANGAM which is a cultural function, “Spoorti a sports event, and Funfair which involves participation from staff and their families. It also organizes annual event Chaupal for senior citizens of Campus.

Environmental Awareness

Campus maintains lush green gardens with a rich collection of flora and fauna. Every year during the monsoon, tree plantation drives are conducted with the help of the students and staff. Solar water heaters are provided at all hostels which accommodate 3500+ students. On grid solar power generation of 100 KW is installed over roof of main building. Around 40 standalone solar powered street lights are installed in the campus. Around 95% of the street lights in the campus are connected to off-grid solar power plant of 21 kW per day. These street lights function on solar power for about six to eight hours every night. Groundwater recharge points are created across the campus. In this, the surface runoff water during monsoon is directed to a designated area which then percolates in the ground resulting in groundwater recharge. All overhead tanks and water coolers are fitted with floats, sensors and other mechanisms to shut the water supply and avoid overflow. Domestic waste generated in the campus at residences, hostels, messes, etc. is segregated at source into dry, wet, electrical and medical waste. Wet waste is treated in a bio-gas plant and composter machine, with the capacity to treat one ton of waste each on daily basis. Dry waste is further segregated as per norms and handed over to GHMS approved vendor for recycling. All garden waste is composted and converted into manure which is used to maintain the garden.

The Sewage Treatment Plant (STP), with the capacity of 600 cusec is working round the clock to treat sewage generated by residents of the campus. The treated water is also recycled by using it to maintain lush green garden. The sludge generated at STP is transferred to drying bed in the vicinity of STP which is used as manure after drying. Eco Club by students also carries out activities such as campus clean up drive, bird watching. The animal welfare committee works towards the harmonious coexistence with animals and birds in the campus especially street dogs.

ROUTE TO BITS PILANI – K.K. BIRLA GOA CAMPUS



Institutional Address:
BITS Pilani – K.K. Birla Goa Campus
NH17 B, By-Pass Road
Zuarinagar – 403 726, GOA
Phone: 0832 - 2580101
Home page: http://www.bits-goa.ac.in

The campus houses the main academic building, hostels for boys and girls, Student Activity Centre (SAC), library, residential quarters for faculty and staff, medical centre, playgrounds and a shopping complex. The main building comprises of centrally air conditioned classrooms, Central library, Auditorium, laboratories, lecture theatres, faculty chambers and administrative offices.

Student Housing

BITS Pilani, Hyderabad Campus is a fully residential campus outside the bustle of the city, yet not far from the attractions of the city during weekends. BITS Hyderabad boasts **9 boys & 3 girls**' hostels accommodating both UG & PG students and provides 64 quarters for married research scholars. The campus provides spacious well-ventilated **double/single** room Non-AC accommodation to each student. Each room is provided with modern furniture, internet connectivity and round the clock security. Floor wise common room is facilitated with cable TV, magazines, newspapers, Table Tennis, Chess and carom boards. Other recreational facility like volley ball is also available in each hostel QTs. Potable drinking water is available in each floor and telephones are provided in all the hostel offices.

The central dining facility is available for all the students. There are two independent large dining halls with modern and well-equipped kitchens with RO plant for drinking water. A variety of food and beverage joints spread across the campus.

Computer Centre (CC):

The Computer Centre provides IT facilities and services to support students, faculty and staff for teaching, research, learning and administration. It facilitates and maintains the state-of-art networking and computational environment for the Institute. The Computer Centre has three operational sub-divisions- (i) CCIT (ii) CC Lab and (iii) Website maintenance.

The CCIT maintains the server room, which contains four Dell PowerEdge 540 servers, an IBM Blade Server-H with 14 Blade Chassis, of which 7 blades are populated on the network supporting Pentium-based PCs and Workstations of Lenovo/HP/Dell with Windows and/or Linux environments supporting a variety of software applications. The Computer Centre has supplied approximately 450 laptops and desktops for office use to our faculty and non-teaching staff. In addition to the above, we have installed approximately 1500 desktop computers for academic use in various labs. Operating Systems (Windows 10 or Windows 11/Ubuntu/Linux/Centos) and Microsoft Office are installed on all computers, along with e-scan comprehensive security.

The CCIT manages and maintains the campus-wide network which is built using Cisco three-tier architecture with wired and WiFi access to users. At present, the campus LAN is connected to 3.0 Gbps dedicated fiber leased line (taken from four different ISPs) for Internet connectivity to the entire campus community, and one 2 Mbps PRI line for telephones at various offices within the campus. Provision is made to increase the total Internet bandwidth to 4.0 Gbps, if needed.

Recently, the SSL-VPN has been configured for accessing our network resources remotely and securely.

The ISP WAN (from different vendors) links are load balanced through a Radware Alteon load-balancer for better monitoring of WAN links, bandwidth allocation to different VLANs, and to provide application level QoS to users. Two Sophos XG7500 UTM devices sit on the periphery of the network for authenticating users, performing web and spam filtering etc.

The CCIT is also responsible for creating and managing official e-mail IDs for all students, staff, departments and divisions, using Google's centralized e-mail solutions.

The CCIT also maintains the Voice over IP (VoIP) infrastructure and the Telepresence (TP) infrastructure in the campus. Using the TP facility, BITS Hyderabad campus establishes connectivity with three other BITS campuses to conduct conferences, meetings and online live lecture sessions.

The **Central Computing Laboratory (CC Lab)** facilitates the computational requirements for teaching and research in BITS Pilani Hyderabad campus. It manages eight computational laboratories for teaching and research. The CC-Labs facility with approximately 500 PCs is accommodating integrated teaching with computational/ numerical tools. In each academic year, CC Lab facilitated 50 courses (approx.) from engineering and science departments, and the number may increase in the next academic year. A dedicated research lab equipped with 50 desktops is serving the research needs of the faculty and students working on funded projects, dissertations as well as on design-oriented-projects. The CC Lab maintains 30 network-based software/numerical tools, including the course-specific software and the general application software. The course-specific licenses include Design Tools- Auto CAD, FLEXSIM and PTC Creo, Numerical Computing Tools- MATLAB, MATHEMATICA and MATHCAD, Computational Fluid Dynamics (CFD) Tools- ANSYS CFD, Open Foam and COMSOL, Finite Element Method (FEM) analysis Tools- ABAQUS and ANSYS Mechanical, Civil Engineering Design Software- Bentley, and several other Statistical and Geographical Information System (GIS) tools. The CC Lab is also involved in the procurement and maintenance of computer-aided tools or software and the supporting hardware infrastructure for educational use. The vision of the CC Lab is to facilitate advanced computing facilities for faculty and students to enhance the teaching and research endeavors of the institute. To achieve its aim, the CC lab is constantly conducting training to staff/students that impart knowledge on basics and advancements in software/numerical tools. Further, the CC Lab helps AUGSD and AGSRD divisions in online instruction and Admissions Division in conducting the BITSAT online entrance examination. The CC Lab also supports various departments and student associations in conducting workshops, conferences, and seminars.

The **Website maintenance** of the Computer Centre manages the website specific to Hyderabad Campus. At present our Website maintenance team is heavily involved in Website upgradation activity proposed by the University.

The **Central Workshop** provides training to students and caters to the maintenance & fabrication needs of the Institute. Through the course *"Workshop Practice"*, all the first-degree students are trained to acquire the necessary skills related to various manufacturing processes like machining, casting, rapid prototyping (3D printing&3D scanning) & various trades like fitting, metrology, carpentry, smithy, foundry, sheet metal, welding, mechatronics etc. and two computer-oriented exercises, CNC Programming using CNC Simulation software (by CIMCO) and a Manufacturing Simulation software called FlexSim. Further, students of B.E. (Mechanical Engineering) are given in-depth training in various courses such as "Manufacturing Processes", "Advanced Manufacturing Process", "Computer-Aided Manufacturing" and for ME "Flexible Manufacturing Systems" & Machine Tool Engineering. Apart from routine maintenance and training, the workshop also provides fabrication services pertaining to the project works of students and also offers technical support for TBI works.

The workshop comprises various labs and sections namely Computer Aided Manufacturing Lab(CAM), Advanced Machining Lab, Metal Forming Lab, Powder Metallurgy Lab, Additive Manufacturing Lab, Metrology Lab, Machine shop, Welding, Fitting, Smithy, Sheet Metal, Carpentry, Foundry and Mechatronics. Major equipment include 1 Vertical Machining Center (Bridgeport VMC GX600), 1 EDM Wire cut facility (Model: SPRINT CUT), 1 CNC Lathe (Model PTC- 200), 1 Hydraulic press with computer control (40T), 9 Lathes, 2 Shapers, 1 Radial Drilling Machine, 1 Universal Milling Machine (Batlibai make) with indexing attachment, 1 Cylindrical Grinding Machine with internal grinding attachment, 1 Surface Grinding Machine, 1 Tool and Cutter Grinder, 1 Pedestal Grinder, 1 Slotting Machine, 1 Power Shearing Machine (Vivek Brand), 1 Portable Drilling Machine, 1 Injection Moulding Machine, 1 TIG Welding Machine, 1 MIG Welding Machine, 1 Spot Welding Machine, 1 Universal Milling Machine (BFW make), 1 Shaper (Sagar make), 1 Surface

Roughness Tester (Mitutoyo make) and 1 Hydraulic Bulge Test Rig, 1 Electro Chemical Machining (ECM) setup, 1 Lathe Tool Dynamometer, and 1 Rotational Moulding Machine, 1 M TAB CNC Lathe Trainer, 1 3-D Coordinate Measuring Machine (CMM) "Spectra", 1 HMT PRAGA Universal Tool & Cutter Grinding Machine, 1 FRITSCH Vibratory Sieve Shaker, Magnesium metal stir casting Furnace, 1 Milling tool dynamometer, 1 Drilling tool dynamometer, 1 Lathe tool dynamometer, 1 200 TON capacity Compression testing machine, Mold Testing Equipment, 1 Open-hearth furnace for smithy, 1 Gas-fired furnace for foundry, 5 Wood-working Lathes, 2 Arc-welding equipment's, 1 Oxy-Acetylene gas welding equipment, 1 Gauge planner for wood works, 1 Power Hacksaw, metrology instruments,1 Sand Muller (Capacity-75kg), 5 Panther make lathe machines, 1 HMT make High Speed Precision Lathe Machine and two 3D Printers, 13 Lenovo make desktops, 15 Dell make desktops, a CNC Simulation software by CIMCO (20 Licenses),and a NC programming software called MASTER CAM (15 Licenses), 1 Plasma arc cutting machine, 3 AC Welding Transformers, 1 Powder mixing unit, 1 Metal foam fabrication set up, 1 Muffle Furnace,1 Balance(Sartorius),1 Trolley, 1 Precision Micro Machining Center,1 FRITSCH Ball Mill (Planetary Micro Mill), 1 RETSCH Pellet Press, 1 NABERTHERM High temperature Furnace,1 Voltammetry, Corrosion, and Energy System (software included) (VERSASTAT3-500),1 BFW CNC Milling, 1 Vision Measuring Machine and 1 3D Scanner with Geo magic software(Space Spider), 1 Deep Drawing Hydraulic Press(200T) and 1 Three zone split furnace.

Medical Centre

Welcome to our esteemed Health Center, where our community well-being is our top priority. With a team of highly qualified professionals, including five dedicated doctors, eight skilled nursing staff members, and a proficient lab technician, we ensure that students and the whole staff receive the best possible care. Additionally, we have visiting consultants such as Gynecologist, Pediatrician, and Cardiologist who visits weekly. Furthermore, our team is complemented by a female and male dentist who visits regularly and a physiotherapist who provides their expertise three times a week. Whether you require a routine check-up, consultation, or emergency treatment, we are here for the community 24 hours a day, 7 days a week. We are equipped with a state-of-the-art laboratory that is capable of performing a wide range of blood tests and diagnostics. Our health center had got separate inpatient wards for male, female and staff members.

As mental health is important along with physical health, we are providing mental wellness with help of M-power which compromises 3 psychologists' who offer their services 6 days a week and a psychiatrist who visits weekly once and extend their best services to our community and students. We strive to offer comprehensive healthcare services that cater to all our community needs and help all to achieve optimal health and wellness.

Shopping Complex & Bank

The Shopping complex (Connaught Place) comprises of Aggarwal Super Market, Gents Saloon, Beauty Parlor, Laundry, Medical Shop, Post Office, Book Shop, Stationery Shop with photocopying facilities, a Fruit and Vegetable Shop, and a bakery shop.

Laboratories

The **Department of Biological Sciences** at the BITS Pilani, Hyderabad Campus has achieved numerous milestones aligned with the goals and objectives of BITS Pilani University. We have developed a robust research culture, evidenced by the long list of sponsored projects, high-impact publications, and patents in the targeted thrust areas. Our department offers various academic programs and research-oriented courses that have evolved into a perfect blend of theory and practical training. We are dedicated to making this department the country's best research and development facility. Our assets-faculty members and students continually work to improve the departmental academic and research outputs. Our students and research scholars are encouraged to do well in academics and find solutions to real-life problems. Since its inception, the department has successfully offered M.Sc., M.E., and Ph.D.

programs, making it a popular choice for many undergraduate and graduate students nationwide. Several Ph.D. students in the department have received national fellowships from organizations, including CSIR, UGC, DBT, and DST. Our faculty members have also established startup companies and strong industry linkages and are working towards strengthening these and establishing more. The department has eighteen faculty members holding Ph.D. degrees from reputed institutes who are well-recognized in their fields. Many faculty members have received reputed fellowships, including the Ramalingaswami, Ramanujan, and Wellcome Trust. The research thrust areas of the department have become highly diversified and focus on various aspects of Medical Biotechnology, Agriculture Biotechnology, Food and Nutrition, Environment and Bioenergy, Structural Biology and Bioinformatics, Parasitology, Developmental Biology, Biophysics, Microbiology, Cancer Biology, Drug Delivery, Neurobiology, Biochemistry, Molecular biology, and Health Sciences.

The department has several Inter-institutional collaborative projects at the national and international levels. The national institutes that the department collaborates with are Apollo Hospitals, Bangalore; All India Institute of Medical Sciences, New Delhi, National Institute of Ayurveda, Jaipur; Ranbaxy Research Labs, New Delhi, India; SP College of Medicine, Bikaner, Rajasthan; Indian Institute of Science, Bangalore; LV Prasad Eye Institute, Hyderabad; Shankar Netralaya, Chennai, Tamil Nadu; Mallareddy Institute of Medical Sciences, Hyderabad; Elite School of Optometry, Chennai, Tamil Nadu and Grasim Industries, Nagda. The International collaborations are with Baylor College of Medicine, USA; Humboldt University of Berlin, Germany; Osaka University, Japan; SickKids Hospital, Toronto, Canada; Huazhong Agricultural University, Wuhan, China; Avans University of Applied Sciences, Breda, The Netherlands; University of Mainz, Germany; China Agricultural University, Beijing, University of Pittsburgh, USA; University of Chicago at Illinois, USA; Mälardalens Högskola, Swedish Council of Higher Education, Sustainable Innovations Inc, Virginia, USA; Equate Health, Silicon Valley, California, USA.

Our department has organized the first International Symposium on Human Diseases in 2022 (ISHD-2022). The event brought together leading experts in inherited, infectious and neurodegenerative diseases in humans. A series of internationally-renowned speakers, including Dr. Volker Haucke (FMP Berlin), Shanti Swaroop Bhatnagar Awardee Dr. Pushkar Sharma (NII), Dr. Raghunand Tirumalai (CSIR-CCMB), Dr. Karthika Rajeeve and Dr. Rajeeve Sivadasan (RGCB-Trivendrum), Dr. Swati Biswas and Dr. Nishith Gupta (BPHC) presented their state-of-the-art research engaging young minds. Conversely, 10 Ph.D. scholars from the department held Turbo-Talks, charging the old minds. It concluded on a high note with “Career in Science”. The active participation of >120 researchers was a major highlight leaving a footprint of basic and translational research in India and beyond. Additionally, our department hosted several international scientists through Synapsis talks which triggered intense discussions that translated into active collaborations.

There are seventeen laboratories, of which three, i.e., Biology laboratory, Microbiology, and Genetic engineering, serve undergraduate and post-graduate teaching activities. In addition, Animal Cell Technology and Bioinformatics labs serve both teaching and research-related activities. The Department has developed research laboratories, namely, Genomics, Stem Cell, Plant Biotechnology, Structural Biology, and Environmental Biotechnology. In addition, four more labs have been developed to support research in Immunology, Infectious Diseases, RNA Biology, Cancer Biology, and Neurology. A specialized laboratory (DST-FIST) has been set up with financial support from the Department of Science and Technology, housing equipment like a flow-cytometer and RT-PCR machine.

The sophisticated and high-end equipment that caters to both research and teaching purposes includes BSL-2a and -2b laminar flow hoods, refrigerated orbital shakers, CO_2 incubators, FPLC, plant growth chambers, plant growth room, Inverted

microscope, fluorescent microscope, UV-vis spectrophotometers, multimode readers, advanced PCR machines, qRT-PCR machines, hybridization ovens, advanced table and floor top cooling centrifuges, ELISA reader, gel documentation system, Nanodrop spectrophotometer, Millipore Unit, -80 °C Freezers, workstation and servers for computational work. Also, the Electrophysiology unit sanctioned by the DBT-Builder project has been housed in the department. A greenhouse facility has also been constructed, pushing several exciting discoveries in Plant Biotechnology research.

On behalf of the department, we pay respect to two of our former colleagues: Late Prof. V. Ramakrishna and Late Prof. Suman Kapur. They contributed immensely to our department's development, and we will always be grateful to them.

The **Central Analytical Laboratory** (CAL) of BITS Pilani Hyderabad Campus (CAL-1 in B-Block and CAL-2 in D-Block), is equipped with modern state of the art instruments used in teaching and advanced research. These instruments cover a wide range of analysis including elemental analysis, various spectroscopic techniques, separation techniques, thermal studies, material characterization and imaging. The following list of equipment highlights some of the salient facilities that are functional: Powder XRD, single crystal XRD, FE-SEM, XPS, Laser scanning confocal microscope, Cell Sorter, 400 MHz NMR, SAXS, AAS-7000, Flame photometry, XRF, BET surface area analyser, GC, HPLC (detectors: diode array UV, RI, fluorescence), Ultracentrifuge, LC-MS-MS, DSC-60, TGA-DTA, simultaneous TG-DSC, contact angle measurement, FPLC, spectrofluorometer FP-6300, UV-Vis-NIR spectrophotometer, ATR-FT-IR spectrometer, CD, Polarimeter, Milli Q water, Impedance analyzer, Time-correlated single-photon counting spectrofluorometer, vapor sorption analyser, GC-MS and high-pressure reactor and Rheometer. Besides, three more high-end equipment namely, CHNS analyzer, Electron Paramagnetic Resonance (EPR) and vibrating sample magnetometer (VSM) are in the process of procurement. In addition to serving the internal teaching and research purposes, CAL also extends its service support to the external institutions, TBI incubates and industries.

The **Department of Chemistry** offers M.Sc. and Ph. D. (Chemistry) courses where the students are systematically trained in well-equipped laboratories as a part of their practical courses. Individual students are given the scope to run the experiments on their own with the guidance of faculty members. The laboratory facilities include organic, inorganic, physical, analytical, spectroscopy, material science and computational chemistry laboratories. The students enjoy the state of the art facilities like FTIR, AAS, Fluorescence, Raman spectroscopy, microwave synthesizer, high-end UV-Vis-NIR spectroscopy, flash chromatography, gas chromatography etc. Recently, the department has been awarded DST-FIST grant to further develop infrastructural facilities. Apart from the core facilities, department also extensively make use of the facilities in Central Analytical Laboratory. The faculty members for the department are involved in various projects such as organic synthesis, material science, and computational, physical, inorganic and analytical chemistry.

The **Department of Physics** offers M.Sc., Ph.D. and minor programs in Physics. In addition to the first-year courses, core courses for MSc are offered along with several electives. The department's faculty members conduct research in Gravity and High Energy Physics(AdS/CFT Correspondence, Quantum fields in curved spacetime, Dynamical horizons, Cosmology & gravitational waves, Mathematical Physics), Astrophysics (Neutron stars, Black Hole and Gravitational Waves emission from merger of compact objects, constraining modified gravity) Quantum optics(Quantum Optomechanics, Plasmonic Cavities, Quantum metrology and hybrid quantum systems), Computational Physics(Flow in porous media, Active matter), Materials Physics and Experimental Physics (Condensed matter - Magnetic nano-materials, Multiferroics, Quantum dots, Plasmonics, Photo-voltaics, Microfluidics).

There are three research labs - Materials Science Lab, Magneto-Optics & Photovoltaics Lab and Microfluidics Lab. The current research facilities include an Atomic Force Microscope, a Fluorescence Microscope, a Dynamic Mechanical Analyzer (TA Q800), a Faraday rotation measurement unit, a Thin Film Deposition - DC Magnetron Sputtering unit, and a four-probe resistivity measurement unit; additionally, there is a CO_2 laser engraving and cutting machine, an Impedance Analyzer (20 Hz - 1 MHz), a Programmable 2-channel Microfluidics, a high-temperature box furnace, a hot air oven, a spin coater, a Zeiss Axiolab 5 optical microscope, three servers for computing, a COMSOL simulation software with a microfluidics module, and the data analysis programmes - Igor Pro and Microcal Origin, a soft lithography fabrication unit, a PCO Edge camera (3 Megapixels at 200 fps) to study micro-flows.

The department runs undergraduate teaching labs-one First year and three Core Disciplinary Courses-Electromagnetic & Optics, Modern Physics and Advanced Physics. The "Advanced Physics Lab" course gives M.Sc. students exposure to some of the research tools. In addition, equipment to measure the Zeeman Effect, the Velocity of light, Frank-Hertz equipment, etc. has been added to the Modern Physics lab. To give students practical experience in the collection and processing of astronomical data, a computer-interfaced telescope has been purchased. Sessions for Skywatch and workshops are often held.

The **Department of Pharmacy** offers B. Pharm, M. Pharm and Ph.D. courses where the students are trained in well-equipped laboratories for their practical exposure. The laboratory facilities include analytical instruments, equipment for pharmaceutical dosage form preparations, computer aided drug design lab, medicinal chemistry lab, pharmacology lab, molecular biology lab and BSL-3. The department has clean room facility for making formulations. Recently, it added a state-of-the-art Central Animal Facility to its existing infrastructure for carrying out advanced in-vivo experiments on rodents. The faculty of the department are involved in various projects including development of new lead molecules for cancer, TB, chronic inflammation, renal, cardiovascular and metabolic disorders; formulation development, nano-delivery systems, transdermal delivery systems, natural product chemistry and pharmacological systems.

The **Civil Engineering** department has established following state-of-art laboratories and facilities, which can provide opportunities at various levels to students, academicians, researchers and to outside agencies for consulting works:

Structural Engineering Laboratory: The major test equipment/facilities are loading frame with 200 tons' capacity static compression testing facility, Compression testing machine of 3000 kN capacity, Servo-hydraulic MTS actuator (250 kN) for Dynamic Testing, Advanced dynamic testing shake table of size 2m×3m with 12 tons payload capacity (maximum displacement ± 75 mm, velocity 1 m/s, acceleration 3g, frequency 0 to 50 Hz), Horizontal load testing strong support rig up to 250 kN capacity, Base isolator testing facility upto 150mm horizontal displacement with 100kN vertical load, A-Frame double girder crane of 10 ton capacity for lifting and shifting heavy loads, NI-9234 data acquisition system with LabView, Dytran Piezoelectric uniaxial accelerometers (5g-1000mV/g,10g-500mV/g, 500g-mV/g) Impact hammer with force sensor (500LbF-10 mV/LbF), Loadcell (500LbF range, 10 mV/LbF), Waycon laser displacement sensor (100-600mm), LAS linear potentiometer (0-500mm), HEICO Extensometer (0-4mm), APS 113 Long Stroke Shaker with DAQ system, APS0112 Reaction mass assembly with vertical and horizontal table kit.

Concrete Technology Laboratory: The major equipment/facilities available in the lab are Servo Hydraulic Compression Testing Machine (2000 KN), Universal Testing Machine-UTM (1000 KN), 20kN Tensile Test UTM, Vibrating table, Vibrating machine needle type, Sieve shaker, Cement/Mortar/Concrete Permeability Apparatus, Cement Autoclave, Torsion testing Machine, Air Permeability Apparatus, Flexural Testing, Machine, Compressometer / Extensometer, Rebound Hammer Test-NDT, Profometer (Rebar Locator)-NDT, Ultrasonic Pulse Velocity Tester, Dynamic Pull-Off Tester,

Stereo Microscope and Strain Gauges of 120 ohms and 350 ohms capacity attached with Lab View Tester, Concrete mixer hand & motorized, Concrete cutter, Flow table, Hot air oven.

Advanced Characterisation and Analysis of Materials Laboratory: The lab has Olympus Stereomicroscope, Laminar Air Flow chamber, Vibratory wire strain gage setup, Length comparator, Digital height gauge, Dilatometer bench, Muffle furnace, Colorimeter, Rapid Chloride Permeability Test setup, Orbital shaking incubator (Heating), Mini fridge.

Highway Material Testing Laboratory: Highway Material Testing Laboratory is equipped with equipment namely universal penetrometer, ring and ball softening point apparatus, advanced ductility and elastic recovery apparatus with both heating and cooling arrangements, pycnometers for specific gravity, closed cup Pensky Martin apparatus for flash and fire points of bitumen, Rolling thin film oven test, Brookfield Rotational Viscometer, Cannon Manning Vacuum Viscometer for absolute viscosity of bitumen (indigenous), Silverson High shear laboratory mixer, Ika Magnetic stirrer and heating plate, Hobart N50 Mixer, Ika Low shear Mixer, Jaw Crusher, Abrasion Testing Machine, Aggregate Impact Test setup, Aggregate Crushing Value test setup, Pycnometers and immersion basket methods of aggregate specific gravity test, Length gauge and thickness gauge for finding the shape of the aggregates, Modified Marshall apparatus with automatic compacting equipment and Indirect Tensile Strength test setup, Asphalt density Meter, Field CBR test setup, Modified Proctors density apparatus, Fifth Wheel Bump Integrator for measuring the roughness of pavement surface, Benkelman Beam for measuring the pavement rebound deflection, Merlene, Dynamic Cone Penetrometer, Soxhlet bitumen extractor, Hamburg Wheel Tracking Device (indigenous), Humidity Chamber, Straight edge, Camber Board, Cold plate hot plate thermal conductivity test setup, Cement autoclave, TRL Pendulum type pavement friction tester, Permeability test apparatus (indigenous), Centrifuge, Ovens of various sizes and capacities, 5Kva Generator, Core cutting machine Hilti Make, FRASS equipment, Asphalt Mixer, & Rice apparatus ,

Geotechnical Engineering Laboratory: The Geotechnical Engineering Laboratory has all basic and a majority of advanced instruments and set-ups to test properties of soil and rock. These include Universal Permeability Test set-up, Hot air ovens, CBR Manual & Motorized, Electronic Direct Shear apparatus Manual & Motorised, Large Shear Box apparatus, Electronic Tri-axial set-up, Brazilian Test Apparatus Unconfined Compressive Strength test set-up, Electronic Consolidometer, Linear and Volumetric Shrinkage measurement device, Swelling Pressure measurement apparatus, Model Plate Load Test set-up, Model Retaining Wall Test set-up, Model Stone-Column test set-up (Single and Group Columns), Rock Permeability Apparatus, Automatic Liquid limit Apparatus, Cone Penetrometer, Core drilling Machine, Soil Trimmer – CBR, Automatic Soil Compaction Machine and Relative density Apparatus, Cutting & Polishing machine , Sieve shaker, vacuum pump, weighing balances . The lab also has finite element software Plaxis 2D for modelling soil.

Environmental Engineering Laboratory: The lab has facilities to test most of the water quality parameters. The facilities include, Spectrophotometer – Single & Double, Thermo reactor, water bath, Jar test Apparatus, Portable water & Microbial testing kits, Hot Air Oven, Rocky Max Shaker, Multi parameter Sonde, Digital PH meter, Fluoride meter, Water level meter, Double Distillation Unit, Portable DO meter, Magnetic stirrers, weighing balance , Portable turbidity, conductivity & TDS meter , Fume Hood, Rain Gauge Equipment, BOD Incubator, BOD Analyzer , PM 2.5 and PM 10 dual dust sampler, Colony Counter , Fridge and Auto clave.

Geomatics Laboratory: The Geomatics lab has a majority of advanced instruments available for executing modern surveying techniques. The major surveying instruments available are Drone, Total stations, DGPS R4s & R3, Handheld GPS, Auto levels, Electronic Digital Theodolites Planimeter, Rodo meters & Dumpy levels along with conventional surveying instruments. The lab also has ArcGIS software for mapping and spatial analysis.

Traffic and Transportation Engineering Laboratory: This laboratory has a majority of advanced instruments and software related to traffic engineering and transportation planning. The major instruments available added to this laboratory are Speed Radar Gun, V-Box with Video camera, Noise-meter, Alcoholmeter, Lux meter, Safety manuals and Traffic signboards. The lab has the software such as N-Gene, M-Plus, NLogit software and has a traffic simulation software VISSIM.

Advanced Hydraulic Lab: This laboratory has a 2.5 m Flow channel and Wind Tunnel**.**

Structural Computational Laboratory: The Laboratory has been set for the computational requirements of graduate students and research scholars. The laboratory has seating space for 29 scholars and can be used as an instruction laboratory for computation and simulation based courses. The lab currently has 3 workstations with 32 GB RAM, Xeon octa core processor. More number of workstations are planned to be set up in this lab. The installed workstations have software such as MATLAB, Python, FeniCS.

The Civil Engineering Department also has a **Centre for Excellence in Water Resources Management** (CEWRM), which has been initiated for innovation in sustainable research, education and training in water resources management and allied fields.

The Associate Research Center (ARC) of Volvo Research Education Foundation's Centre of Excellence for Sustainable Urban Freight Systems is dedicated to investigating new ways of infusing sustainability and efficiency into the way businesses send and receive goods. BITS Pilani – Hyderabad campus is the only private institute and one of the three Indian academic institutions with this research partnership. The mission of ARC of VREF's CoE-SUFS is to change the idea of urban freight systems from one driven by profit maximization to one that accounts for the externalities produced. The research team use technology, public policy, and proactive engagement of the private sector as building blocks to design and implement actionable strategies to transform and push forward the leading edge of urban freight systems.

The **Department of Chemical Engineering** has Six undergraduate labs namely Selected Chemical Engineering Operations, Transport Phenomena, Chemical Reaction Engineering, Process Control lab, Environmental Engineering lab, Petroleum Engineering lab and. The department also houses Multiphase Systems lab, Advanced Separation processes lab, Instrumentation lab, Research Lab I & Research Lab II, Material interfacial lab, Materials Science and Engineering lab and polymer engineering lab for the Master's program.

Selected Chemical Engineering Operations Lab: This lab caters the requirements of UG students and M.E/PhD students. Both semesters students will come to this lab to perform CEL-1 and CEL-2 experiments, This lab is equipped with Super mass collider which is a ultrafine grinding machine (MKCA6-2J) used to make nanoparticles or nanofibers using wet grinding, , Fluidized bed dryer used to dry the sand and other small sized grains, Granulator used for size enlargement using binder, Double Effect Evaporator, Water Cooling Tower, Rotary Drum Vacuum Filter used for continuous filtration (solid cake is removed continuously), Jaw crusher for size reduction (cm to mm), Centrifugal pump , Fluid Mixing Apparatus, Reciprocating pump, Plate-and-frame filter press used for batch filtration, Lab-Valley beater used for refining the pulp (size reduction), Salt Spray Test Chamber As per ASTM B117 and crystallization equipment's. Thermax Boiler used to generate steam (REVOMAX) of 200Kg/hr.

Transport Phenomena Lab: This lab houses the following apparatus required for understanding several phenomena related to Heat transfer, Mass transfer and Fluid mechanics, Bubble Cap Distillation Column, Absorption in wetted wall column, Sieve plate column, Liquid-Liquid extraction column, Vapour in air diffusion, Heat exchanger teaching set up, Natural and forced convection, Thermal conductivity solids and liquids, Fluid friction measurements and losses due to fitting, Venturi and orifice meters, Bernoulli's theorem apparatus, Heat Transfer Through Composite Wall Apparatus etc. All the equipment is from K

C Engineers, and is used by UG students in their course work and research purpose.

Chemical Reaction Engineering Lab: This lab seeks to introduce undergraduate and graduate students to Kinetics and Reaction engineering processes and their study. The principal objective of this lab is to train the students on the operation of different types of reactors (namely Batch reactors, Continuous stirred tank reactors (CSTRs), and Plug flow reactors (PFRs)). This laboratory has the following equipment's- Five reactors of Mechtrix Engineers make and they are as follows: Batch Reactor, PFR, CSTR, CSTR followed by PFR in series and CSTR in series.

Process Control Lab: Process control is one of the most important concepts that is predominantly used in all chemical industries. We aim to impart the practical knowledge about various control concepts studied in the theory class via different control experiments. The lab is focused mainly for FD students where they have hands on experience related to level, temperature, pressure and pH control. Each of these experimental setups are connected to software, which further enable the students to understand the impact of each controller parameters on the desired control action. All of these experiments are based on the feedback control strategy. Details about the instruments in the lab is as follows: pH Process Control Rig, Level & Flow Process Control Rig, Temperature Process Control Rig, Pressure Process Control Rig, Make (Feedback Instruments Company).

Petroleum Engineering Lab: Petroleum Engineering Lab Provides Study and Analysis of Petroleum Products characteristics and its Properties. The facilities are mainly used by UG, HD and PhD students. The Laboratory is equipped with Red Wood Viscometer, Abels Flash Point Apparatus, Cloud & pour Point apparatus, Aniline Point Apparatus, Distillation apparatus from (Popular Science Apparatus). And Automatic Bomb Calorimeter Apparatus Reid Vapour Pressure Apparatus, Smoke Point Apparatus, and Carbon Residue Apparatus from (Koehler instrument Company), Copper Corrosion Apparatus from (Norma Lab), AVL Smoke Meter and Emission analyzer, Micro Gas chromatography from Agilent, and Fluid Cracking Reactor Unit.

Environmental Engineering Lab: The main function of the Environmental Engineering laboratory is to study systems that can be used for the control of air and water pollution. The various equipment and instruments hosted by this laboratory are as follows. Laminar Air Flow made by Bio-AIRCON which can be used to maintain sterile air flow. This provides an environment to prevent microbial contamination form air, BOD Incubator made by HMG INDIA Temp. Range: 5- 60^0 C (for BOD estimation), Dust Sampler (APM 460 NL) made by EnviroTech Particle size: PM10 (to collect and analyze dust present in the work environment), Microscope made by Thermo Fisher Scientific (to observe the size and shape of biological and particulate matter). Reverse Osmosis based water purification system Test Rig: To Develop and test technologies that can be used to improve functioning of Reverse Osmosis based water purification systems (from micro to macro scale). Measurement Techniques for Water Purification studies: pH meter made by Systronics, Colorimeter made by Systronics Wavelength, Conductivity meter made by Spectra Lab Range 0.2uS – 200 mS, Turbidity meter and water analysis kit made by Spectra Lab, are present to determine the water quality. The facilities are mainly used by UG, HD and PhD students for their research projects

Instrumentation Lab: The instrumentation lab contains state of art equipment to train all FD, HD and PhD students on characterization methods of gas chromatography (Liquid GC and additional columns), UV-vis Spectroscopy, Potentiostat & Galvanostat (Metro ohm, used to measure the Electrochemical energy conversion and storage), BET surface area analyzer, CO_2analyzer and Karl Fischer titrator (Moisture measurement in solids and liquids using chemical agents. In addition to these facilities, Instrumentation lab is also equipped with rotary evaporator, Distillation Analyser (Haage Estanit for analysis of liquid mineral oil hydrocarbons As per ASTM D86,D1078,D850 standard) Orbital Shaking Incubator REMI-CIS-24PLUS (Temp range 5- 60 deg C), Refrigerated Centrifuge), pH meter, Deep Freezer (400Litrs Up to -25 deg C), ultrasonic cleaner, probe sonicator, weighing balances, magnetic stirrers with hot plate, Digital Oil bath (6Litrs Up to 250 deg C)vacuum oven, cyclo

mixer and refrigerated centrifuge for the synthesis of nanomaterials, fibers & polymers. Additional equipment such as Orbital Shaking Incubator, optical microscope, Moisture Analyzer (50 to 200 OC, Shimadzu MOC63U), Portable D.O Meter and HD students, PhD scholar and FD project students regularly use these equipment for their projects.

Polymer and Science Engineering Laboratory: Laboratory is equipped with the International Equipment's make (Model LT-160) Digital izod&charpy impact tester & V notch cutter, The Izod test is most commonly used to evaluate the relative toughness or impact toughness of materials. Respectively. Noztek Extruder model Pro HT 600 (Temp.Range 600Deg.C), this can be used for mixing of polymers and making polymer blends and nanocomposites which can be processed further using techniques like 3D printing and injection molding. International Equipment's make (Model IE-111) Melt Flow Index Tester (Temp.Range 420Deg.C) is used to measure the flow rate of different Polymers. Hand operated injection molding which can be used to make specimen for tensile testing as per ASTM D638 standards. Compression molding machine is used to make an object according shape of mold die polymer material. Muffle Furnace 7 L (Temp.Range1200 °C): Furnaces this means heat is applied to a chamber through induction or convection by a high-temperature heating coil inside an insulated material. All these equipment used for teaching of the undergraduate course higher degree course CHE F243 and CHE G522. In addition to these facilities the lab also has melting /boiling Point apparatus which can be used upto300ºC, fume hood, hot air oven 91 L(Temp.Range300°C), magnetic stirrer, shaking water bath.

Material & Interfacial Science Lab: This laboratory has some of the state of art facilities for measurement and modification of surface and interfacial properties of various materials. The facilities include UV / Ozone System (Nova Scan,PSDP- UV4), Contact angle and surface tension measuring system (Apex Instruments, ACM-NCS), Fume hood (L1500xD915xH2300mm), Stereo Micro Scope 0.8x to 10x Magnification, Hot air oven (100L Temp Range:300°C), DC to AC Converter etc.

Research Facilities. (Multi-phase Systems lab, Advanced Separation processes lab, & Research Lab I & Research Lab II): The Aim of these labs is to promote and develop basic and applied scientific research to support ongoing research Projects. These labs have the following facilities. Fixed bed reactor (Chemito, up to 1200 OC), High pressure Autoclave (PARR reactor, 350 OC, 140 Kg/cm2), Climatic Test Chamber (Humidity 30%-95% Temperature -20 to 85°C Range), Electro Chemical Work Station From Kanopy Techno Solution PG-LYTE1.0, Bio Safety Cabinet, Ultra-Pure grade Water System ,Brookfield Rheometer (coaxial cylinder 0.026 to 8830 Pas) Temperature controller bath (RHC1000S-S1) refrigerating/ heating, -20 to 200 OC), Rotary Microtome (Leica, sections of 500 nm using tungsten carbide and diamond knife, automated), Hot Air Oven(Up to 300OC), Humidity Chamber (40 to 80% RH, 10 OC - 60 OC), Table Top Centrifuge, Probe Snoicator, Gas Detectors(Co,H2), Micro Syringe Pump, High Speed Camera , CO2 Gas Analyzer, Back Pressure Regulator, Mass Flow Controllers, Rotary Pulp Digester (160 OC, 10 Kg/cm2), The department has recently added Paper and pulp technology equipment's from the Global Engineering. Corp. Make. Consistency Determination Apparatus, Beating & Freeness Tester - Canadian Type Pneumatic Model, Reflectometer, Densometer (Gurley Type), In addition to these Facilities Electro spinning Machine (Super-ES-2, Nano scale fibers and core-shell fibers), Hot air oven (100L Temp Range: 300°C), Reverse Osmosis System (500LPH), Autoclave (Ambient to 140 degC),Tray Fermenter (Biomate India, BI-FERM-8D), Fixed bed Flow reactor Setup for CO2 adsorption study, TPD Analyzer Apparatus, Are Available for HD students, PhD scholar and FD project students.

The Department of Computer Science and Information Systems has six physical lab spaces with a total seating capacity of around 300 students. The Department also has a virtual lab infrastructure which is remotely accessible by all faculty members as well as the students of the department on request.

Academic Computing Lab 1

The Systems Lab houses 56 desktop class machines with Intel Core i7 2.8 GHz 6C processors, 16 GB memory, and Nvidia Quadro K420 2GB GPUs. This lab is used to run the core Computer Science courses in the systems domain like Computer Architecture, Operating Systems and Computer Networks and higher degree core systems courses like Advanced Computer Architecture, Advanced Operating Systems, Network Security and Advanced Computer Networks. This lab also supports popular electives like Cryptography, Parallel Computing, Network Programming, Human Computer Interaction (HCI), Pervasive Computing etc. All machines in the lab run the Ubuntu Operating System and have Free/Libre and Open Source Software, like Wireshark, compilers like GCC and JDK, interpreters like Tcl/Tk, Perl 5.0, and gawk, installed on them for academic and research purposes. The lab is accessible 24x7 for the FD/HD students, the research scholars and the faculty, through biometric authentication modules. All the machines in the lab are interconnected through a high speed LAN and connected to the other network infrastructures of the dept. The lab is connected to the Internet through the campus network.

Academic Computing Lab 2

The Data Science Lab currently has 84 desktop class machines with Intel Core i7 2.8 GHz 6C processors, 16GB memory and Nvidia Quadro K420 2GB GPUs. This lab is used to run the core Computer Science courses like Data Structures and Algorithms, Object Oriented Programming, Database Management Systems, and popular electives like Machine Learning, Data Mining, Artificial Intelligence and Foundations of Data Sciences. All machines in the lab run on the Ubuntu Operating System and have Free/Libre and Open Source Software like tensorflow, Cuda, Nodejs, Matplotlib, ffmpeg, OpenGL, installed on them for academic and research use. This lab is accessible 24x7 for the FD/HD students, the research scholars and the faculty, through biometric authentication modules. All machines in the lab are interconnected through a high speed LAN and connected to the other network infrastructures of the dept. The lab is connected to the Internet through the Campus Network.

Research & Innovation Lab 1

This lab is dedicated for sponsored research projects. Currently, it hosts three research projects: (i) ML-Aided Secure SoC and Analytics (MASTIC) funded by Axiado, (ii) Multipath Networking Test-bed for Drone Communications (MUT-DROCO) funded by DST-SERB, Govt. of India, and (iii) Defend Internet of Things-based Espionage through analysis of encrypted or unencrypted network traffic using machine learning funded by DST-SERB, Govt. of India. The lab is accessible 24x7 for the PhD students. Several state-of-the-art equipment and prototypes are designed in this lab including Drone Prototypes (Quadcopter and Hexacopter), experimental setups for investigating USB-based cyber-attacks and corresponding software solutions, and experimental setups (with corresponding equipment) to investigate cyber espionage with several types of spy IoT devices.

Research & Innovation Lab 2

This lab is also dedicated for sponsored research projects. Currently, it hosts three research projects: (i) QoE Optimized Multimedia Content Delivery through Caching in D2D undelay networks, funded by DST-SERB, Govt. of India, (ii) Defending malicious attacks on Bio-CPS devices, funded by DST, Govt. of India and (iii) Data-driven Multimodal System for Academic Stress Management in Indian Universities. The lab is accessible 24x7 for the PhD students. Several state-of-the-art equipment including smart routers, servers and several IoT devices are used by the researchers in this lab. The lab is connected to the Internet through the Campus Network.

Research Scholar Lab 1

This is a lab with dedicated workstations for the research scholars in the department. The lab has a total seating capacity of 25 and has cubicles equipped with HP Mini Towers with Intel Xeon E3-1225 V5 processors, 16 GB memory and Nvidia Quadro K420 2GB GPUs. Three cubicles have upgraded Nvidia Quadro K1200 4GB for GPUs for intensive computing and research requirements. All the workstations

are equipped with Logitech 270 auto-focused web-cams and audio devices. Each research scholar is allocated a workstation and the scholars run Ubuntu Operating Systems with the scholars assigned privileges to install any Free/Libre Open Source Software to aid their research work. This lab is accessible 24x7 through biometric authentication modules.

Research Scholar Lab 2

This is the latest addition to the department lab physical infrastructure, with 20 dedicated workstations for the research scholars. Each workstation is powered by Dell OptiPlex 5080 Tower XCTO with Intel i7 (8-Core, 16MB Cache, 2.9GHz to 4.8GHz, 65W) processors, 16 GB memory, 256 GB NVMe class 35 SSD, 1 TB hard disk, and NVIDIA GeForce GT 730, 2GB GPUs. All the workstations are equipped with web cams and audio devices. One workstation each is allocated to each research scholar and they work on Ubuntu Operating Systems. The research scholars are free to install any Free/Libre Open Source Software to aid their research work. The lab is accessible 24x7 through biometric authentication modules.

Department Virtual Infrastructure

The department has setup a virtual infrastructure which is being extensively used during the online semesters to run the lab components of different courses. In addition, server support to run projects is also facilitated. The department has dedicated 2 HPE DL 380 Gen 10 Rack Servers with Intel Xeon Silver 4114 (Deca core) processor and 256 GB RAM for this purpose.

The servers run Ubuntu operating system and are equipped to run any software tool for the lab components in any course. The servers are accessible from anywhere using ssh through a dedicated port forwarding at the campus network gateway. All the students, the research scholars and the faculty in the department have accounts on the virtual infrastructure. In addition, the department has several rack servers on standby (1 HP rack server, 2 IBM rack servers, 1 IBM storage server) which can be commissioned into the virtual infrastructure as the demand rises. The virtual infra is housed in a dedicated server room with two server racks and two 8-port KVM switches.

In addition to meeting the lab requirements of the academics and research in the CSIS dept, the department receives requests for GPU access from other depts for their research purpose and such computing resources are also provided.

The Mechanical Engineering Department has thirteen laboratories, catering to the undergraduate and postgraduate teaching and research activities of the department: Mechatronics and Automation, AI and Robotics Lab, Material Testing Lab, Product Design & Realization (PDR) Lab, Dynamics and Vibration Lab, Tribology Lab, Refrigeration Air-conditioning and Energy (RACE) Lab, Heat Transfer Lab, Hydraulic Machines Lab, IC Engines Lab, Soft Matter and Microfluidics Lab, Applied Energy Lab and Central Workshop.

Mechatronics and Automation laboratory is presently equipped with facilities such as 5-axis industrial robot, NI-Myrio Kit, Multiple sets of Docile X mobile robot, Omni wheel robot loaded with sonars, LiDAR Steering Smart Car, ABB Articulated arm Robot with finger and vacuum gripper, Smart camera evaluation kit, Mechatronic workbenches, Industrial AC servo motor kit, PLC, Hydraulic and Pneumatic training kit, etc.

The AI and Robotics Laboratory is equipped with fundamental and advanced state-of-the-art infrastructures. It includes different types of locomotion robots - Poppy Humanoid robot (27 DoF), Robonova Humanoid robot (18 DoF), DJI Mini2 drone, DJI Tello drone, BlueROV2 V4 Underwater Robot, LiDAR Steering Smart Car (Hanback). It also includes Scorbot-ER-4U Manipulator (Intelitek), Geomagic Touch Haptic Device (3D Systems) to facilitate work on Kinematics and Dynamics of Robot manipulators. Apart from these, this lab has Nvidia Jetson, Raspberry Pi, Intel Realsense, and many other sensors and actuators to aid work on the development and computation work in the area of robotics.

Material Testing Laboratory Material Testing Laboratory has the following important facilities: Universal testing machine (Zwick / Roell) consist of tension, compression, bending test

facility from cryogenic temperatures to elevated temperatures (-100º C to 1200º C) for metal, composite and polymers, Drop weight impact tester for measuring the toughness of polymers and composites, Pultrusion machine for composites processing, Rotating fatigue testing machine for metallic specimens, Creep and rupture testing machine under constant load condition, Torsion testing machine for circular metallic specimens, Ultrasonic flaw detector to detect hidden defects Other facilities include Polariscope, Polishing machine, Hot mounting machine, Digital density meter, Stereo and Inverted metallurgical microscopes (up to 500X magnification), Micro-Vickers, Rockwell, Barcol and Brinell hardness testing, Charpy and Izod impact testing, Muffle furnace (1200º C), Vacuum Oven, Magnetic stirrer, weighing balance and Euler buckling setup.

PDR (Product Design & Realization) laboratory is equipped with Rank-Taylor-Hobson computerized profilometer, additive manufacturing machine (rapid prototyping), David SL2 & 3D scanner, milling dynamometer and etching machines along with the softwares like ABAQUS, DEFORM-3D, LS-DYNA, and Design-Expert.

Dynamics and Vibration laboratory has small and medium range shakers, uniaxial/triaxial accelerometers, universal vibration apparatus, whirling of shaft apparatus, gyroscopes, static and dynamic balancing machines, wireless strain remote monitoring WSDA link, stroboscope, gearbox with spur gear arrangement to perform condition monitoring studies, planetary gearbox for wind turbine fault diagnosis, NI DAQ system for data acquisition, sensors for monitoring lubricating oil, microphones for acquiring acoustic signals, Laser Doppler Vibrometer, for contactless vibration sensing.

Tribology laboratory is equipped with a number of sophisticated equipment to study the friction and wear characteristics of bulk materials, coatings and lubricants. The available facilities include pin-on-disc tribometer, four ball tester, scratch tester with humidity controller, journal bearing equipment, micro balance, electropolishing equipment, universal tribometer with linear and rotatory modules, vacuum tribometer, tool maker's stereo microscope, infrared camera and ABAQUS and DEFORM 3D simulation software.

RACE (Refrigeration, Air-conditioning and Energy) laboratory is equipped with refrigeration and air conditioning test rigs, Solar drier test rig, Cooling Thermal Energy Storage test rig, Refrigerated/heating circulator, Water desalination cum cold storage equipment, wind emulator, wind energy training system, indoor air quality testing instrument, cooling tower, heat pump test rig, steam power plant test rig, PCM test setup, solar concentrator training system and data loggers as well as data acquisition system.

Heat Transfer laboratory is equipped with fundamental and advanced state-of-the-art infrastructures including heat exchanger modules, convection, conduction and radiation equipment setups, convection drier, thermal constant analyser, flame propagation unit, computerized fluidized bed, and a high speed camera (model no: Phantom VEO440L). Apart from these, a temperature test chamber (-5ºC to 70ºC), battery testing equipment, 3-stage hybrid evaporative cooling system, Bryair dehumidifier, ultrasonic humidifier, ejector-based hybrid vehicle thermal management system are also added in its feather as research infrastructure.

Hydraulic Machines laboratory caters to both classroom and research needs of fluid mechanics, prime movers and hydraulic machines. The lab is equipped with fundamental equipments to measure fluid flow rates, major losses, minor losses, fluid viscosity,
centrifugal/reciprocating/submersible/gear/jet pump performance test rigs, reciprocating compressor test rig, centrifugal blower test rig, hydraulic turbines, nozzle performance test module, and air flow bench for boundary layer measurements. The lab houses some of the state-of-art equipment for research in fluid mechanics such as low speed wind tunnel facility, fan array tunnel facility, hot wire anemometer, laser flow visualization, smoke generator, pulsed and continuous laser for PIV applications.

IC Engines laboratory is equipped with computerized SI and CI engine, AVL Ditest MDS 650 system with features such as smoke

meter and gas analyzer, pressure sensor adapter & tooling device, computerized dual fuel VCR system, a test rig for evaluating alternate fuels, LPG & CNG sequential kits.

Soft Matter and Microfluidics laboratory is established in 2023 primarily as a research lab that focuses on multidisciplinary research involving fundamentals of micro-scale fluid flows, interactions of soft interfaces at micro-scale, active matter and their applications in the broad areas of biology, chemistry, and material sciences. The lab makes use of research tools including, but are not limited to, microfabrication, optical microscopy, spectroscopy, wet lab tools, multi-physics simulation, mathematical modeling, and coding.

Applied Energy laboratory is equipped with Air pre conditioner, Adiabatic simulator for Advanced building materials, rotating machine and hot air convection oven, Solar driven ORC based trigeneration system

Central Workshop is equipped with numerous manual, semi-automatic and automatic machine tools and machines and providing services to all other departments and divisions

Also Mechanical Engineering Department is supported by a **Centralized CAD laboratory.** Centralized CAD laboratory has a variety of computer aided design and engineering software like Pro/Engineer, ANSYS, COMSOL, MATLAB, etc. In addition, the Mechanical Engineering Department has collaboration with Hemair Systems Ltd. Hyderabad, for establishing an **ISO-6 (Class-1000) Clean Room** in the institute for micro-electro-mechanical systems (MEMS) fabrication, which is part of the Institute's Technology Business Incubation (TBI) programme funded by the Department of Science and Technology (DST), Government of India.

Since its inception, the **EEE department** at Hyderabad campus has established laboratories with Equipment and Software worth more than ₹ **22.35** Crores. Currently, the **17** lab rooms are spanned in more than **31,000** square feet area. These labs include, Analog Electronics Lab, Communication Systems Lab, RF & Microwave Engineering Lab, Microelectronic Circuits Lab, Digital Design Lab, Microprocessor and Interfacing Lab, Digital Signal Processing Lab, Electrical Machines Lab, Control System Lab, Power Electronics Lab, Power systems lab, Instrumentation and Transducers lab, MEMS, Microfluidics and Nanoelectronics (MMNE) Lab, Optical Communications Lab, Advanced Communication Lab, Embedded Systems lab, Data processing Lab, Machine Learning Lab, Advanced Digital Communication Lab, FPGA design Lab, Mobile and personal communication, Computer Architecture, VLSI CAD Lab, Advanced Computing Lab, High Voltage Lab, IoT Lab, Electronic Materials and Devices Lab (EMDL), VLSI Architecture Lab, Analog VLSI Design Lab, Software for Embedded System Lab. These labs cater the teaching and learning requirements of the undergraduate programs in EEE, ECE & EEI and the higher degree programs in Communication Engineering, Embedded System Design and Microelectronics. Further, the students' projects, thesis, PhD research work and several sponsored projects are also implemented in these labs. A summary about a few labs are given here alphabetically:

Advanced Computing Facility is the best-in-class and one of the core labs catering to the computational needs of many laboratories in the Department. Advanced Computing Facility consists of 12 High-Performance Computing server nodes, Red Hat Enterprise Linux (RHEL) and Community Enterprise OS (CentOS), High-Performance Computing Software, and 150 High-Performance Workstations along with several general computing resources also.

Communication Systems Lab covers the basic understanding of functionalities of various block-sets involved in communication systems. It involves system design and simulation exercises using MATLAB and Simulink and experiments based on HW boards. In this Lab, the students study in detail about the various types of modulators and demodulators, transceivers and spectrum analyzer and also different types of Pulse Code Modulation (PCM) formats both using hardware and software.

Electronic Materials and Devices Lab holds the cutting edge Nanoelectronic and opto-electronic devices fabrication, characterization, and simulation facilities such as thermal evaporator, Chemical Vapor Deposition, rapid

thermal processor, spin-coater, Hot Air Oven, Electrospinning set up, Materials synthesis equipment, different furnaces (with ambiances), Automated Agilent B2912A SMU, Probe station, Keithley 2450 SMU, Four probe unit, Solar simulator, RF amplifier, optical exposure unit, Plasma Transistor Setup. Electrochemical WorkStation etc.

Instrumentation Lab focused on designing and developing various instrument layout including sensing unit, data processing unit and signal processing unit. Various data acquisition hardware, sensors, mini-microprocessors, LCD interfacing and governing software are covered in this lab.

Internet of Things Lab provides the concepts of IoT, its ecosystem, widespread applications, and design challenges. The experiments include interaction options with real-world objects through cyber-infrastructure, systematic development of IoT based solutions, approach to handling data from IoT, introduction to Python programming and Raspberry Pi kit, introduction to Arduino programming and develop controllers, basic machine learning to process data from IoT on the fly, understanding the security implications while deploying IoT applications, and basics of developing mobile applications to command and control IoT. A wide variety of sensors, actuators, and controllers are available to design real-time projects. A number of simulation platforms facilitate the understanding of cloud computing and sensor networks.

High Voltage Lab has recently been set up and it consists of all state-of the art equipment such as 100 KV AC/DC Source and control panel, 3 stage 300 KV 3 KJ Impulse Generator, C and Tan-delta Test Kit (Schering Bridge), Vacuum and Pressure Vessel, Rod Gap Apparatus – Horizontal Sphere Gap Apparatus, Rain Making Equipment, Salt Fog Chamber, and Electrolytic Tank 2-channel Arbitrary function generator 60 MHz Bandwidth, Real time signal analyzer 6 KHz - 6.2 GHz, On the other side, some sophisticated instruments also added up which include Solar simulator, Laser engraver, contact angle measurement, UV laser writer, and dry film photoresist. On the other side, some sophisticated instruments also added up which include Solar simulator, Laser engraver, contact angle measurement, UV laser writer, and dry film photoresist.

MEMS, Microfluidics & Nanoelectronics (MMNE) lab is working towards realizing futuristic smart sensors and intelligent energy harvesters encompassing various Multidisciplinary domains. This include micro/ nanoelectronics; 3D printed sensors/ actuators; microfluidics; miniaturized Bio/Chemical Fuel Cells; Solar cells; Bio-Electro-Chemical sensors; printed /flexible /wearable/implantable devices; Bio-MEMS etc. MMNE lab has a multitude of fabrication and testing capabilities such as soft-lithography, inkjet printing, 3D Printing, direct UV/ CO2/ Visible laser writing, paper-based devices, different types of microscopies, electrochemical/ optical detection setups, Solar simulators, high-speed vision etc. The global industry-academia-government collaboration of MMNE lab is directed at addressing scientific gaps and developing relevant technology while imparting state-of-the-art knowledge in the field.

Power Electronics Lab covers modelling, simulation and experimental verification of different power electronics devices/converter applications. Students are also provided with power electronic drives for performing minor projects as part of the power electronic course. Lab Consists hardware: 3-Ø Power Module, SCR – Diode Power Module, IGBT – Diode Power Module and Software: MATLAB - 2015a, P-Sim Software.

RF & Microwave Engineering Lab consists of various microwave equipment and components, to determine and plot the characteristics of Gunn Oscillator, Reflex klystron and other passive microwave components. It also included how to use various simulation software to design various microwave devices with desired characteristics, scattering parameters and field patterns. Using ANSYS HFSS to Design Waveguides, Microstrip Antenna, Microstrip Quadrature Hybrid & Design of Ring Hybrid. The Lab is also augmented with Rapid prototyping PCB Machine and Anechoic Chamber for Antenna Measurements recently. In addition to this high end workstations and softwares like CST Studio, COMSOL, AWR Office, ADS & HFSS are available

Software for Embedded Systems Design lab supports students in learning software development process as well as modeling complex embedded systems using Unified Modeling Language (UML). Students also learn to program embedded systems using Embedded C and RTOS as well as implement intelligent embedded system designs using Python programming language. The Lab has open-source tools such as Robot Operating System (ROS) and Simulators such as Gazebo, to create 3D scenarios on a computer with robots and obstacles, etc. to challenge the students to carry out interesting projects.

VLSI Lab has Industry-standard licensed tools for Computational VLSI & VLSI Design, such as Cadence EDA tools (Research Bundle), Synopsys TCAD tools (Advanced Research Bundle), Synopsys Front-End and Back-end tools, Synopsys Quantum-Wise Atomistic Modeling tools, Mentor Graphics HEP-I and HEP-II tools, etc. A new FD elective lab has been started which gives exposure of Synopsys TCAD and Quantum -wise Atomistic tools to the students.

Apart from these, EEE Department is leveraging the facilities provided by a Central Workshop, Centralized CAD Lab Central Computing Facility, Central Analytical Lab, and a Clean Room.

Sandboxx

Sandboxx is a multi-disciplinary platform to develop technologies in the domains of Internet of Things, Wearable Technologies and Consumer Electronics. The lab is envisioned as a platform that enables students in the creation of technologies that solve real world problems at the interface of engineering (Mech, EEE, CS, etc) sciences (biology, pharmacy, physics, etc) and design. This lab is for facilitating student ideas and implementation with easy access to equipment and tools such as sensors, microprocessors, power tools etc.

Tinkerers' Lab

The Tinkerers' Lab is a new addition to Sandboxx and both collectively function under I-Cell. A Tinkerer is someone who enjoys experimenting. At Tinkerers' Lab, we promote and motivate such tinkerers with the objective of growing the community of innovators. We provide them the platform to convert their creative and innovative ideas into actual engineering products. The Lab is one of its kind advanced technical facility where innovators get an opportunity to apply the theoretical knowledge learned in classes. The lab is spread over total floor area of more than 2500 sq.ft and the facility is currently being utilized by 80 innovators.

In both labs, there are many helpful equipment like Drill Stand, 3D Printers, Thermocol Cutters, Lathes and CNCs, etc, and many power tools like Heat Gun, Drilling Machine, Soldering Rods etc, along with the new addition of machines like PCB Design Machine, Laser Cutter, newer CNCs, which are student accessible and it satisfies their needs.

Some of the projects that are being innovated at the Tinkerers' Lab include but are not limited to Hybrid Aerial Vehicles, Sub scaled Rockets, Autonomous Underwater Rover.

Technology Business Incubator (TBI)

The role of Technology Business Incubator (TBI) is to proliferate overall entrepreneurial process, and to encourage and nurture an innovative idea to become a successful venture. This can be supported through creation of conducive environment, facilities, activities and engagements. In the present context, TBI is a desirable link between manifesting the potential of technical innovations and new enterprise creation. Thus, TBI plays a significant role in the regional and national socio-economic development.

To encourage innovative entrepreneurship, and to facilitate translation of inhouse generated ideas and technologies into ventures, BITS Pilani Hyderabad has established a TBI with the support of National Science and Technology Entrepreneurship Development Board (NSTEDB), DST, Govt. of India called BITS Pilani Hyderabad Campus TBI Society (TBIS).

TBIS is aimed at fostering technology / knowledge based entrepreneurial start-ups by:

- Nurturing them at an early-stage and helping them overcome limitation trough low cost services
- Offer value added services *viz*. legal, financial, technical and IPR mentoring, networking and industry connect, and fundraising support.
- Providing business environment for operation with well-equipped infrastructure support
- Support in technology commercialization and nurturing business collaborations
- Strengthening business skills / knowledge of startups and making them more enterprising
- Skill development in the region in terms of Innovation & Entrepreneurship, and creating job opportunities.
- Creating a sustainable ecosystem with multiple stakeholders for enterprise creation.

Sectors of Intervention:

TBIS offers services and incubation support to technology / knowledge-based business ideas across the sectors. However, the major thrust areas of TBIS are as follows:

1. Information & Computer Technology (ICT) for Healthcare
2. Micro-Electro-Mechanical devices
3. Biotechnology & Pharmaceuticals
4. Other ICT, such as social media, edutainment, e-commerce, *etc.*

Current Infrastructural support and facility

Working Area:

TBIS provides working area spanning over 5,000 sq ft comprising of 12 individual offices and co-working space with 14 cubicles with total capacity of housing around 25 startups.

Bio-Tech/Pharma Lab

Dedicated bio / pharma lab of approximately 2000 sq ft is available for R&D activities of incubatee startups. This includes common instrumentation facilities, cell culture lab, basic chemistry lab, five dedicated lab spaces, and access to Central Analytical Lab facilities of the host institute.

MEMS clean room (Micro-Electro-Mechanical Systems)

Clean room (Micro and Nano Fabrication Facility)

https://universe.bits-pilani.ac.in/hyderabad/cleanroom/cleanroom

BITS Pilani Hyderabad campus has established state of the art facilities for Micro and Nano device fabrication and characterization. The size of the clean room is 581 square feet and 80% of it is maintained as (ISO 6) class 1000 and the rest is (ISO 5) class 100. Entire class 100 area is covered with yellow light and dedicated for Lithography process. The facility consists of the following equipment: Wet Chemical Work Station, Two-Inch Tubular Furnace, Spin Coater System, Probe station with Source Measure Unit, UV Exposure System, Electron Beam Evaporator System, Mask Aligner with accuracy up to 3 micrometer, RF Sputter System, RF Reactive Ion Etch System, Profilometer, Microscope and Reflectometer. The facility serves to the diverse academic and research requirements of students, research scholars and faculties across various departments.

Makers space: 3D printer's, CNC machine, machining tools, Lathe etc.

Psychoacoustics Laboratory: Department of Humanities and Social Sciences has the psychoacoustics laboratory. It is a chamber with walls covered in anechoic material, providing quieter environment. The lab is used for running the hearing experiments, and for recording experimental stimuli with minimal noise intervention. Basic recording equipment is available.

High Performance Computing Cluster – Sharanga

Sharanga is the high-performance computing cluster at the BITS Pilani - Hyderabad Campus. This facility is meant for research and is used in computational sciences related to biology, chemistry, pharmaceutics, data analytics, machine learning, micromagnetics, and fluid and structural dynamics. The sister campuses at Pilani and Dubai also use this facility.

It is a heterogeneous system consisting of 25 compute nodes and 4 accelerator nodes, supporting CPU and GPU parallel computations. It has two primary (login or controller) nodes to access the cluster, compile software, and submit jobs. Furthermore, it has two parallel file system (PFS) nodes for managing the read and write operations of a parallel file system. Regarding storage, it has 250 TiB of Lustre space, excluding the redundancy. Overall, the HPC cluster has 2240 cores for CPU parallel computations. The total computing power Rpeak (a metric used to measure the theoretical computational performance) is around 220 Teraflops.

More details on the cluster can be found at https://sharanga.hpc.bits-hyderabad.ac.in.

Central Animal Facility

Central Animal Facility (CAF) at Birla Institute of Technology and Science (BITS) Pilani Hyderabad Campus was established in the year 2016 to cater the need of scientific community of different departments. CAF is registered with the Committee for Control and Supervision of Experiments on Animals (CCSEA), Ministry of Fisheries, Animal Husbandry and Dairying, Government of India, New Delhi (Registration No: - 1912/PO/Re/S/16/CPCSEA). Recently, a GLP-compliant new extension with an area of 3738 sq., ft. was added to this facility.

The major objectives of the facility are to conduct high quality animal research, provide scientific services and animal resources to students/researchers in and around this region and educate students/ researchers through certificate courses, internships and other programs. The CAF activities include: Periodical Institutional Animal Ethic committee meeting, in-vivo studies for PhD level and collaborative projects, mentoring approved scientific studies & animal welfare, and training the faculty and students for applied animal studies. The facility is used for conducting advanced research in the areas of pharmacokinetics, bioavailability studies, pharmacological screening of various compounds.

CAF has an animal holding capacity of 1000 mice, 400 rats and 50 rabbits. The building is designed as 'Two Way Corridor System (Clean and Dirty Corridor)' to minimize cross-contamination. The animal species housed in the facility are being used for various research projects approved by the Institutional Animal Ethics Committee (IAEC). All activities associated to laboratory animal research at CAF are performed as per the guidelines of CCSEA, New Delhi as well as institutional guidelines under the supervision of IAEC. Health status of the animals is being monitored by a Veterinary Doctor.

The state-of-the-art CAF has all the important requisites for a modern laboratory animal facility including animal holding rooms for different species/strains, quarantine rooms, experimentation rooms, procedure room, surgery room, autoclave room, storage room, washing area, waste collection room, etc. The facility also has exclusive nude mice rooms provided with Individually Ventilated Caging (IVC) systems and Bio-Containment Unit for housing immune-deficient mice. One experimental room with negative pressure is exclusively used to do research on animals with non-pathogenic microbial strains. Dedicated rooms to conduct behavioral study for neuroscience research are also available. Provision of a dedicated room with In-Vivo Imaging System is made for preclinical research support.

Entire facility is supported with auto controlled Heating, Ventilation, and Air Conditioning (HVAC) system including dedicated chilling plant, air handling unit and control panel. The working of HVAC system can be monitored through BMS software. As a biosafety measure, air shower, UV sterilizer, and air curtains are installed to prevent the entry pathogen into the facility. Fire protection facilities such as smoke detectors, fire alarm, and emergency exit are also available.

Provision of separate rooms for housing each species in individual rooms with controlled environment conditions such as temperature (23+2°C), relative humidity (55-60%), dark and light cycles (12:12 h) are available. A heavy-duty steam sterilizer (autoclave) has been provided for sterilization of all materials entering into the animal rooms. Biometric access control system is also installed to restrict the unnecessary inflow of personnel. All the

procedures followed in the CAF are as per the respective guidelines.

Campus Placements

At BITS Pilani-Hyderabad campus, the Placement Unit is one of the pillars which has consistently contributed to the institute's growth by meeting student aspirations & skill sets. Apart from Key placement statistics, where the BITS Pilani Hyderabad campus has witnessed a progressive growth year on year (YoY), the Placement unit has also played a stellar role in shaping the career of students by aligning them in their areas of interest.

The placement unit focuses on the recruiter connect, enhancing outreach and footprint, student skilling and providing a 'career awareness program' through scientifically designed training programs in sync with industry expectations & increase diversity in job roles/profiles. Placement Unit also worked out an industry-academic department engagement model, where students work on real-time industry problems, taking it as a semester coursework/ project. This has helped the faculty and students to be relevant to the emerging trends & industry demands. Around 309 flagship and medium size companies visited the Hyderabad campus last year (AY 2021-22), with the overall placement percentage reaching 92.8%.

Details of the companies are mentioned below:

LIST OF RECRUITERS:

Serial No	Company (AY 2021-22)
1	Accenture
2	Accolite
3	Acqueon Group
4	ACT Fibernet
5	Addverb Technologies
6	Aditya Birla Capital
7	Adobe
8	AECOM
9	Aerchain
10	Aizant
11	AkzoNobel
12	Altair Engineering
13	Altruista
14	Amazon
15	American Express
16	Analog Devices
17	Anand Group
18	Apple
19	Applied Data Finance
20	Argen Life Sciences
21	Arcadis
22	Arcesium
23	Arup
24	Assystem STUP
25	Ather Energy
26	Atkins
27	Axtria
28	Axxela
29	Bain Capability Network (BCN)
30	Bajaj Auto
31	Baker Hughes
32	Barclays
33	Bicon Biologics
34	Big Basket
35	Blaize
36	Blend360
37	Bloomreach
38	Blue yonder
39	Burns & McDonnell
40	Byju's
41	Capcount Solutions
42	Capgemini
43	Capillary
44	Carrier-UTC
45	Celigo
46	Ceremorphic
47	Chalo
48	Cipla
49	Cisco
50	City Mall
51	Class Plus
52	Codenation
53	Cohesity
54	CommercelQ
55	Coupa Software
56	Credit Suisse
57	Crowdchat
58	Custom furnish
59	Cyient

60	D.E Shaw
61	Dalberg Advisors
62	Dar Group
63	Darwinbox
64	Dassault Systems
65	Datanimbus
66	Datazymes
67	Deepak Fertilisers & Petrochemicals
68	Dell
69	Deloitte
70	Delveinsight
71	Deutsche Bank
72	Devrev
73	Dezerv Investments
74	Dinero
75	Direct-i(Media.net)
76	Disney+Hotstar
77	Doubtnut
78	Dover Group
79	Dr. Reddy's Lab
80	Dremio
81	Eltropy
82	Epsilon
83	Equilibrium Solutions
84	Ericsson
85	Ernst & Young (EY)
86	EXL Services
87	Expedia
88	Express Stores
89	Exxon Mobil
90	F5 Networks
91	Fanatics
92	Fareportal
93	Faurecia (Forvia)
94	Finance peer
95	Finwell
96	Fiorano
97	First Meridian
98	Fischer Jordan
99	Flipkart
100	Fractal Analytics
101	Freo
102	FT Cash
103	Futures First
104	GAP
105	General Electric

106	Genpact
107	Gland Pharma
108	Go Swift
109	Gojek
110	Goldman Sachs
111	Google (Software & Hardware)
112	Grey Orange
113	Groww
114	HCL
115	HDFC Life
116	Head Digital Works
117	Health Edge
118	Here Maps
119	IBM
120	ICICI Securities
121	Incedo
122	Indeed
123	Indus Insights
124	Infineon
125	Info edge
126	Infosys Edgeverve
127	Inmobi
128	Innominds
129	Innovapptive
130	Innovium(Marvell)
131	Institutional Shareholder Services (ISS)
132	Intel
133	IQVIA
134	Jacobs
135	Jio
136	Jivox
137	JP Morgan & Chase
138	JP Morgan (Quantitative Research)
139	Kfintech
140	Knowfly Labs
141	Kore.ai
142	KPMG
143	Kuhoo
144	Kyndryl
145	L&T (Limited & ECC)
146	L&T Infotech
147	L&T Infra Engineering
148	LAM Research
149	Landmark Group
150	Latent View Analytics
151	Legato

152	Lenscorp AI
153	Licious (Delightful Gourmet Pvt.Ltd)
154	Linecraft
155	Loesche
156	Logic fruit Technologies
157	LookOut
158	Lumenci
159	MathWorks
160	Maxlinear
161	Maybank (MBB Labs)
162	Mckinsey Capability Centre (MCC)
163	MediaTek
164	Medi buddy
165	Medplus
166	Meesho
167	Mercedes-Benz R&D
168	Merilytics
169	Microchip-Microsemi
170	Micron
171	Microsoft
172	Miko.ai
173	Morgan Stanley
174	MVDB Tech Services
175	Myntra
176	NatWest Group
177	Navi
178	NCR Corporation
179	Netcracker
180	Nference
181	Nielsen IQ
182	Ninjacart
183	Niro
184	Nomura Global Markets
185	Nordic Semiconductor
186	Nouveau Labs
187	Nutanix
188	Nuture.farm
189	Nvidia Corporation
190	NXP Semiconductors
191	O9 Solutions
192	On Semi
193	Onebanc Technologies
194	Oracle
195	Orbees
196	Orbicular Pharma
197	PayPal
198	PayU
199	Pega Systems
200	PepsiCo
201	Pfizer
202	Pharmeasy
203	PhonePe
204	Piramal
205	Pokarna
206	Polygon
207	Porter
208	Postman
209	Praj Industries
210	Price Waterhouse Coopers (PwC)
211	ProteanTecs
212	Providence
213	Publicis Sapient
214	Q2 Banking
215	Qualcomm
216	Ramboll
217	Razorpay
218	RBL
219	Recur
220	Regology Inc
221	Reliance Industries Limited (RIL)
222	Retain IQ
223	Rippling
224	Rivigo
225	Royota
226	RSM US LLP
227	Rupeek
228	Rupifi
229	S&P Global
230	Sainapse
231	Salesforce
232	Samsung R&D
233	Saras Analytics
234	Searce
235	SecureWorks
236	Sedamac
237	ServiceNow
238	Short Hills
239	Siemens Healthineers
240	Siemens Industries
241	Sigmoid Analytics
242	Silicon Labs
243	Siply

244	Slice
245	SMEC
246	Sona Comstar
247	SP Software
248	Spectrum Consultants
249	Sprinklr
250	SS Supply Chain Solutions
251	Star Union Daichi Life Insurance
252	Stellantis
253	Strand life Sciences
254	Super Procure(Truck hall)
255	Swiggy
256	Symphony AI
257	Synchrony
258	Tata Advance System Limited (TASL)
259	TATA Consulting Engineers (TCE)
260	Taxilla
261	Teikametrics
262	Tejas Networks
263	Terradata
264	Texas Instruments
265	Thorogood Associates
266	Threado
267	Thornton Tomasetti
268	Tiger Analytics
269	Time tooth Technologies
270	Tiny Tactics
271	Tismotech
272	TomTom
273	Tonbo Imaging Pvt Ltd
274	Toppr
275	Trane technologies
276	Tredence Analytics (US)
277	Tridiagonal
278	Truminds
279	Turvo
280	TVS Capital
281	Uber
282	UBS
283	Udaan
284	Unacademy
285	UnDos Tres
286	United Lex
287	Urban Company (Urban Clap)
288	Varian Medical Systems
289	Viacom 18
290	Visa
291	VM Ware
292	Vurbalize
293	Walmart
294	Wave labs
295	WCB Robotics
296	Western Digital
297	William O'Neil
298	Wingman
299	Workspot
300	Xilinx-AMD
301	Zeda.IO
302	Zendrive
303	Zentree Labs
304	Zeotap
305	ZF Wabco
306	Zinnov
307	Zivame
308	Zluri
309	ZS Associates

Library facility

The BITS Pilani: Hyderabad Campus Library is a gateway to knowledge resources. The Library is one of the central support services of the BITS Pilani - Hyderabad Campus. It provides information services and access to textual and bibliographic digital and print resources to the BITS Community—Institute's state-of-the-art Library with two floors spread over 45000sq.ft. The Library is fully air-conditioned with a WI-FI facility as well. Open seven days a week till 11 pm and during the tests and examinations till 1 am (mid-night). It has over 47000+ books and 1382 educational CD-ROMs and subscribes to over 50 Indian and foreign journals.

The library also subscribes to 10250+ e-journals like American Chemical Society, American Society for Civil Engineers (ASCE), American Society of Mechanical Engineers (ASME), Association of Computing Machinery (ACM), JSTOR, SciFinder, SCOPUS, Royal Society of Chemistry, IOP, APS, Nature, IEEE, Science Direct, Wiley online, etc. The Library has over 7860 e-books on engineering, computer science, life sciences and Bio-Medical Engineering. In the Digital Library, the previous year's question papers are available.

The library operations are fully computerized, and students can access the Online Public Access Catalogue (OPAC) from anywhere. The introduction of RFID technology in 2016 has enabled faculty and students to borrow and return materials whenever the library is open. This self-check-in & check out facility has made the circulation process very simple. No time restrictions for book issues and returns. Self-service facilities also allow for a much faster and more efficient borrowing and returning of books. Discussion rooms are available in the Library for the faculty and students to meet and discuss their projects and other academic-related work. The Library is equipped with the most modern furniture. The Library has been designed considering the future growth of the library collection and users' needs in the coming years.

Students Activity Centre (SAC)

Physical Education and Sports play a pivotal role in shaping students personality and maintaining good health. In this Kinesthetic learning model, students perform hands-on physical activities which values movement and creativity over technological skills, is most commonly used to augment traditional type of instruction. BITS, Pilani, Hyderabad campus have specially developed a sports and games environment that matches international standards and give a truly global experience to all our students.

There are multiple sport facilities to keep our students engaged and physically fit.

BITS, Pilani Hyderabad campus offers facilities for various Indoor Games & Sports like Chess, Carom, Table Tennis, Cue Sports, Badminton and Squash. In addition to indoor facilities, modern facilities for outdoor sports like Tennis, Basketball, Volleyball and Throw ball are available in the premises. Two indoor Badminton wooden flooring courts with Yonex mat, two Tennis and Basketball courts with synthetic surface have been provided with flood lights. The cricket ground having two pitches with grass playfields along with a spectator gallery is located inside the institute premises. Football and hockey ground along with kabaddi courts are located centrally inside the institute. A standard 400 meters clay track along with football field and swimming pool (short course) available in the Camus. In addition to the common sports facilities, separate play areas for Volley ball, Table tennis, Chess and Carom are provided in each hostel.

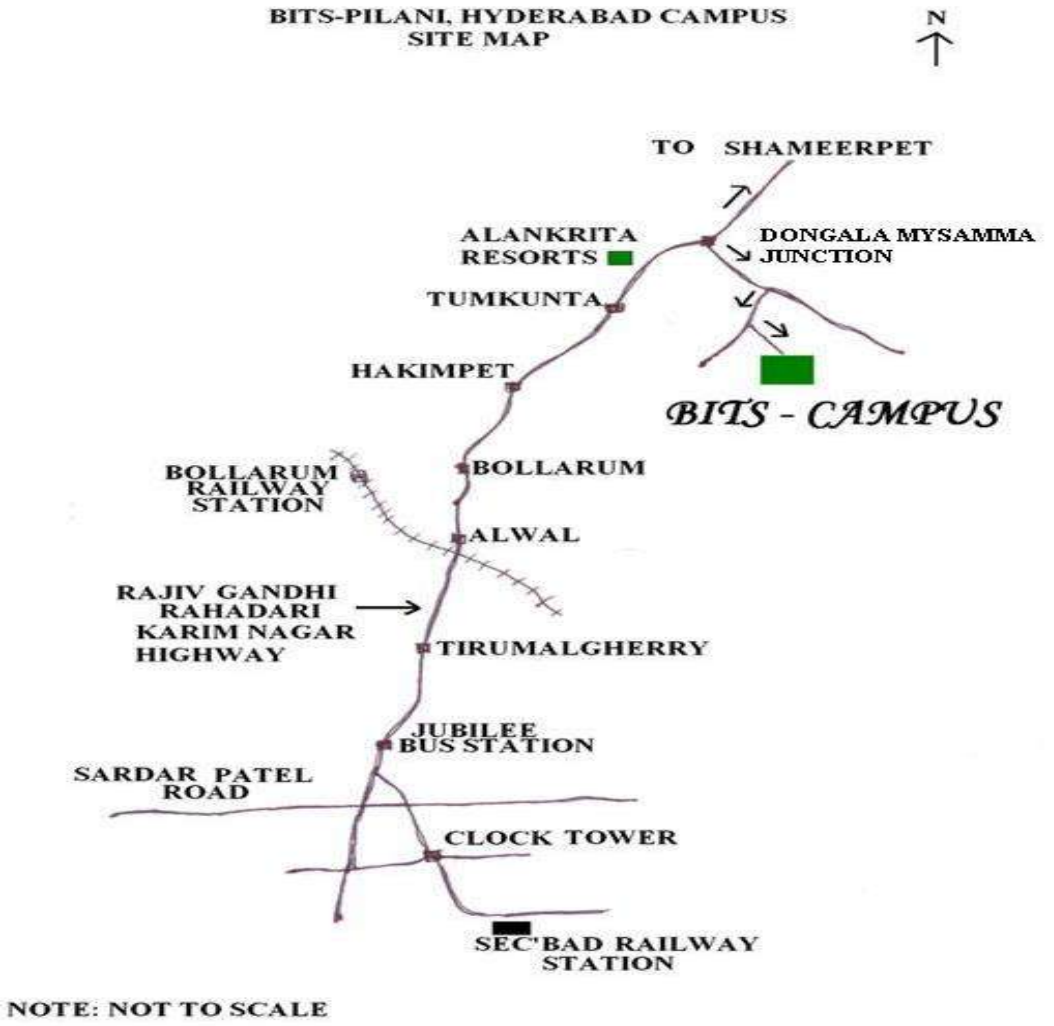
Gym: In order to ensure a sound mind in sound body, students are given special attention on health and fitness. A modern gym, with all the latest equipment has been set up in the Student Activity Center.

Inter College Tournaments: BITS, Hyderabad campus contingent participated in IIT Kanpur Sports fest UDGOSH 2022 at Kanpur. Hyderabad campus organized Inter College Tournament ARENA 2023 at our campus and universities and colleges from various cities from India.

Student Clubs

A separate hall with wooden flooring is being provided for Dance practice. The Students Union and various clubs like Music (Indian and Western), VFX, Photography, Dramatics, Shades (Fine Arts) and English Language Activities Society (ELAS) are provided with rooms inside SAC to pursue their activities. Many more clubs share space in SAC for their activities.

A variety of musical instruments like synthesizers, drums, guitars, etc., have been made available for students of the Music Club to encourage them to practice and perform.



Institutional address:

Jawahar Nagar, Kapra Mandal,
Medchal District, Hyderabad – 500078.
Telangana State. Phone: 040 – 66 303 999.
Home page: http://universe.bits-pilani.ac.in/ /Hyderaba

MEMBERSHIP OF DISTINGUISHED BODIES

The Institute is an institutional member of the following Associations and Bodies:

(i) Association of Commonwealth Universities, London.

(ii) International Association of Universities, Paris.

(iii) Association of Indian Universities, New Delhi.

(iv) Current Science Association, Bangalore.

(v) Federation of Indian Chambers of Commerce and Industry – Higher Education Network, New Delhi.

(vi) India International Centre, New Delhi.

(vii) Indian Association of Social Science Institutions, New Delhi.

(viii) Indian Distance Education Association, Hyderabad.

(ix) Indian Institute of Foreign Trade, New Delhi.

(x) Indian Society for Technical Education, New Delhi.

(xi) Institution of Communication Engineers and Information Technologists, New Delhi.

(xii) International Council for Open and Distance Education, Oslo, Norway.

(xiii) National Council of Applied Economic Research, New Delhi.

(xiv) Petrotech Society, New Delhi.

(xv) Pharmacy Council of India, New Delhi.

(xvi) The Institution of Engineers (India), Kolkata.

(xvii) World Association for Cooperative Education, Boston, USA.

(xviii) Council for Advancement and Support of Education, Washington.

(xix) Association for Institutional Research, Florida

COLLABORATION WITH FOREIGN EDUCATIONAL INSTITUTIONS

The Institute has collaborative arrangements in terms of exchange of students, faculty and information with the following institutions:

1. The University of Oklahoma, Norman, Oklahoma, U.S.A.
2. Tulane University Medical Centre, New Orleans, Louisiana, U.S.A.
3. Purdue University, West Lafayette, Indiana, U.S.A.
4. Uniformed Services University of the Health Sciences, Bethesda, Maryland, U.S.A.
5. Kathmandu University, Kathmandu, Nepal.
6. University of Otago, Dunedin, New Zealand.
7. Rivers State University of Science and Technology, Nigeria.
8. University of Colombo, Srilanka.
9. George Mason University, Fairfax, USA.
10. ETA Network of Education and Training, Dubai, UAE.
11. University of Windsor, Windsor, Canada.
12. The George Washington University, Washington, USA.
13. Massachusetts Institute of Technology, Cambridge, Massachusetts, USA.
14. Cornell University, Ithaca, USA.
15. Northeastern University, Boston, USA.
16. Waseda University, Tokyo, Japan.
17. Högskolan i Borås (University College of Borås), Sweden.
18. The University of New South Wales, Sydney, Australia.
19. Binghamton University (State University of New York), Binghamton, New York, USA.
20. Victoria University of Technology, “Victoria University”, Melbourne, Australia.
21. University of Southern California, California, USA.
22. Iowa State University of Science and Technology, Ames, Iowa, USA.
23. University of Maryland, College Park, USA.
24. Kansas State University (KSU), Manhattan, Kansas, USA.
25. Arizona State University IRA A. Fulton School of Engineering, USA.

26. The Tun Hussein Onn National Eye Hospital, Petaling Jaya, Malaysia and National Institute of Ophthalmology, Petaling Jaya, Sede Boquer Campus, Malaysia.
27. Universities of Ontario, Canada.
28. The Jacob Blaustein Institute for Desert Research (BIDR) of Ben Gurion University (BGU), Israel.
29. Utah State University, Logan, USA.
30. York University, Toronto, Ontario, Canada.
31. University at Buffalo, The State University of New York, USA.
32. University of Dundee, United Kingdom.
33. Lund University, Sweden
34. Helsinki University of Technology, Espoo, Finland.
35. Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA 15213, USA.
36. TELECOM Bretagne, Cedex 3, France.
37. The University of North Carolina at Greensboro, Greensboro, NC, USA.
38. The University of Toledo, College of Engineering Toledo, Ohio, USA.
39. Lunghwa University of Science and Technology, Taoyuan, Taiwan.
40. Ecole Nationale Supérieure D'Ingénieurs De Limoges (ENSIL), Université de Limoges, France.
41. Concordia University, Montereal, Quebec, Canada.
42. Technische Universität Braunchweig, Germany.
43. Faculty of Engineering and Graduate School of Science and Technology, Kumamoto University, Japan.
44. Carleton University, Ottawa, Canada.
45. University of Savoie, Chambéry Cédex, France.
46. Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA 15213, USA.
47. La Trobe University in Australia.
48. University of Rhode Island, Rhode Island, Kingston, USA.
49. USC Viterbi School of Engineering, USA.
50. RAK Medical & Health Sciences University, UAE.
51. New Mexico State University, USA.
52. "n+i" Network of Engineering Institutes, France.
53. Pace University, New York, USA.
54. Florida International University, Miami, Florida, USA.
55. Norwegian University of Life Sciences (NMBU), Norway.
56. University College Dublin, National University of Ireland, Dublin.
57. Macquaire University, Australia.
58. Michigan State University, College of Engineering, East Lansing, Michigan, USA.
59. The University of Wisconsin-Madison, USA.
60. University of Tartu, Estonia, EU.
61. University of Limoges, France.
62. CSIR National Institute of Oceanography(NIO), Goa.
63. The Universite De Perpignan Via Domitia, France.
64. Tunghai University, Taichung, Taiwan.
65. Carleton University, Ottawa, Canada.
66. University of Leeds, Leed, United Kingdom.
67. School of Mechanical Engineering, Kyungpook National University, Republic of Korea.
68. The Technische Universitat Braunschweig, Germany.
69. The Uiversity of South Florida, Florida, USA.
70. Tel Aviv University, Israel.
71. Cardiff University, Cardiff, U.K .
72. Maktoum Bin Hamdan Dental University College, Dubai.
73. Saint Petersburg Electro technical University, Russia.

74. The Graduate School of Engineering, Hiroshima University, Japan.
75. Memorial University of Newfoundland, Canada.
76. Al Ain University of Science and Technology, Al Ain, UAE.
77. The University of Nottingham, UK.
78. University College Dublin, Ireland.
79. University of Virginia, Charlottesville, Virginia, USA.
80. Hiroshima University, Hiroshima, Japan.
81. International Center for Biosaline Agriculture, Dubai, UAE.
82. Trinity College, University of Dublin, Dublin, Ireland.
83. The College of Engineering, National Cheng-Kung University, Tainan, Taiwan.
84. Ontario Universities International, Toranto, Canada.
85. The University of Queensland, St. Lucia, Australia.
86. College of Life Sciences, Kaohsiung Medical University, Taiwan.
87. Nanhua University, Taiwan.
88. The Norwegian University of Science and Technology (NTNU), Gloshaugen, Norway.
89. The University of Illinois, Champaign, USA.
90. International Water Association (IWA), London (United Kingdom)
91. University of Agder, Grimstad (Norway)
92. University of Central Florida, Orlando (U.S.A.)
93. Pace University, New York, USA
94. La Trobe University, Australia
95. Kregzo, Dubai, UAE
96. Curtin University, Australia
97. FIGURE Network Association Poitiers, France
98. Leonardo MW Ltd., Edinburgh, U.K. – Defence & Research
99. RAK Medical & Health Sciences University, UAE
100. University of Virginia Charlottesville, USA
101. Macquarie University, Sydney, Australia
102. Memorial University of Newfoundland, St John's, NL, Canada
103. Ben-Gurion University of the Negev, Beer-Sheva, Israel
104. Telecom Paris, France
105. Veggitech, UAE
106. KTH Royal Institute of Technology, Stockholm, Sweden
107. Safe Line Group of Companies Dubai, UAE
108. Mohammed Bin Rashid Foundation for the Development of Small and Medium Enterprises, Dubai
109. EPF Ecole dingenieur-e-s(Sceaux), France
110. Innovation Center Denmark
111. The Technische Universitat, Braunschweig, Germany
112. Schindler Group, Dubai, UAE
113. Maker Bhavan Foundation, USA
114. AIDirections (AID), Dubai, UAE
115. Regents of the University of Minnessota, USA
116. Institute of Geology, Karelian Res. Cen of the RAS_Petrozavodsk, Russia
117. UiT-The Arctic University of Norway
118. Bahwan Cybertec, Dubai
119. Curtin University, Bentley, Perth, WA 6102, Australia
120. Human Biosciences, Inc, Gaithersburg, MD, USA
121. Mohammed Bin Rashid Establishment for Small and Medium Enterprises (SMEs) Development, Dubai, UAE
122. Deutsche Akademie fur Digitale Bildung (DADB), Germany
123. University of Central Florida, Orlando, Florida, USA University of Central Florida, Orlando, Florida, USA
124. CRC for Contamination Assessment and Remediation of the Environment (CRC CARE), Australia

PART II
EDUCATIONAL PROCESS AND PROGRAMMES OF STUDIES

EDUCATIONAL PROCESS

The mission of BITS Pilani is to prepare young men and women to act as leaders for the promotion of the economic and industrial development of the country and to play a creative role in society. It has the reputation of a highly purposive and innovative university often setting the pace for workable reforms in higher education, suitable and relevant for the Indian cultural milieu.

BITS Pilani has been following semester system with continuous and internal evaluation since its inception. The educational programmes are modular and flexible. Through its Practice School programme, BITS Pilani has established purposeful linkages with industries. The Institute has evolved a direction for Research which makes research relevant to the national development and social needs. It has developed and adopted a unique academic administrative structure which makes all its innovations possible and workable.

The Institute operates educational programmes at three tiers of education, namely, the Integrated First Degree programmes, Higher Degree programmes and the Doctoral programmes. All programmes in the Institute are designed to allow as many components of science and applied science as are necessary for the graduates of the programmes to function effectively and efficiently in the technological society. All programmes contain certain structural commonality and the common courses are invariably operated together irrespective of the clientele who are required to take the courses. Similarly, irrespective of the ultimate degree for which a student qualifies, the large factor of this commonality between all students creates an educational basis which provides easy professional linkage, communication and group activity among students graduating in different degrees. This similarity among different students graduating with different degrees is further welded in a stronger professional bond when they work as internees in the Practice School stations or as members in a team working on mission-oriented time-bound research and development projects.

The various structural flexibilities provide not only scope for multiple point entries but also enable the system to accommodate many legitimate educational and operational needs of students. Some of these aspects are described in various sections that follow.

PROGRAMMES OF STUDIES

All programmes of studies are based on the principle that a series of courses make up the hierarchy of the structure where each course is self-contained but nevertheless acts as a bridge between what precedes and what comes after. A formal contact hour is such that a student is invariably required to spend several times of these hours towards self-study. Attempt here is to awaken curiosity in the mind of the student and train him to think rationally and scientifically and enable him to face the unfamiliar. Through the Practice School option, the flavour of the professional world is sought to be imbibed by the student as well as the teacher. Even many co-curricular activities are converted into a learning situation whereby the growth of a student becomes a continuing operation.

The Institute also conducts Off-campus Work-Integrated degree programmes as a means of continuing education for employed professionals as part of the human resource development programmes of specific organizations at the various off-campus centers. In all these programmes, emphasis is on self-learning and the pedagogy attempts to incorporate as many modern technologies as desirable. While each one of these programmes requires collaboration of an organization, some programmes have a highly structured collaboration with planned classroom activities and some programmes may have less structured planning. While a number of degrees are offered through structured collaboration with many collaborating organizations, there are also degrees, which are available in an open manner for a large number of organizations, each of which may sponsor only few students. For all these programmes,

faculty/resource persons are drawn from the Institute and the participating organizations as well as other Institutions.

The Three Tier Structure shown on page II-3 gives all the programmes offered by the Institute.

Integrated First Degree Programmes

The Integrated First Degree Programmes are offered at the first tier with nomenclatures like B.E., B. Pharm. and M. Sc. These are all level wise equivalent degrees. These are called integrated degrees for two reasons: (i) there are several common courses amongst these degrees, and (ii) no intermediate degrees, like, B.Sc. etc. are awarded. These degrees are based on a modular structure and their academic requirements are spelt out in respect of the number of courses and units rather than the number of years. All these programmes are structured in such a way that normally a student will be able to finish a programme in eight semesters. Of course, the flexibility of the Institute allows a student to do his programme at a faster pace and finish it earlier than 8 semesters or at a slower pace to finish it later than 8 semesters.

(a) B.E.

These programmes in engineering are mathematics and hard science based and incorporates many up-to-date techniques of analysis and synthesis.

(b) B.Pharm.

This programme has been so structured that it not only meets the requirements of the Pharmacy Council of India but also has additional courses which give a shape and flavour of both engineering and fundamental sciences to the programme.

(c) M.Sc. (Programmes under Group B)

These are integrated degree programmes without any intermediate B.Sc. degree. While these programmes ensure the required science component in any comparable postgraduate science degrees of other universities are met, they also incorporate many courses which have been notionally considered to be part of the engineering domain. The integrated nature of the programmes and their analytical and engineering science contents give them a professional character and enable students to participate usefully in industrial jobs. While a good 10+2 input may be able to complete these programmes in four years, any person coming from 10+2+3 system with a B.Sc. degree admitted on advanced standing basis will require two to three years to finish the programme. Almost all students who are admitted for these degrees also aspire and work towards a second degree under the dual degree scheme.

(d) M.Sc. (Programmes under Group C)

These programmes are basically multi-disciplinary and technological in character and are designed to meet the requirements of newly emerging professional activities. The area which is currently incorporated in these degree programme is Information Systems, Finance and General Studies.

The programme on Information Systems gives among other things a good exposure to the students on computer software and software engineering techniques, both at the conceptual and application levels. The Finance degree has been designed to meet the manpower needs arising due to the new thrust given to growth patterns in the economy. The courses planned for this programme are of such a nature that they fulfil the requirements of financial institutions as well as financial management needs of any industry. This programme is complementary to the M.Sc. Economics programme.

Details of Work Integrated Learning Programmes are given in Part V.

Birla Institute of Technology & Science, Pilani

Three Tier Structure of Education

Ph. D. Degrees	
Higher Degrees	
On-campus programmes	**Work-Integrated Learning Programmes**
M.E. Biotechnology, Chemical, Civil with specialization in Structural Engineering, Civil with specialization in Infrastructure Engineering & Management, Civil with specialization in Transportation Engineering, Computer Science, Communication Engineering, Design Engineering, Embedded Systems, Manufacturing Systems Engineering, Mechanical, Microelectronics, Software Systems, Environmental Engineering ***Chemical with specialization in Petroleum Engineering, Chemical with specialization in Nuclear Engineering, Civil with specialization in Water Resources Engineering, Computer Science with specialization in Information Security, Electrical with specialization in Power Electronics & Drives, Mechanical with specialization in Thermal Engineering* **M. Pharm.** M. Pharm. with specialization in Pharmaceutics, M. Pharm. with specialization in Pharmaceutical Chemistry, M. Pharm. with specialization in Pharmacology, ***M. Pharm.* **M. Phil.** *** Liberal Studies Biological Sciences, Chemistry, Economics, English, Management, Mathematics, Physics* **Master of Business Administration (MBA)** Business Analytics, ***Finance, Information Systems Management, Marketing, Operations and Decision Sciences, Organization Behavior and Human Resource Management, Strategy & Entrepreneurship* **Note: Details of On campus Programmes are given in Part IV and Part VI.**	**M. Tech.** Artificial Intelligence and Machine Learning, Automotive Electronics, Automotive Engineering, Cloud Computing, Computing Systems and Infrastructure, Data Science and Engineering, Design Engineering, Digital Manufacturing, Embedded Systems, Environmental Engineering, Manufacturing Management, Microelectronics, Pharmaceutical Operations and Management, Quality Management, Sanitation Science, Technology and Management, Software Engineering, Software Systems, Systems Engineering **M.B.A.** Business Analytics, Consultancy Management, Digital Business, Finance, FinTech, Hospital and Health Systems Management, Manufacturing Management, Quality Management. **Note: Details of Work Integrated Learning Programmes are given in Part V.**

Integrated First Degrees			
On-campus programmes			**Work-Integrated Learning Programmes**
Group A	**Group B**	**Group C**	
B.E. Chemical, Civil, Computer Science, Electrical & Electronics, Electronics & Communication, Electronics & Instrumentation, Manufacturing, Mechanical, ** *Biotechnology,* **B. Pharm.**	**M.Sc.** Biological Sciences, Chemistry, Economics, Mathematics, Physics	**M.Sc.** General Studies, ***Information Systems,* ***Finance*	**B.Tech.** Electronics Engineering, Engineering Design, Engineering Technology, Information Systems Manufacturing Technology, Power Engineering, Process Engineering, Software Systems and Engineering. **M.Sc.** Business Analytics, Information Systems **B.Sc.** Computer Science Design & Computing, Engineering Science Pharmaceutical Sciences **B.Sc. (Hons.)** Computer Science
***These programmes are not offered during academic year 2023-24*			

Minor programs

Minor programs are being offered in certain areas as options for integrated first degree students with the intent of encouraging them to add focus to their supplemental learning (outside a major area) as well as recognizing and certifying the knowledge obtained in an area that is outside of their major area. A minor would allow a Department (or multiple Departments) to offer a package of courses in an area/sub-area to students for whom this area/sub-area would not be part of their (major) program (e.g. a minor in Finance for students who are not pursuing a program in Finance). A minor will be recognized by means of a separate certificate.

At present Sixteen minor programs viz. Minor in Aeronautics, Computational Economics, Computing and Intelligence, Data Science, English Studies, Entrepreneurship, Film and Media, Finance, Management, Materials Science and Engineering, Philosophy, Economics and Politics (PEP), Physics, Public Policy, Robotics and Automation, Supply Chain Analytics and Water and Sanitation have been designed which are selectively being offered at different Campuses. The details of minor programs are described in Part IV of this Bulletin.

For Admission to on-campus programmes	
Integrated First Degree :	**Higher Degree :**
For admission to all the programmes: Candidates should have passed the 12th examination of 10+2 system from a recognized Central or State board or its equivalent with adequate proficiency in English. Except for admission to B. Pharm., the candidates should have Physics, Chemistry, and Mathematics as subjects. For admission to B. Pharm. , candidates should have Physics, Chemistry, and either Biology or Mathematics as subjects.	Normal input: Integrated First Degree of BITS Pilani or its equivalent. **Ph.D. Degree:** Normal Input: Higher Degree of BITS Pilani or its equivalent.

The General Studies programme aims at providing an opportunity to the students to acquire specific skills to meet varied career objectives through judicious use of electives and project oriented courses. Students are given opportunities to take two different streams, namely Communications and Media Studies or Development Studies by choosing courses of specific streams. Further, the requirements of mathematics, science and applied science, etc. are normally different from Group A and Group B Programmes. Candidates admitted to this programme have to take humanities courses as well as certain general science and technology courses.

All the Integrated First Degree programmes described above have a Practice School option which consists of two courses, Practice School I and Practice School II. A student goes to Practice School I of two months' duration during the summer following second year and to Practice School II of five and a half months' duration during the final year. The curriculum, through Practice School, finds a formal method of bringing the reality of professional environment into the educational process.

For the various programmes in all the three tiers of education, the admission policy and the educational process at BITS take care of multiple entry into the programmes and allow several other flexibilities. The on-campus integrated First Degree programmes are divided into Groups A, B and C. The following table provides a tabular condensation of the information.

INTEGRATED FIRST DEGREE PROGRAMMES

Name of the Programme	Normal Input	Special features
Group A programmes: B.E. : Biotechnology : Chemical : Civil : Computer Science : Electrical & Electronics : Electronics & Instrumentation : Electronics & Communication : Manufacturing : Mechanical B.Pharm. **Group B Programmes:** M.Sc. : Biological Sciences : Chemistry : Economics : Mathematics : Physics **Group C Programmes:** M.Sc. : General Studies	**For admission to all the programmes:** Candidates should have passed the 12th examination of 10+2 system from a recognized Central or State board or its equivalent with adequate proficiency in English. Except for admission to B. Pharm., the candidates should have Physics, Chemistry, and Mathematics as subjects. For admission to B. Pharm., candidates should have Physics, Chemistry, and either Biology or Mathematics as subjects. **Admission to all the programmes is subject to the conditions given below:** Admissions will be made purely on merit. The merit position of the candidate will be based on the score obtained by the candidate in a Computer based Online Test (BITSAT) conducted by BITS, Pilani. The candidate should have obtained a minimum of aggregate 75% marks in Physics, Chemistry and Mathematics subjects (if he/she has taken Mathematics in BITSAT) or a minimum of aggregate 75% marks in Physics, Chemistry and Biology subjects (if he/she has taken Biology in BITSAT) in 12th examination, with at least 60% marks in each of the Physics, Chemistry, and Mathematics / Biology subjects..	**Duration:** Planning has been made such that a student will be able to finish any of the integrated first degrees in 4 years (8 semesters). However, the flexibilities available and the modular structure of the system will allow the individual students to have variation in the duration of his degrees. Some can finish earlier than 4 years and some may take more than 4 years. Students who take two degrees simultaneously under dual degree scheme will spend about 5 to 5½ years (10 to 11 semesters). **Practice School:** All the integrated first degree programmes have Practice School options. **Dual Degree:** Institute offers dual degree facility to number of students who are admitted. The features of dual degree scheme are described later in this part under the section 'Flexibilities'. **Electives:** A student is required to complete at least 12 elective courses under the categories of Humanities electives, Discipline electives and Open electives. By judicious choice of these courses a student can obtain depth in his/her discipline and/or expand his/her horizon to gain exposure to one or more other areas of study.
For Details of Admission policy to Work Integrated Learning Programmes Refer to Part V.		

M.E./M.Pharm./M.Phil.

The requirements of these programmes are described in terms of the total number of units which a student is required to complete rather than the duration. However, a normal student may be able to complete such a programme in four semesters, wherein the last semester may be spent for either of the two available alternatives, namely, Dissertation and Practice School. The programmes are intended to give a penetrating professional experience and an opportunity to acquire further competence either in one's own discipline or in many other traditional areas of Engineering, Pharmacy as well as interdisciplinary areas, like, Embedded Systems, Microelectronics, Software Systems, Biotechnology, Manufacturing Systems, Design Engineering, Transportation Engineering, etc.

Following is the exhaustive list of all the Higher Degree programmes approved by the Senate.

<table>
<tr><th>Name of the programme</th><th>Input</th></tr>
<tr><td>M.E.</td><td>Normal input</td></tr>
<tr><td>: Chemical</td><td rowspan="4">Integrated First Degree of BITS in the same discipline or its equivalent.</td></tr>
<tr><td>: Chemical with Specialization in
• Petroleum Engineering
• Nuclear Engineering</td></tr>
<tr><td>: Civil with Specialization in
• Infrastructure Engineering & Management
• Structural Engineering
• Transportation Engineering
• Water Resources Engineering</td></tr>
<tr><td>: Computer Science
: Mechanical
• Mechanical with specialization in Thermal Engineering</td></tr>
<tr><td>: Communication Engineering
: Electrical with specialization in Power Electronics and Drives</td><td>Integrated First Degree of BITS in Electrical & Electronics or in Electronics & Instrumentation or its equivalent</td></tr>
<tr><td>: Embedded Systems</td><td>Integrated First Degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent.</td></tr>
<tr><td>: Design Engineering
: Manufacturing Systems Engineering</td><td>Integrated First Degree of BITS in Mechanical or its equivalent.
Any other Integrated first degree of A & B groups or M. Sc. Engineering Technology of BITS or its equivalent with the requirement of taking certain additional courses.</td></tr>
<tr><td>: Microelectronics</td><td>Integrated First Degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or Physics or its equivalent.</td></tr>
</table>

Name of the programme	Input
: Software Systems	Any First Degree of the Institute, provided the minimum component of MATH, TA, Science, ENGG, prescribed in each of the groups A, B and C through compulsory requirements or conventional options. **Other inputs:** (a) For those Integrated first degree programmes under Work Integrated Learning Programmes which have no counterpart in Groups A, B and C, the minimum requirement should be at least what is prescribed in Group C. (b) Any equivalent degree from other University with preparation indicated above.
: Biotechnology	Any Integrated First Degree of BITS or its equivalent with adequate preparation in Bio-Chemistry and Microbiology.
:Sanitation Science, Technology and Management	Any Integrated First Degree of BITS or its equivalent in the areas of Biology, Civil, Chemical Engineering, and Chemistry. Any other M.Sc. or B.E. with adequate preparations may be considered for this programme
: Environmental Engineering	Integrated First Degree of BITS or its equivalent in the areas of Biology, Civil, Chemical Engineering, and Chemistry. Any other M.Sc. or B.E. with adequate preparations may be considered for this programme
M. Pharm.	Integrated First Degree of BITS in Pharmacy or its equivalent.
: M. Pharm.	
: M. Pharm. with Specialization in Pharmaceutics	
: M. Pharm. with Specialization in Pharmaceutical Chemistry	
: M. Pharm. with Specialization in Pharmacology	
M.Phil. Liberal Studies	Any Integrated First Degree of BITS or its equivalent in respective discipline.

Special features of Admissions to any M.E. programme:

Students coming with integrated First Degree of BITS Pilani in A & B groups may be considered for admission to any M.E. Programme with the requirement of taking additional courses. The duration in these cases may be more than the normal duration and will be determined on a case by case basis. Similar dispensation may also be possible for students coming with an engineering degree from IITs and other reputed institutions.

Note: While no direct admissions are planned for M.Phil. degree, students who are admitted to Ph.D. may be asked whenever necessary, to register for this degree.

Master of Business Administration (MBA) and Master of Business Administration (MBA) in Business Analytics

The Institute is running an MBA programme with input requirement as First Degree of BITS Pilani or its equivalent. The programme endeavors to create manpower who have scientific and engineering approach to business administration. Students will also have a reasonable exposure to certain modern technologies. The programme is designed to have many flexibilities and a very strong component of industry project experience. The input for the programme may have multiple entry points. While principal input will, be students already possessing an engineering degree, those who have other qualifications like B.Sc., B.A., B.Com. may also apply provided they have aptitude towards having training in science, mathematics and technology as well.

Master of Business Administration (MBA) in	Input
(i) Finance (ii) Information Systems Management (iii) Marketing (iv) Operations and Decision Sciences (v) Organization Behavior and Human Resource Management (vi) Strategy & Entrepreneurship (vii) Business Analytics	Candidates holding a bachelor's degree of minimum three years duration in any discipline or its equivalent with at least 60% aggregate marks, and having studied at least one subject in mathematics or statistics at the high school (10+2) or higher level.

DOCTORAL PROGRAMMES

The Institute's Ph.D. programme is structured on the basis of a preferred input of those who have completed one of the Institute's higher degrees. It requires each student to finally qualify for formal acceptance in the programme only after passing a qualifying examination.

The Institute also offers a unique opportunity for working professionals to work for Ph.D. in the settings of their own work environments through part-time, Off-campus Ph.D. scheme.

Ph.D.	**Normal input** Any Higher degree of BITS or its equivalent. **Other inputs** a) Integrated First Degree of BITS or its equivalent. b) Any preparation between the above described first degree and higher degree. c) High professional standing and proven competence even without a formal degree. **Note:** Each case of other inputs will be decided on a case by case basis regarding admission and with the requirement of doing higher degree courses before taking qualifying examination. In the case of inputs with qualification like B.E., M.Sc., etc. the selected candidates will be required to do course work.	**Structure:** Qualifying examination, Research Methodology, teaching practice, Foreign language when required, Thesis and Seminar. Course work as specified for various input and prior preparation. **Locale:** Normally any of the BITS campuses and other off-campus locations with prior approval. **Ph.D. Aspirant:** To help in the development of professionals at large, provision exists for taking directly the qualifying examination as a `Ph.D. Aspirant' even before seeking admission to the Ph.D. Programme. The Aspirants can work in the settings of their own work environment with the approval of Research Board.

PROGRAMMES OFFERED AT BITS PILANI – PILANI CAMPUS

Integrated First Degree Programmes

B.E. Chemical
B.E. Civil
B.E. Computer Science
B.E. Electrical & Electronics
B.E. Electronics & Instrumentation
B.E. Electronics and Communication
B.E. Manufacturing
B.E. Mechanical
B. Pharm.
M.Sc. Biological Sciences
M.Sc. Chemistry
M.Sc. Economics
M.Sc. Mathematics
M.Sc. Physics
M.Sc. General Studies

Higher Degree Programmes

M.E.:

Biotechnology
Chemical
Civil with specialization in Structural Engineering
Civil with specialization in Infrastructure Engineering & Management
Civil with specialization in Transportation Engineering
Communication Engineering
Computer Science
Design Engineering
Embedded Systems
Manufacturing Systems Engineering
Mechanical
Microelectronics
Software Systems
Environmental Engineering

M. Pharm:

M. Pharm. with specialization in Pharmaceutics
M. Pharm. with specialization in Pharmaceutical Chemistry
M. Pharm. with specialization in Pharmacology

Master of Business Administration (MBA)

Business Analytics

Doctoral Programme

Doctor of Philosophy (Ph.D.)

PROGRAMMES OFFERED AT BITS PILANI – K.K. BIRLA GOA CAMPUS

Integrated First Degree Programmes

B.E. Chemical
B.E. Computer Science
B.E. Electrical & Electronics
B.E. Electronics & Communication
B.E. Electronics & Instrumentation
B.E. Mechanical
M.Sc. Biological Sciences
M.Sc. Chemistry
M.Sc. Economics
M.Sc. Mathematics
M.Sc. Physics

Higher Degree Programmes

M.E.:

Biotechnology
Chemical
Communication Engineering
Computer Science
Design Engineering
Embedded Systems
Mechanical
Microelectronics
Environmental Engineering

All these programmes have the same educational process, syllabus, evaluation method and academic flexibilities like transfer, dual degree etc. as followed at BITS, Pilani – Pilani Campus.

M. Phil

Liberal Studies

Doctoral Programme

Doctor of Philosophy (Ph.D.)

All these programmes have the same educational process, syllabus, evaluation method and academic flexibilities like transfer, dual degree etc. as followed at BITS, Pilani – Pilani Campus.

PROGRAMMES OFFERED AT BITS PILANI – HYDERABAD CAMPUS

Integrated First Degree Programmes

B.E. Chemical
B.E. Civil
B.E. Computer Science
B.E. Electrical & Electronics
B.E. Electronics & Communication
B.E. Electronics & Instrumentation
B.E. Mechanical
B. Pharm.
M.Sc. Biological Sciences
M.Sc. Chemistry
M.Sc. Economics
M.Sc. Mathematics
M.Sc. Physics

Higher Degree Programmes

Biotechnology
Chemical Engineering
Civil with specialization in Structural Engineering
Civil with specialization in Transportation Engineering
Communication Engineering
Computer Science
Design Engineering
Embedded Systems
Manufacturing Systems Engineering
Mechanical
Microelectronics
Environmental Engineering

M. Pharm:

M. Pharm. with specialization in Pharmaceutics
M. Pharm. with specialization in Pharmacology

All these programmes have the same educational process, syllabus, evaluation method and academic flexibilities like transfer, dual degree etc. as followed at BITS, Pilani – Pilani Campus.

Doctoral Programme

Doctor of Philosophy (Ph.D.)

All these programmes have the same educational process, syllabus, evaluation method and academic flexibilities like transfer, dual degree etc. as followed at BITS, Pilani – Pilani Campus.

PROGRAMMES OFFERED AT BITS PILANI – DUBAI CAMPUS

First Degree Programmes

- B.E. Chemical Engineering
- B.E. Civil Engineering
- B.E. Electrical & Electronics Engineering
- B.E. Mechanical Engineering
- B.E. Computer Science
- B.E. Biotechnology
- B.E. Electronics & Communication Engineering
- B.E. Electronics & Computer Engineering

Higher Degree Programmes

M.E.:

- M.E. Software Systems
- M.E. Microelectronics
- M.E. Electrical with specialization in Power Electronics and Drives
- M.E. Civil with specialization in Infrastructure Engineering and Management
- M.E. Design Engineering

M.B.A.:

- Master of Business Administration (MBA)
- MBA in Business Analytics

Doctoral Programme

Doctor of Philosophy (Ph.D.)

TEACHING-LEARNING PROCESS

The objective of class room education is to awaken the curiosity of the student, generate habits of rational thinking in him/her, gear his/her mind to face the unfamiliar and train him/her to be able to stand on his/her own. With its team of committed and dedicated faculty, BITS Pilani aims at maximizing the learning process through teaching. Through their innovative teaching, the teachers enable the student search for knowledge on his/her own and motivate him/her to use the facilities like the library, laboratory and the environment to optimize his/her learning process. Self-study by the student is therefore an important factor in the planning of teaching and evaluation and in this environment the student exhibits interest and responds to this challenge. Teaching and evaluation form a unity of function and operate in a climate of mutual understanding and trust.

Every course whether single section or multi-section is conducted by a member of the faculty called instructor-in-charge, with the assistance, where necessary, of the required number of instructors – who will be partners with him in meeting the full academic perceptions and organizational needs of teaching the course and evaluating the students.

Within one week of the beginning of class work, the instructor-in-charge/ instructor announces to his class/section through a hand-out, the necessary information in respect of (i) the operations of the course (its pace, coverage and level of treatment, textbooks and other reading assignments, home tasks etc.); (ii) various components of evaluation, such as tutorials, laboratory exercises, home assignment, project, several quizzes/ tests/ examinations (announced or unannounced, open book or closed book), regularity of attendance, etc., (iii) the frequency, duration, tentative schedule, relative weightage etc. of these various components; (iv) the broad policy which governs decisions about make-up; (v) mid-semester grading; (vi) grading procedure (overall basis, review of border line cases, effect of class average, etc.) and (vii) other matters found desirable and relevant.

EVALUATION

All courses are conducted and evaluated in a continuous & internal manner by the faculty who teach these courses. The student registers for a certain number of courses each semester; the year being divided into two semesters, and a summer term, whenever offered. A faculty member, as registration advisor, helps a student to draw up his programme, suitable to his pace and needs, which is made possible by the course wise time-table of the Institute. Every student gets, incidentally, a training in decision-making through (i) choice of load, i.e. number of courses per semester to suit his/her pace, (ii) selection of his/her own time-table to suit his/her convenience, and (iii) picking up courses as electives to meet his/her own aspirations. It is the responsibility of the student to attend classes regularly and to maintain a required level of scholastic standing.

The performance of a student in each course is assessed by the teacher by means of continuous evaluation throughout the semester in classwork, periodical quizzes (sometimes unannounced), tests (both open and closed book), tutorials, laboratory work, homework, seminars, group discussions, project, etc., and a comprehensive examination at the end of the semester. The student is thereby given a large number of opportunities to carryout various academic assignments and be evaluated. Besides encouraging and rewarding continuous and systematic study, the system provides a constant feedback to the student as to where he/she stands, thus enabling him/her to cultivate regular habits of studying and preparing himself/herself for the future.

The system discards the conventional emphasis on a single final examination and numerical marks as the only absolute indication of the quality of student's performance. Thus, at the end of the semester the teacher of the course awards letter grades **A, A⁻, B, B⁻, C, C⁻, D, E** to the student based on the total performance of the student and it is relative to the performance of others taking the same course. These letter grades stand for quality of performance: A (Excellent), A⁻ (Very Good), B (Good), B⁻ **(**Above Average), C (Average), C⁻ (Below Average), D (Poor) and E (Exposed). Further,

these letter grades have points associated with them in a quantified hierarchy: a maximum of 10 (for an A) to a minimum of 2 (for an E). There are also courses in which the teacher awards non-letter grades which have only a qualitative hierarchy. The teacher may also pronounce the performance of a student in a course in terms of certain reports which should not be misconstrued as grades.

Although BITS Pilani does not stipulate a minimum percentage of attendance before a student is permitted to appear in any test/examination, the Institute, being a fully residential university with internal and continuous evaluation system, expects every student to be responsible for regularity of his/her attendance in classrooms and laboratories, to appear in scheduled tests and examinations and to fulfill all other tasks assigned to him/her in every course. The system has adequate resilience to accommodate unforeseen situations through withdrawal from a course, make-up test, feedback from examinations and interaction with teachers. In spite of all these facilities when a student fails to cooperate with the teacher in the discharge of his/her part of the contract to such an extent that the teacher is unable to award any grade, the teacher is authorized to give a “Not Cleared” (**NC**) report.

A student is deemed to have cleared a course if he/she obtains a grade in the course. However, the educational philosophy of the Institute interlinks and at the same time distinguishes between the performance of a student in a single course and his/her overall cumulative performance. The overall performance of a student is indicated by an index known as the “Cumulative Grade Point Average” (CGPA). It is the weighted average of the grade points of all the letter grades received by the student since his/her entry into the Institute and is expressed on a 10-point scale. In the case of Integrated First Degree programmes the final division for the degree is decided on the basis of CGPA and there are three classifications, namely Distinction, First Division and Second Division. However, in the case of Higher Degree and the Doctoral programmes no division is awarded.

During the student’s stay in the Institute, the Institute expects him/her to show a certain minimum performance and progress. The minimum academic requirements regarding the performance and progress for the Integrated First Degrees and Higher Degrees are:

(i) A CGPA of at least 4.5 at the end of every semester for integrated First Degree students and 5.5 for Higher Degree/Ph.D. students.

(ii) Not more than one E grade in a semester for integrated First Degree programmes and no E grade in the Higher Degree programmes.

(iii) The pace of progress of a student should be such that at any stage of reckoning he/she should not have spent more than 50% extra time than what is prescribed for him/her upto that stage in his/her programme.

The Institute's Academic Regulations must be consulted regarding the minimum academic requirements for the pursuit of the Ph.D. programme and also for off-campus programmes.

Students who fail to meet the minimum academic requirements stipulated above are put under an appropriate committee which monitors their programmes and give guidance so that they are properly rehabilitated at the earliest. In case of Ph.D., this is done by the Departmental Research Committee (DRC) and Doctoral Counselling Committee and in the case of Higher Degrees and integrated First Degrees this is done by Academic Counselling Board (ACB). These Committees are appointed by the Senate and are given authority to take appropriate action including discontinuance of the student or transfer to other programme.

FLEXIBILITIES

The admission policy and the educational process at BITS take care of multiple entry into the programmes and allow several other flexibilities.

Wherever a flexibility is possible according to the Academic Regulations of the Institute, the implementation of the decision invariably takes place along with registration at the beginning of a semester for the continuing students. As in

the admission process, the decision is guided by the principle of merit, preferences and facilities available.

It is obvious that CGPA cannot serve as the only measure of merit when the total number of courses/units is different between two competing candidates. To normalize all competing candidates, generally the Institute uses a Progressive Branching Index (**PBI**).

Admissions in both the Semesters

The structural flexibilities available in the Institute make it possible to admit students in both the semesters. However, in the case of both First Degree and Higher Degree programmes most of the admissions are made during the first semester itself. In the case of Ph.D. and off-campus Degree programmes, admissions are planned in both the semesters. However, a separate advertisement is given for the second semester admissions and applications for the same are made available only after an advertisement is issued.

Admission with Marginal Deficiency

While the academic preparation required for the admission to each Degree has been clearly spelt out there is a provision in the Institute Academic Regulations whereby brilliant students whose prior preparation has been marginally deficient in terms of stated courses/subjects may also be admitted with the condition that they are required to do additional courses over and above those prescribed for a student with normal preparation and the sequence is determined by the institute. This flexibility is invariably used in the case of higher Degree programmes where students may come without sufficient exposure to courses like computer programming.

Admission with Advanced Standing

When a candidate for any programme in the three tiers of education of the Institute comes with a preparation beyond the minimum requirement for admission in that programme, the admission of such a candidate is handled under what is known as admission with advanced standing. While such admission is not available as a matter of right, at the time of admission the Institute would spell out in detail the advanced credit it proposes to give to the candidate and the matter would be handled within the framework of the Institute's operation for normal students. Essentially the guiding principle is two-fold: the courses the candidate has already done before entering the Institute cannot be repeated and also that the time spent elsewhere is not wasted. Such an open-ended situation is handled on a case by case basis. It is important that the candidate supplies all the pertinent data in respect of syllabus of courses taken by him/her, examinations passed, question papers of the examinations and the grades/marks obtained by him/her in different subjects. A candidate who is shortlisted for such admissions would be asked to come to Pilani and explore a workable programme that would be appropriate for him/her before admission is completed. If required, the candidate may have to take certain examinations in various subjects that he/she has completed before a prescribed programme is pronounced for him/her there onwards.

However, there are certain situations which cannot be treated as advanced standing. In view of the uncertainty of the level to which some of the courses of the First Degree programmes is treated as optional subjects in the 10+2 system, to be consistent with the past tradition, no student is allowed to register in a course if he/she is considered to be overprepared in relation to the content of the course. Some examples of such courses are: General Biology, Engineering Graphics and Workshop Practice. Such an overprepared student is required to take an appropriate higher level course, as determined by the Associate Dean, Academic, Undergraduate Studies Division.

Dual Degree Scheme

The Institute has created facility by which any student who is admitted to M.Sc. programmes (offered under Group B) is offered a second degree in B.E programmes under dual degree scheme. This assignment is made on the basis of Progressive Branching Index (PBI) at BITS at the end of the first year, separately in Pilani, Goa and Hyderabad campuses.

Number of dual degree seats in any particular branch of engineering is decided by using following formula:

$$A = \frac{P \times Q}{R}$$

Where A is the number of dual degree seats in an engineering branch; P is the total number of students eligible for dual degree in science; Q is the number of engineering students admitted in an Engineering Branch in which number of dual degree seats need to be assigned; and R is the total number of students admitted in Engineering on the day of admission.

If any student is under the purview of ACB, his/her pursuit of the Dual Degree will be governed by the clause 7.02 of the Academic Regulations. He/She is required to maintain a minimum CGPA of 4.5 at the end of the fourth Semester failing which ACB may recommend withdrawal of the dual degree offer made to him/her.

Students in any other group seeking a second degree from amongst the programmes in the same group or another group will also be considered under 'other' priorities.

Transfer

(i) Within the same tier

It is possible for a student to seek transfer from one programme to another in the middle of a programme without starting from the beginning. This is possible because he/she is given credit for what he/she has done till then towards the requirements of the programme to which he/she seeks the transfer. Details have to be seen in the Academic Regulations. Transfer is possible from M.E. (all branches) and M.Pharm. to M.Phil. On the other hand, very restricted and tutored transfer would be possible from M.Phil. to M.E./ M.Pharm.

Since admission to a programme is done on assigned and competitive basis, there cannot be any scope of undoing the fact of an assigned admission through transfer. Thus only exceptionally meritorious students in a limited number of cases can expect to compete for transfer to a more sought-after programme. On the other hand, transfer to a less sought-after programme for a student who is unable to cope with the rigors of the programme in which he/she has been admitted would be readily used to rehabilitate him/her without much loss of time. In any event, transfer must be treated as an admission process.

(ii) From First Degree to Higher Degree / Ph.D. Degree:

In the case of bright and promising student of the Integrated First degree programmes a transfer to Higher Degree and/or Ph.D. degree may also be provided.

(iii) Between Ph.D. and higher degree programmes:

Under special situations a transfer between Ph.D. and higher degree programmes may be permitted. Movement in either direction is theoretically possible. The Institute's Academic Regulations must be consulted for details.

Audit

The facility of taking a course on audit is principally conceived to give an opportunity to a student to update his/her knowledge in selected courses. It is expected to meet primarily the needs of casual students (not enrolled for degree). No degree of the Institute can be acquired by merely taking courses on audit.

There are certain courses like Foreign Languages, Music, etc. which are neither part of a degree programme nor are available through electives. Any student who wishes to take such courses can take them only on audit basis and also on payment of additional fees.

Other Flexibilities

The structure of degree programmes and the Academic Regulations also provide certain other flexibilities like choice of electives, number of electives, repetition of courses, departure from normal pace, withdrawal from or substitution of course(s) etc.

Skill Oriented Courses

For any nation, knowledge and skills are the main drivers of social and economic development. In order to overcome the demand-supply imbalance, BITS provides high-quality

education that includes both skill development and traditional coursework, giving students the chance to advance in further education or transition directly into the workforce. It provides a flexible, open education system that also meets the demands of lifelong learning.

Skill Oriented Courses
GS F224 Print & Audio Visual Advertising
GS F244 Reporting & Writing for Media
GS F241 Creative Writing
GS F245 Effective public speaking
GS F343 Short Film & Video Production
BITS F226 Soft Skills for Professionals
GS F326 Creative Thinking
GS F344 Copywriting
HSS F222 Linguistics
HSS F223 Appreciation of Indian Music
HSS F224 English Skills for Academics
HSS F227 Cross Cultural Skills
HSS F236 Symbolic Logic
HSS F325 Cinematic Adaptation
HSS F329 Musicology-An-Introduction
HSS F334 Srimad Bhagvad Gita
HSS F343 Professional Ethics
HSS F346 International Relation

Interdisciplinary/Multidisciplinary Courses

The BITS curriculum blurs the lines between traditional disciplines and centres teaching and learning around the creation of meaning in the context of issues or topics that are relevant to the real world. A single subject can be studied from a variety of angles in several of our degree programmes, which meets learning objectives and keeps students engaged and interested throughout the learning process. The following courses present a certain degree of interdisciplinarity in higher education sphere.

Interdisciplinary/Multidisciplinary Courses
GS F221 Business Communication
GS F222 Language Lab Practice
BITS F226 Soft Skills for Professionals
HSS F224 English Skills for Academics
HSS F227 Cross Cultural Skills
HSS F236 Symbolic Logic
HSS F323 Organizational Psychology
HSS F328 Human Resource Development
HSS F334 Srimad Bhagvad Gita
HSS F343 Professional Ethics
HSS F344 Heritage of India
HSS F346 International Relation

Outcome based education

Outcome based education clearly defines the learning outcome, duly supported by the well-defined learning outcomes in the handouts of the courses. It aligns well with the holistic development of the students by making them aware of the societal issues and challenges. Presentations, group work, field work, open ended projects and assignments, take home and class assignments, open-book and close-book assignments are used as the tools to assess and measure their achievement. For the clarity and precision, answer rubrics and well split marking scheme provide the guidelines. Students are encouraged to take note of their own learning by putting them on a relative scale and helping them assess their skills through marks and their own satisfaction regarding their performance. Feedback is shared with the students, through written comments in their individual assignments/evaluations and through the solved problems/answer solutions, openly shared with them. Flexibility of courses, class hours, instructors, etc. provide an impetus to learn progressively. This learning equips them with skills, knowledge, attitude, etc. to become job ready and a responsible social being.

Academic Regulations

The operations described above are not exhaustive. For precise rules, Academic Regulations of the Institute may be consulted.

RESEARCH AT BITS

Research is an important academic activity at BITS Pilani. A large number of students at all levels of the educational programmes are involved in research that exploits the multidisciplinary educational base emerging out of the broad-based integrated education in engineering, science and humanities. Strong emphasis is laid on interdisciplinary, mission-oriented and relevant research. The Practice School, which is an important component of the integrated programmes of BITS Pilani, provides an opportunity to identify research problems relevant to industrial needs. The participation of students and the faculty members in research ensures a team effort towards problem solving activities. Such a total involvement of the faculty as well as the student population integrate research and teaching activities of the Institute in such a manner that they draw strength and support from each other.

Research Areas

Topics of Research can be chosen from any of the disciplines in which the Institute offers Higher Degree and First Degree programmes and also from the areas given in Table at the end of this Part.

Research Linkages

The Institute has built up research linkages with a large number of R & D organizations in the country and abroad and provisions exist for candidates to work for a part or whole of the research work at these organizations in their thrust areas. Some of the organizations are: Uniformed Services University of Health Sciences, Bethesda, USA; Tata Institute of Fundamental Research, Mumbai; Central Electronics Engineering Research Institute, Pilani; Central Drug Research Institute, Lucknow; Institute of Pathology, New Delhi; Sankara Nethralaya and Elite School of Optometry, Chennai; LV Prasad Eye Institute, Hyderabad; and Institute of Cardio-Vascular Diseases, Chennai.

Research Components in the Educational Programme

Research is emphasized in all the educational programmes of the Institute. At the first degree level, Thesis and at the higher degree level Dissertation are optional alternatives to the Practice School. Thesis is an integral component of the Ph.D programme.

While some salient features are described below, for further details, please refer to Academic Regulations.

(A) First Degree

(i) In the First tier, a single degree student must take either Thesis or PS and a dual degree student has to normally do Thesis for one degree and PS for the other degree. Such a student can also opt for PS/Thesis for both the degrees.

(ii) Students will be assigned a topic of research and a supervisor after giving due consideration to the student's preference, the research goals of the Institute and the equalization of the work-load of the supervisors.

(iii) A first degree student opting for a Thesis has two options: (i) register for a 16-units Thesis, in which case the student cannot be simultaneously registered in any other course; or (ii) register for a 9-units Thesis, in which case it may be necessary for the student to take additional elective courses to meet graduation requirements and He/she may be permitted to register in courses simultaneously with the Thesis

(iv) Thesis is graded in terms of same letter grades.

(v) Thesis can also be done at collaborating organization, industries under joint supervision.

(B) Higher Degree

For students who opt out of Practice School, Dissertation of 15-25 units is a required component. Student may be registered for one full semester after completing all courses or may be registered concurrently for varied units along with other courses. This is a course in which the student takes up a research topic under the supervision of faculty member (s). Pursuit of research through this course in any semester must end up in a written report at the end of the semester. The performance is graded in terms of same letter grades. Dissertation can also be done at collaborating organizations, industries under joint supervision.

(C) Ph.D. Degree

Thesis is an integral component in the Ph.D. Degree programme. It requires a minimum of 40 units to be distributed normally across four semesters. A Ph.D. student can register for the Thesis course only after passing the Qualifying Examination and after approval of his topic of research and supervisor(s) by the Dean, Academics (Graduate Studies and Research).

The pursuit of the thesis can be on the campus or at Practice School Centres and in certain circumstances at other specific centres with prior permission.

Other Components and Features of the Ph.D. Programme

(i) Types of Input

While the preferred input is a Higher Degree of BITS Pilani or its equivalent, the Institute's Academic Regulations permit an input which is at least a first degree of BITS or its equivalent or any input between these two extremes. Further, in a rare case of a person of high professional standing and proven competence who is deemed to have acquired mastery over all or substantial part of the course-work of a Higher Degree of the Institute through long professional experience exhibited through published papers, technical reports, etc. would also be an acceptable input.

(ii) Qualifying Examination

Every student admitted to Ph.D. must pass the qualifying examination which is based on two areas chosen by the candidate depending on his intended area of research and courses done. The qualifying examination tests the student's knowledge, grasp of fundamentals and his ability to use them in unknown situations.

The admission to On-campus Ph.D. programme is provisional in the first instance and gets confirmed only after passing the Qualifying examination within the prescribed time. Whenever a candidate is unable to pass the qualifying examination within the prescribed time, he will automatically be discontinued from the programme.

(iii) Seminar / Independent Study

Normally a Ph.D. student will have to register every semester in the Seminar course or in the Independent Study course.

(iv) Course work

The various categories of courses including Research Methodology I, for the whole possible range of input of Ph.D. students are described in the Academic Regulations. In most cases, the course work consists of courses which are required for obtaining the knowledge in the area of research. Further, the qualifying examination is conducted on the basis of chosen two sub-areas approved by the Senate

(v) Research Methodology and Teaching Practice

Research Methodology I course is done in semester/term following the semester of passing the Qualifying Examination. This course is designed to impart training in analysis of research problem, mathematical and statistical analysis of data, experimental techniques etc. Teaching Practice I or when it cannot be arranged, its alternative Practice Lecture Series-I is done in the semester/term following the semester of passing the Qualifying Examination. These courses attempt to train a Ph.D. student in the art, methodology and skill of teaching, communication, etc.

(vi) Language Requirement

Foreign language is prescribed as an eligibility requirement for Ph.D. only when the supervisor(s) and/or the Dean, AGSRD approve the same. Otherwise English or an Indian language, as the case may be, would suffice.

A Ph.D. student for whom foreign language is prescribed is expected to demonstrate an ability to translate a piece from current periodicals in the area of major interest of the student in one of the modern European languages into English with the help of a dictionary.

(vii) Fellowships and Scholarships

Students admitted to Ph.D. Programme normally get fellowship from some funding agencies like UGC, CSIR, DBT, DST, ICMR, MNES or Industries, etc. However, Institute has also instituted fellowship stipends from its own resources intended to take care of the needs of Ph D students.

Ph.D. programme for working professionals

The Institute also offers an unique opportunity for employed professionals working in industries and R&D Organizations and having experience to work towards Ph.D. degree of the Institute. Such students can be admitted either under 'Part- Time' Ph D or under 'Ph D aspirants' scheme. While the 'Part- Time' Ph D students will work on the thrust area(s) identified by the Institute, a "Ph D aspirant will work in the settings of their respective work environments. Normally candidates working in an organization collaborating with BITS Pilani are considered under Aspirant scheme. Industries or organizations interested in the scheme for the development of their manpower at the Doctoral level are invited to seek collaboration with BITS and sponsor their suitable candidates.

A PhD candidate has to choose a BITS Pilani faculty as supervisor. However, co-supervisor may be chosen from the other organization.

Admission

The admission modalities given in the next part also apply to Ph.D. wherever applicable.

Eligibility

- A candidate with a formal Higher Degree which is the minimum qualification for the Ph.D. programme; namely M.E./ M.E. (Coll.)/ M.Phil./ M.Phil. (Applied)/ M.Pharm./M.Tech. of BITS or an equivalent Degree of another university of standing.
- A person of a long and high professional standing and proven competence not possessing a Higher Degree but whose experience, in terms of professional documents, can measure up to a Higher Degree.
- A student coming after clearing the courses prescribed by Departmental Research Committee of the Institute or its equivalent without completing the Degree.

There may be occasions where the admissions of Ph.D. Aspirants end up in protracted correspondence. If the admissions are finalized before the starting of the semester the students will be registered in that semester. Otherwise the admission will be deferred to a subsequent semester.

All 'Ph.D. Aspirants' after passing the qualifying examination shall seek formal admission to the Ph.D. programme at the earliest opportunity available to them and register in the Ph.D. Courses.

Components of Ph.D. Programmes

The components are (a) Course work, (b) Qualifying Examination; (c) Foreign Language, when required; (d)Research Methodology (e) Teaching Practice/Practice Lecture Series; (f) Seminar/Independent Study; and (g) Ph.D. Thesis.

Operational Features

a) Place of work: On-Campus: Any of the BITS Campuses. Off-campus Centre: Any location, where Practice School, Work-Integrated Learning programmes are conducted and organizations having collaborations and research linkages with BITS.

Outside Centre: In worthy circumstances, an outside centre not covered by the above may be approved.

b) Topic of Thesis: From the areas of focus of the Institute or from problems of intimate concern to the in-house R & D needs of the host organization and matching with focus of the Institute.

c) Supervisor: Subject to final approval by the Dean, AGSRD, any regular assistant professor and above of BITS Pilani with standing, authority or competence can become the supervisor for the Ph.D. thesis. However, as per requirement, one or more persons may be approved as co-supervisor for a PhD student. A person from other organization with adequate research credentials can become co-supervisor.

d) Places and Dates of Qualifying Examination: Normally arranged and announced twice in each year at all campuses of BITS.

Areas of Research

1. **Biological Sciences:** Environmental Biotechnology, Bioinformatics, Microbial Biotechnology, Molecular Biology, Molecular Parasitology & Vector Biology, Molecular Diagnostics, Genomics, Plant Biotechnology.
2. **Bioengineering**: Biomaterials, Biomechanics, Bioinstrumentation, Bio-transport Process.
3. **Civil Engineering**: Structural Engineering, Water Resources, Geotechnical, Transportation, Environmental Engineering, Image Processing and G.I.S., Disaster Management, Earthquake Engineering, Solar Architecture, Finite Element Method, Non-traditional optimization algorithms, Artificial Neural Networks, Fuzzy Logic and Multi-criterion Decision Making and their applications, Concrete Technology, Sustainable Construction Materials , Advance Composite Materials for Structure , Composite Manufacturing.
4. **Chemical Engineering:** Advanced Materials, Biomaterials, Coatings, Composites, Bio-Chemical Engineering, Bio-Technology and Bio-System Engineering, Polymer Science and Engineering, Nao Science and Technology, Computation Fluid Dynamics, CO2 capture, utilization and sequestration, environmental chemical engineering, Catalysis and Green Technologies, Energy Storage, Evolutionary Computation, Fuel Cells, Micro-emulsions, Modeling and Simulation, Optimization, Multivariate data analysis, Data modeling, Artificial intelligence, & machine learning, Transport in Porous Media, Process Dynamics and Control, Process Synthesis & Design, Process Integration and Intensification, Industrial fault detection & diagnosis, Paper and Pulp Technology, Polymer Thin Films, Process Synthesis and Design, Petroleum Refining and Petrochemicals, Reaction Engineering, Renewable Energy, Rheology, Soft Lithography, Soft Electronics, Tissue Engineering, Water Treatment and Air Purification.
5. **Chemistry:** Organic including Natural products, Bioorganic, Inorganic, Bioinorganic, Physical, Biophysical, Medicinal, Analytical, Green, Theoretical and Computational Chemistry; Nanomaterials; X-Ray Crystallography.
6. **Computer Science & Information Systems:** Computer Networks, Distributed Systems, Database Systems, Software Engineering, Operating Systems, Multimedia, Computer Control Systems, Computer Architecture, Compilers, Formal Methods, Information Retrieval.
7. **Economics and Finance**: Macroeconomics; Microeconomics; Industrial Economics; Public Finance; Public Policy & Social Economics; International Economics; Econometric Methods & Applications; Environment and Resource Economics; Economics of Growth; Development Economics; Behavioral Economics; Experimental Economics; Computational Economics; Financial Statement Analysis; Corporate Finance; Investment Analysis and Portfolio Management; Business Analysis and Valuation; Financial Economics; Derivatives & Risk Management; Computational Finance; International Finance; Market Microstructure; Asset Pricing; Behavioral Finance.
8. **8. Electrical and Electronics Engineering:** Control Engineering, Power System, High Voltage, Energy Storage, Renewable Energy (RES), Smart Grids, Power Electronics and drives, Cyber Physical systems, Digital and Analog VLSI Circuits, VLSI Architecture, Microelectronics and Nanoelectronics, RF and Microwave Engineering, Antenna, Photonics and Sensors, Communication Systems, Optical Communication, and Fibre Optics, Analog and Digital Communications, Wireless Communications, Digital Image Processing, Signal Processing Biomedical Instrumentation, Embedded Systems, Materials, MEMS, Microfluidics & Fabrication, Instrumentation, Internet of Things, AI techniques and applications.

9. **Humanities and Languages:** Film Studies, Music, Theatre, History and Politics, Language, Communication and Soft Skills, Literature and Cultural Studies, Comparative Indian Literature, ELT, Media Studies and Advertisement, Ethics and Indian Philosophy, Psychology, Public Policy, Public Administration and Development Studies, Urban and Landscape Studies, Digital Humanities, Journalism, Tourism and Travel, Sociology, Philosophy, Ethics, Higher Education, Spiritual Intelligence, Development Studies, Computer-Mediated Communication, Technology Enabled Learning / Education.
10. **Mathematics:** Algebra, Coding Theory, Combinatorics, Complex Analysis, Control Theory, Cosmology and Relativity, Cryptography, Data Analysis, Differential Equations, Discrete Mathematics, Financial Mathematics, Fluid Dynamics, Fractional Calculus, Functional Analysis, Fuzzy Set Theory, Game Theory, Geodesy, Geometry, Graph Theory, Harmonic Analysis, Integral Equations, Linear Algebra, Mathematical Biology, Mathematical Modelling, Neural Networks, Nonlinear Analysis, Number Theory, Numerical Analysis, Operations Research, Optimization, Probability and Statistics, Quantum Information Theory, Scientific Computing, Seismology, Stochastic Processes, Tensor Analysis, Topology, Wavelet Analysis
11. **Mechanical Engineering:** Product Design and Development, Fracture Studies, Non-destructive Testing, Multiscale modeling, Manufacturing Engineering, Supply chain management, Additive manufacturing, Microwave Processing of Materials, Manufacturing Excellence Practices, Design Engineering, Materials Engineering, Thermal Engineering, Renewable Energy, Hydrogen Energy and Fuel Cell Technology, Robotics and Intelligent Systems, Machine Learning, Nano Technology, Refrigeration and air-conditioning, Co2 trans-critical system, Energy Systems Engineering, Energy Management, Energy Storage Devices, air pollution and energy-efficient buildings, Multiphase flows, Fluid-structure interaction, Bio-engineering, MEMS, Microfluidics.
12. **Management**: Indian Management Practices, Management Practices in MNC, Cross Cultural Management, Performance Appraisal, Strategic Marketing, Retail, Brand Management, Clustering Methodology, Strategy, Sustainable Development, Evolving Capitalism& Regulations, Project Management, Production Management, Facility Layout Planning, Application of TOC in Operations Management, Supply Chain Management, R&D Management, R&D Performance Measurement, Technology Management, ERP, MIS, E-business, Image Processing, Risk Management, Capital Markets, Quantitative Methods, Business Modeling, Stochastic Modeling of Production Systems, Reliability Analysis & Modeling, Organizational Behavior, Positive Health Psychology, I/O Psychology, Indian Psychology, Innovation and Creativity, Negotiation Skills, Managerial Skills, Entrepreneurship and Health Care Management.
13. **Pharmacy**: Drug Design and Synthesis, Pharmacological Screening of New Bioactive Molecules and Mechanistic Pathway Exploration, Phytochemistry and Natural Drugs, Understanding Novel Mechanisms in Disease Pathology, Development of Novel Drug Delivery Systems, Devices and their Preclinical Evaluation
14. **Physics**: Materials Physics; Condensed Matter Physics; Nuclear, Particle and High Energy Physics; Optics & Spectroscopy, Atomic and Molecular, Astrophysics and Cosmology, Biophysics .
15. **Interdisciplinary Research:** Nanotechnology and nanoscience, Nano-robotics, Micro-electro-mechanical systems (MEMS), Nanomaterials, Mechatronics, Waste, Water and Energy management
16. **Educational Innovation and Institutional Development**

***Respective Department HOD's may be contacted for further information**

UNIVERSITY-INDUSTRY LINKAGE

A recurring theme in the realm of educational reform and innovation has been that of linking university education with industry experience. Since its very inception in 1964, the Institute has been committed to University-Industry Collaboration. Beginning in 1973, the Institute has taken pioneering initiatives towards the development of institutionalized linkages with industry, through its (i) Practice School, (ii) Technology Innovation Center, and (iii) Off-campus work-integrated learning programmes. The details of Practice School are described here.

PRACTICE SCHOOL

All Integrated First Degree and Higher Degree Programmes of the Institute provide a Practice School option. A student who exercises this option receives, on successful completion of the requirements of the programme, a degree which carries the tag, “With Practice School”.

Theme

BITS is strongly committed to the view that university education must be oriented so as to (i) meet the rapidly changing needs and challenges of the environment, (ii) help people use their intelligence and become capable of facing unfamiliar, open-ended real-life situations, and (iii) bear an economic relevance to the society.

The Practice School (PS) method of education links the university with the professional world, by infusing the reality of the world of work into the educational process. The classroom is shifted for a period of 7½ months to a professional location where the students, under the supervision of the faculty, are involved in applying the knowledge acquired in the classroom to finding solutions to real life problems. The PS experiment began with a small group of 12 students in 1973 and has been extended to accommodate all students from all disciplines. The distinguishing features of the PS method of education - (i) the work of the students is supervised and evaluated by faculty, (ii) the credits earned by the student count towards the total credit requirement of the degree, and (iii) the PS option is available to students of all disciplines - make it a bold and radical educational reform with no parallel.

The **PS** Programme for Higher Degree has a single component, namely Practice School for Higher Degree operating in an identical fashion to PS-II, in the final semester of the Higher Degree Programme.

Practice School - I (PS-I)

This component is the first exposure to the world of work, necessary for the subsequent problem solving experience during PS-II. It is implemented at large industrial complexes, research and development centers, software development houses, pharmaceutical companies, etc. While the general aim of PS-I is to afford an opportunity for the student to learn how work is organized and carried out; by a process of observation and participation, the learning can be quite varied and exhaustive depending on the nature of the organization. It provides an opportunity for a detailed understanding of vast engineering operations and its various facets such as inventory, productivity, management, information systems, human resource development, etc. Students observe science and technology in action, develop an awareness of the method of scientific experimentation, and often get an opportunity to see, study and operate sophisticated and costly equipment. They also learn about the implementation of the principles of management they have learnt in class, when they observe multidisciplinary teams of experts from engineering, science, economics, operations research, and management deal with techno-economic problems at the micro and macro levels. Finally, it enables them to develop and refine their language, communication and inter-personal skills, both by its very nature, and by

the various evaluation components, such as seminar, group discussion, project report preparation, etc. The broad-based core education, strong in mathematics and science and rich in analytical tools, provides the foundation necessary for the student to understand properly the nature of real-life problems. The students are accompanied by a teacher, who is responsible for coordination with the organization and the day-to-day educational as well as evaluation details.

Some of the places where this component has been implemented are Indian Institute of Petroleum, Dehradun; Rourkela Steel Plant, Rourkela; Indian Institute of Remote Sensing, Dehradun; The Institute of Minerals & Materials Technology, Bhubaneshwar; National Chemical Laboratories, Pune, Indira Gandhi Centre for Atomic Research Centre, Kalpakkam, Central Leather Research Institute , Chennai; National Aerospace Laboratories, Bengaluru; Orchid Bio Medical Systems, Goa; Bharat Forge Ltd , Pune.

Practice School - II (PS-II)/ PS for Higher Degree

PS-II is attended by the students of the Integrated First Degree Programmes in their final year of study. This is also faculty supervised, and for this purpose, teachers are located at various centers around the country where PS stations operate. In order to maintain continuity of operation, the students are divided into two batches, about half the students doing PS-II in the first semester and the other half in the second semester. In either case, the time duration is augmented by a part of the summer term (preceding or following the semester). The operation is therefore round the year with batches coming about every six months. PS for Higher Degree is however available only in the final semester of the programme, after completion of the campus-based courses. The PS-II/PS component is implemented at Production and Manufacturing units, Design, Development and Consulting Agencies, Research and Development Centers, Financial Institutions, Software Development organizations, etc. The student education here is in terms of the direct involvement of the student in problem solving efforts of specific interest to the host organization. The assignments are identified by the PS faculty well in advance in consultation with experts from the host organization. The problems are often multidisciplinary in nature, which are assigned to a group of students drawn from different disciplines. The professional expert in charge of a particular problem and the PS faculty play the roles of consultant and supervisor respectively. The students are encouraged to work independently and are required to defend the technical aspects of their work through periodic written and oral presentations. Emphasis is laid on realizing the importance of teamwork, development of leadership qualities, and the need for effective time management.

Some of the typical assignments that the students have undertaken are: Development of Category Configuration Portal; System on Chip Design and Verification; Design and Development of Features in the Mtg-Automation; Risk and Control Tools in Operations; Integrating HP Performance and HP Nonstop Measure; Planning and Implementing Events at ECLUB and Work at Resource Bureau; Partial Metadata Get/Set Support in CDMI Server; Sabre Cruises Booking Analytics Tool; Mobile Engineering at Pocket Gems; Data Management and Organization of Datasets.

Typical PS Station – A Model

The PS station is the analogue, in the professional world, of the university classroom and laboratory. The Institute endeavors to ensure that each PS station has all the physical facilities necessary to carry out meaningful education. In fact, host organizations have always come forward with all possible assistance. At least one faculty member is attached with each PS station. Since a city may have more than one PS station, the term PS Centre is used to designate a location where one or more PS stations are present.

PS Assignments

The general nature of PS-I assignments is of study and orientation. However, the assignment plays a pivotal role in PS-II and is of direct and immediate relevance to the host organization. The educational challenge is therefore that of evolving the pedagogy for teaching, learning, and evaluation while the students are involved in their problem solving efforts. The tasks are generally multidisciplinary, mission oriented and therefore time bound and open ended. The development of solutions to such problems requires a scientific attitude, technical competence, discipline and adherence to procedure, decision making ability, and a spirit of curiosity and exploration. Often, the assignments form a part of long term research and development projects.

Student Allotment in PS

Allotment in PS-I is done keeping the student's preferences and academic performance in view, along with the availability of physical facilities, in particular, accommodation. Student allotment in PS-II is, however, a much more complex and multi-dimensional task. With the help of the PS faculty, information about the total set of skills and attributes required of the student for the task at hand is collected from the host organization. Simultaneously, a profile of each student is prepared, incorporating details such as CGPA, performance in various categories of courses including electives and projects, assignment worked on in PS-I, professional interests, and extra-curricular achievements. With this information base, a matching is carried out, keeping in view the student's preferences and constraints of physical facilities.

Computerization of the various activities related to PS, such as profile preparation, allotment, monitoring, and feedback has made the entire process expeditious and efficient.

Evaluation in PS courses

The PS method of education, as has been emphasized earlier, is a medium for integrating real-life situations with the learning process. In line with this objective, the student is given the responsibility of planning, scheduling, implementing, and defending the steps to the solution of the assigned problem. The students work under the supervision of the faculty, in consultation with the professional expert(s). As with all other courses, a process of continuous evaluation is followed. The PS method of education seeks out and focuses attention on many latent attributes which do not surface in the normal classroom situation. These include professional judgment and decision making capacity, inter-disciplinary approach, data-handling skills, ability in written and oral presentation, leadership qualities, ability for team work, sense of responsibility, ability to meet deadlines, etc. These attributes are judged by the faculty through various instruments of evaluation, namely quiz, viva, seminar, group discussion, project report, diary, and daily observation. At the end of each PS course, a student is awarded a letter grade based on his total performance. Supplementing the degree transcript issued by the Institute, the PS Division issues a 'Practice School Transcript' to those students who opt for the PS stream. This transcript gives a complete record of the performance of the student in the PS programme. It also includes a rating sheet which describes qualitatively the student's personality traits mentioned earlier.

Since the PS programme interfaces with the world outside the campus, whenever the progress of a student in a PS course is found to be unsatisfactory and/or guilty of conduct unworthy of the professional world, the PS option may be withdrawn by the Institute, without any reason being assigned.

Role of Professional Experts in PS

The PS programme clearly places demands on the time and energy of various officers from the host organization. However, every effort is made to ensure that they are not burdened with the day-to-day details concerning the educational and administrative organization of the PS

programme, these being the responsibility of the PS faculty.

In the case of PS-I, the preparation of the educational schedule is initiated at the Institute itself. On reaching the PS station, the faculty discusses the same with officers from the host organization, seeking their concurrence and their suggestions. The faculty engages the students on various assignments and periodically informs the experts of the progress made. The faculty may also arrange meetings of the students with the experts and also invite them to participate in seminars given by the students from time to time. At the end of the course, the faculty seeks the expert's critical comments on the report submitted by the student, to receive essential feedback on the quality of the work.

In respect of PS-II, the officers from the host organization first come into picture when the faculty is compiling the problem bank for the batch of students to come. At this stage, the experts provide the details of the various problems on which the students will work, as well as their requirements in terms of the type of student input for each assignment. After the arrival of the students at the PS station too, the faculty remains at the helm of affairs, forming student groups, assigning projects, conducting evaluation components, etc. The faculty also ensures that each student blends well with the group of fellow students and staff from the host organization, in which he/she is working. When seminars or group discussions are held, the faculty invites the officers to participate. During the course of the assignment, the students seek consultation with the expert, normally through the faculty, who ensures that the student is well-prepared for these meetings. At the end of the course, the student is required to present a seminar and defend the technical credibility of the work before as large a gathering of experts as possible. Detailed discussions ensue on various technical aspects of the problem, often resulting in the resolution of critical issues involved.

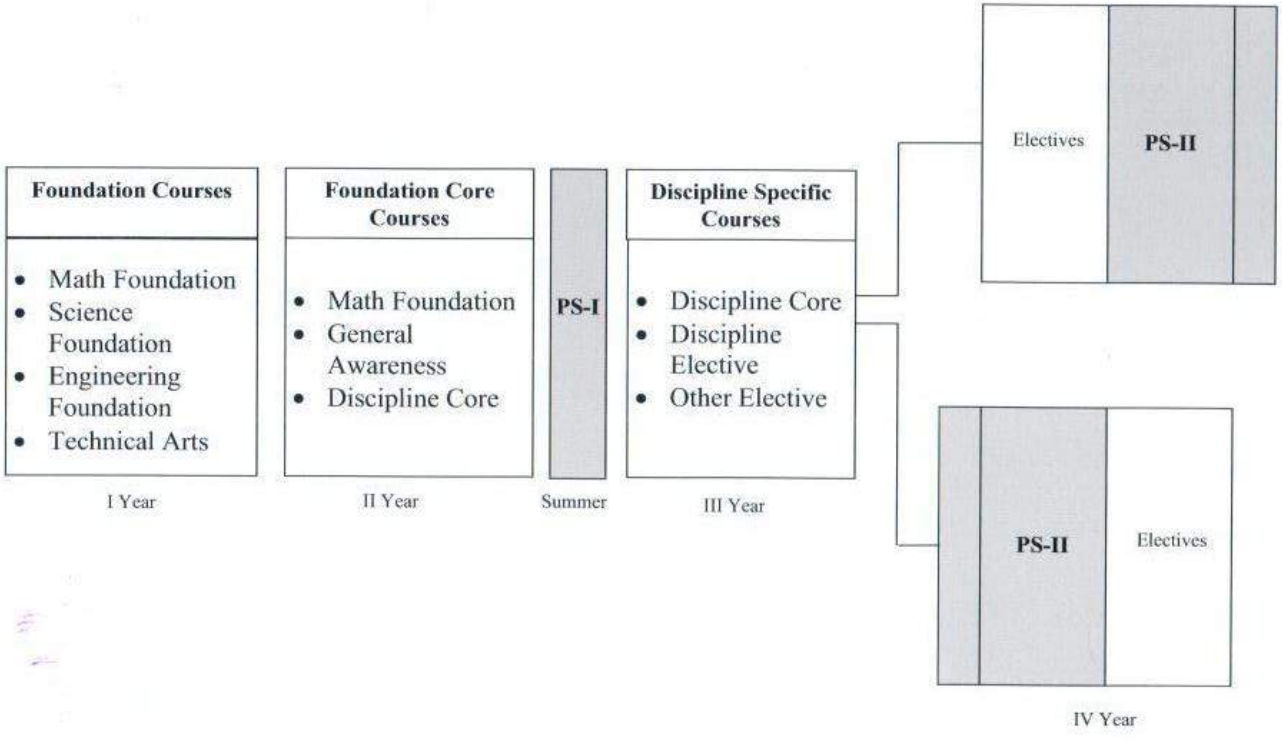
Operation of the PS Programme

The **PS** programme for the Integrated First Degree has two components, namely **PS-I** of two months' duration implemented during the summer following the 2nd year and **PS-II** of five and a half months duration implemented during either of the semesters of the final year. (Refer to the chart on page II-24) Dual degree students can also opt for PS-II in both the semesters of the final year.

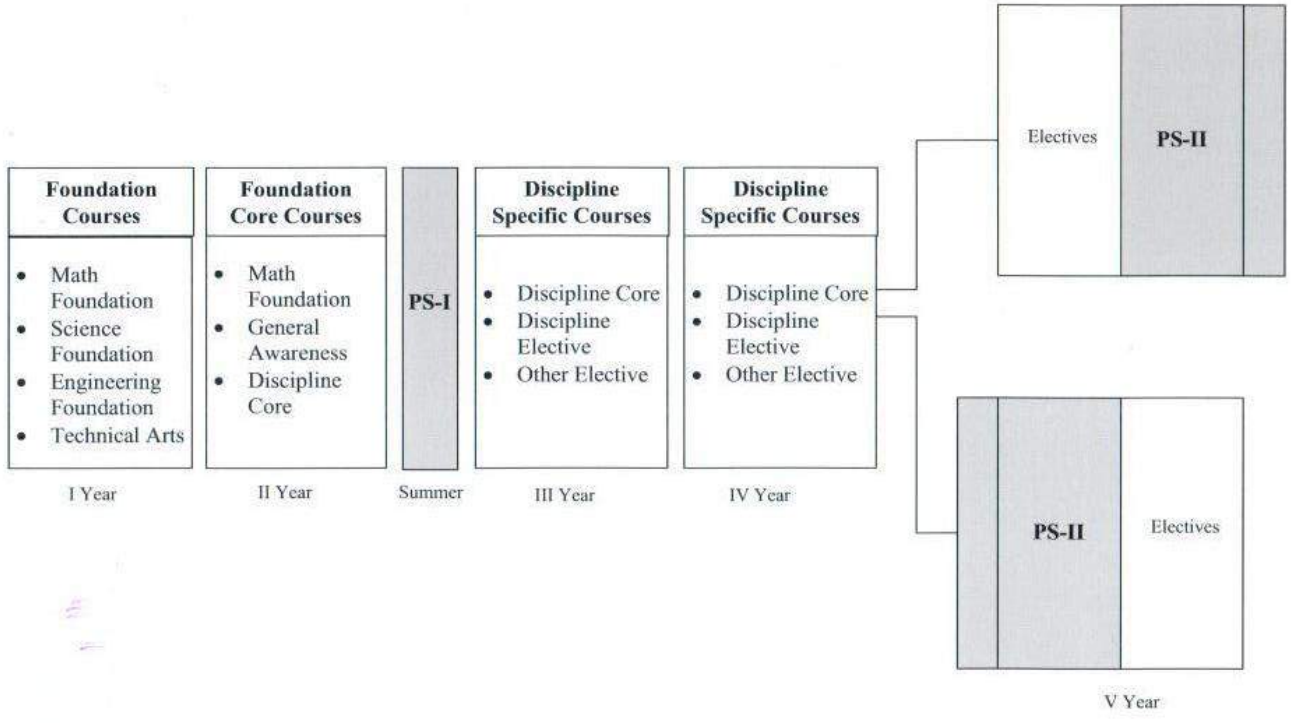
Some PS Statistics (Refer page II-25 to II-31)

Ever since its beginning in the year 1973 with just one station accommodating 12 students and 4 faculty members, the PS has grown immensely. In the academic year 1975-76 the programme was thrown open to all the students of the Institute. During an academic year arrangements have to be made for PS programme for a steady number of 6726 students, accompanied by nearly 174 faculty members. Specifically, it means accommodating a steady number of 2888 students and103 faculty members at about 286 different organizations for PS-I in the summer term and arranging for about 3838 students accompanied by about 71 faculty members to attend PS-II operated round the year at about 592 different host organizations. So far about 91480 students have been benefited by this programme. While all the host organizations pay the students out-of-pocket allowance, some organizations provide the students and the faculty with housing and other facilities as well.

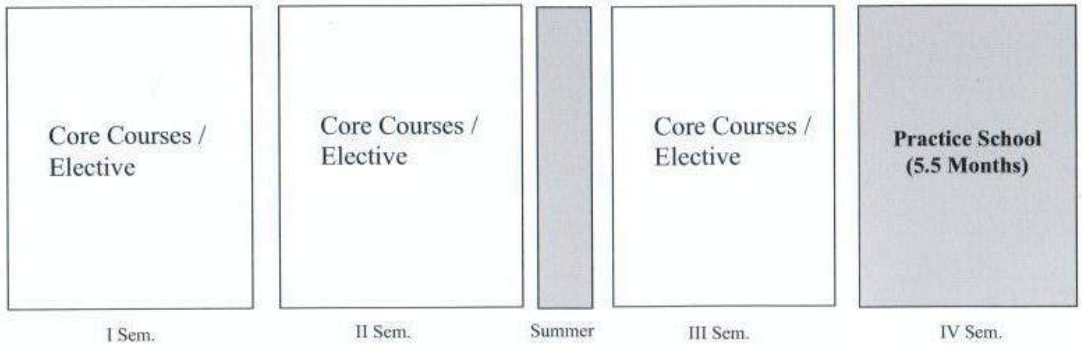
The list of organizations where PS programmes are in operation is given below. There are also organizations outside India where the PS programme is being conducted for several years. (Refer to the following map showing PS Stations).



The Structure of Integrated First (Single) Degree Programme
(Practice School Option)

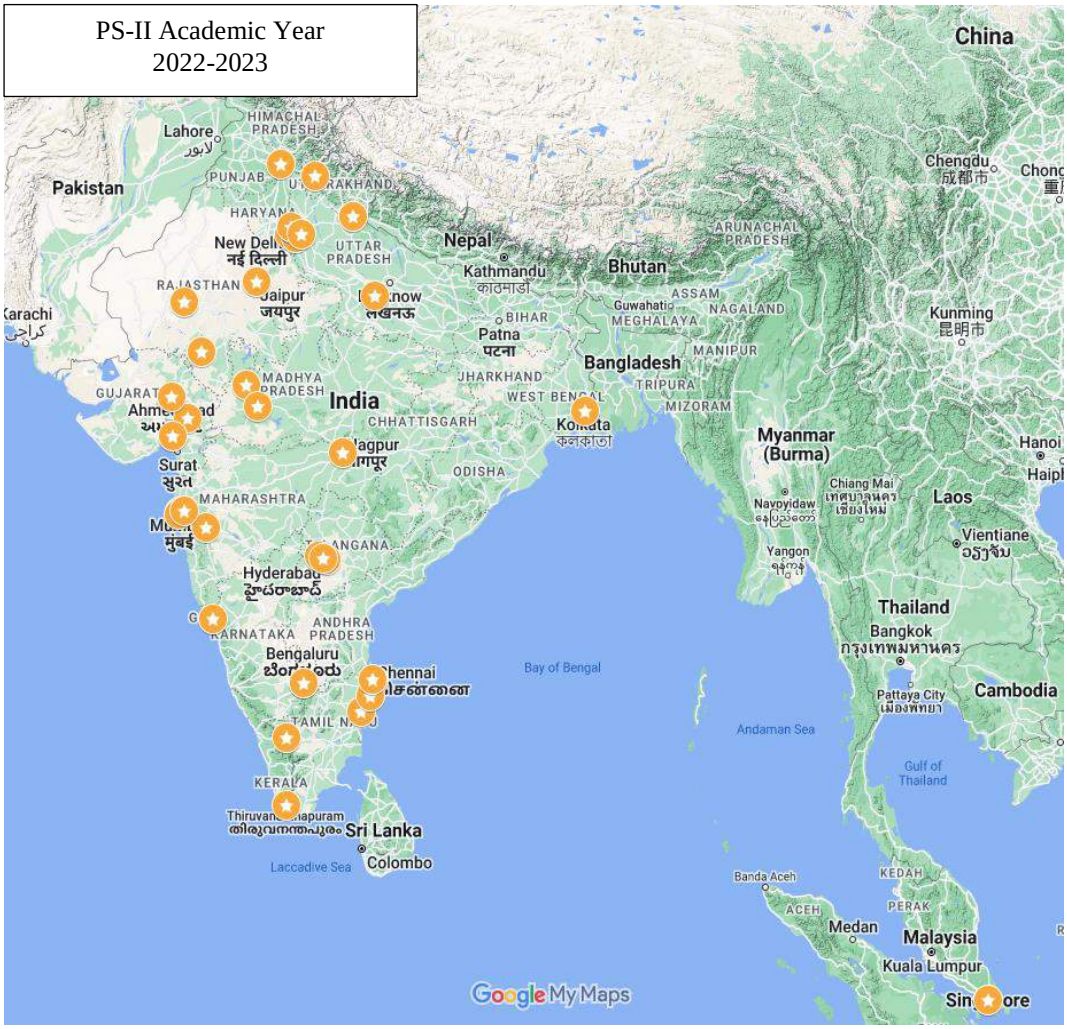


The Structure of Integrated First (Dual) Degree Programme
(Practice School Option)



The Structure of Higher Degree Programme
(Practice School Option)

PS Map highlighting the Practice School Locations
(PS-I Centres operated during summer 2023)



PS Map highlighting the Practice School Locations
(PS-II Centres operated during Academic Year 2022-2023)

LIST OF PS-I STATIONS

Ahmedabad

Indian Red Cross Society (IRS), Integrity Data Services Pvt. Ltd. (IDSPL), Prompt Equipments Pvt. Ltd. (PEPL), Prozeal Infra Engineering Pvt. Ltd. (PIEPL), Silver Touch Technologies Ltd. (ST)

Anand

Sardar Patel Renewable Energy Research Institute (SPRERI)

Angul

National Aluminium Company (NALCO)

Aurangabad

Disha Auto Components (DAC), Siemens (SIEMENS)

Ballabgarh

NCCBM (NCCBM)

Bengaluru

24/7 - I Labs (ILABS), Avidia Labs (AL), Blu Feather Innovations Pvt. Ltd (BFIPL), Commvault Systems (CS), Couture AI Pvt. Ltd. (CA), CSIR-National Aerospace Laboratories (CSIR-NAL), Dynamatic Technologies Ltd (DTL), Electrono Solutions (ES), eShipz.com (ESHIPZ), Feedback Advisory Services Pvt. Ltd. (FASPL), Flamingos Technologies Inc. (FTI), Goavega Software India Pvt. Ltd. (GSIPL), Harman International (HI), i-exceed technology solutions private limited, (I-EXCEED), Immensitas Pvt. Ltd. - Lemnisk (IPL) Indian Red Cross Society (IRCS), Log9 Materials Scientific Pvt. Ltd. (LOG9), OnFinance (ONFINANCE) P2F Semi Pvt Ltd. (P2F-SEMI), Petasense Technologies Pvt. Ltd. (PTPL), Pockvue Solutions Pvt. Ltd (PSPL), Race2Cloud Technologies Pvt. Ltd. (RCTPL), SatSure Analytics India Pvt. Ltd. (SATSURE), Solutionec Pvt. Ltd. (SPL), Stocklite Gemms Private Limited (STOCKLITE), Techverve Solutions (TS), Unibic Foods India Pvt Ltd (UFIPL), Verse Innovation Private Limited (VIPL), VoiceQube (VOICEQUBE), William O Neil - (WILLIAM O NEIL)

Bhopal

IRCS (IRCS)

Bhubaneswar

The Institute Of Minerals And Materials Technology (IMMT)

Bilaspur

Farmers Pride (FP)

Chandigarh

CSIR Central Scientific Instruments Organization (CSIO), CSIR IMTEC (IMTEC), IRCS (IRCS)

Chennai

City Union Bank (CITY-BANK), Consulting & Beyond (C&B), Chennai Petroleum Corporation Ltd. (CPCL), DYSL-CT DRDO (DYSL-CT), Mahindra Research Valley (MRV), Mel Systems and Services Ltd (MELSS), MSME Development Institute (MSME-DI), National Metallurgical Laboratory Madras Centre (NML), Palmtree Infotech (PI), Tamil Nadu eGovernance Agency (TN-EGOVERNANCE), Tamil Nadu Medical Services Corporation Limited (TN-MSCL), Urjanet (URJANET), UST Global (UST GLOBAl)

Coimbatore

Ciyes Systems (Caliber Interconnect Solutions Pvt Ltd (CIYES SYSTEMS)

Dehradun

Indian Institute of Petroleum (IIP), Indian Institute of Remote Sensing -(IIRS), IRCS (IRCS), Survey of India (SI), Wadia Institute of Himalayan Geology (WIHG)

Delhi

ABC Consultants Pvt. Ltd. (ABC-CPL), Act Now India (ANI), Agrix Agrotech Private Limited - Electronics (AAPL), AlmaConnect (AC), Arbunize Digital Media Pvt. Ltd (ADMPL), Avricus Pvt. Ltd. (APL), Centre for Development of Telemetics (CDOT), Centre for Railway Information Systems (CFRIS), Central Road Research Institute (CRRI), Delhi Metro Rail Corporation (DMRC), EFY Group (EFY GROUP), E-Sutra Technologies Pvt. Ltd. (E-SUTRA), Grad Capital Advisors (GCA), Indian Council for Research on International Economic Relations (ICRIER), Integra Design (ID), Indian Oil Corporation Ltd.,(IOCL), IRCS (IRCS), Lakshyam (LAKSHYAM), MapmyIndia (CE Info Systems Pvt Ltd) (MAPMYINDIA), NCAER (NCAER)

Dombivli

PNT Robotics & Automation Solutions LLP (PNT-ROBOTICS)

Faridabad

Agromach Engineering Pvt. Ltd. (AEPL), AIotBlocks Pvt. Ltd. (ABPL), Gates India Pvt. Ltd. (GIPL), Medsupervision Pvt. Ltd (MPL), NHPC Ltd (NHPC), SaaSDen (SAASDEN)

Gandhinagar

Bhaskaracharya Institute For Space Applications And Geoinformatic (BISAG), INFLIBNET Centre (INFLIBNET), Institute of Seismological Research (ISR)

Ghaziabad

IFP-Petro Products (P) Ltd (IFP-PETRO)

Goa

Birla Furukawa Fibre Optics Pvt. Ltd. (BFFOPL), Coral Clinical Systems (CCS), Danlaw Technologies India Ltd. (DTIL), Funskool (india) Ltd. (FIL), Goa Shipyard Ltd. (GSL), Maker Asylum (MA), Mormugao Port Trust (MPT), National Centre for Polar and Ocean Research (NCPOR), National Institute of Oceanography (NIO), Orchid Bio Medical Systems (OBMS), Pentair Water India Pvt. Ltd. (PWIPL), Project Management Unit (PMU), Putzmeister (PUTZMEISTER), Siemens (SIEMENS), Smartlink Holdings Ltd (SHL), Starflex Sealing India Pvt. Ltd. (SSIPL), Syntegon Technology India Private Limited (STIPL), Tienda Advanced Materials Pvt. Ltd. (TAMPL), Tulip Diagnostics Private Limited (TDPL), Wakao Foods (WF), Zephyr Biomedical (ZB), Zuari Industries Ltd (ZIL)

Gurugram

A. V. Engineers (AVE), Apollo Tyres Ltd. (ATL), Crossbar Talent (CT), CT Software Solutions India Pvt Ltd (CT-SSIPL), Ernst & Young LLP (E&Y), FinMapp (Fininfinity Technologies Pvt. Ltd.) (FINMAPP) Futures First Info Services Pvt. Ltd. (FFISPL), K2 Cloud Pvt. Ltd. (K2-CLOUD), Macquarie Global Services Private Limited (MGSPL), Northcorp Software Pvt. Ltd. (NSPL), ParallelDots Technology Pvt. Ltd. (PARALLELDOTS)

Harihar

Birla Polyfibers (BP)

Hazira

L&T Defence (L&T-D)

Hyderabad

Akshara Livelihoods Private Limited (ALPL), AlgoUniversity (ALGO-UNIV), Alltronix International Inc (AII), Amazon (AMAZON), Comprotech Engineering Pvt. Ltd. (CEPL), Contenterra Software Private Limited (CSPL), DRDO - Advanced Systems Lab (DRDO-ASL), G.M.R. Varalakshmi Foundation (GMR), Hyderabad Eye Institute (L. V. Prasad Eye Institute) (HEI), Innomagine Consulting Pvt. Ltd. (ICPL), Jio Platforms (JIO), Loop Reality Private Limited (LRPL), MASTH (UltraHive Healthcare Pvt Ltd) (MASTH), Monocept Consulting Pvt Ltd. (MCPL), Nagarjuna Construction Company (NCC), Pass Consulting (PC), Preto Tooling Systems (PTS), Roads and Buildings Department - Govt of Telangana (RBD-GT), T-Hub (T-HUB), T-Work Foundation (T-WF), Vidcentum R & D Pvt. Ltd. (VR&DPL), Yashoda Hospital (YH), YK Innosoft Technologies Pvt. Ltd. (YK-ITPL)

Jabalpur

KEC International Limited (KEC)

Jaipur

Alucoat (ALUCOAT), Deptt. Of Information Technology & Communication (DITC), KDK Software (I) Private Limited (KDK-SIPL), KEC International Ltd (KEC), Rajasthan Housing Board (RHB), Rajasthan State Industrial Development and Investment Corporation (RIICO)

Jamshedpur

CSIR National Metallurgical Laboratory (NML),

Jharsuguda

Odisha Power Generation Corporation (OPGC)

Jodhpur

Regional Remote Sensing Centre (RRSC)

Kalpakkam

Indira Gandhi Centre For Atomic Research (IGCAR)

Kolkata

Asanify Technologies (AT), Forganic Pvt. Ltd. (FPL), Centre for Development of Advanced Computing (CDAC), Health & Family Welfare Department (HFWD), Variable Energy Cyclotron Centre (VECC)

Lambhvel

Hacker4Help (HACKER4HELP)

London

Allos AI Limited (ALLOS-AI)

Lucknow

CSIR-Central Drug Research Institute (CDRI), IRCS (IRCS), Manodayam Pvt. Ltd. (MPL), P2P Microfinance & Allied Services (P2P), Public Work Department (PWD)

Madhapur

Nirmaan Organization (NIRMAAN)

Maihar

RCCPL Pvt. Ltd. (RCCPL), UltraTech Cement Limited (Maihar Cement Works) (ULTRATECH)

Mathura

Indian Oil Corporation Ltd. (IOCL), Weschel Pharma (WP)

Mexico

I care Foundation (ICF)

Mohali

IDS Infotech Ltd. (IDS-IL), Semi- Conductor Laboratory (SCL)

Moradabad

APC Technologies (APC-TECH)

Mumbai

Atomic Energy Regulatory Board (AERB), Bonanza Portfolio Ltd. (BPL), Datamatics (DATAMATICS), Eclipse Prism Medical Device Pvt. Ltd. (ECLIPSE), Future Generali India Life Insurance (FGILI), Hindustan Colas (HC), Indian Red Cross Society (IRCS), IOCL (IOCL), Jio Platforms Ltd. (JPL), Kotak Education Foundation (KEF), Lenest (LENEST), Navork Innovations Pvt. Ltd (NIPL), Pacify Medical Technology Pvt. Ltd (PMTPL), Phillip Capital India Pvt. Ltd. (PCIPL), Qualitykiosk Technologies Pvt. Ltd. (QTPL), Siemens(SIEMENS), TEVA (TEVA), Volofin services Pvt Ltd. (Subsidiary of Volofin Pte Singapore) (VSPL)

Nagda

Grasim Industries Ltd. (GIL),

Nagpur

Bajaj Steel Industries Ltd. (BSIL), Bitcomm Technologies Pvt.Ltd (BTPL), SimpleWorks Solutions Pvt. Ltd. (SimpleCRM) (SWSPL)

Nashik

M/s Mosdorfer India Pvt. Ltd. (MIPL)

Navi Mumbai

Prama Instruments Pvt. Ltd (PIPL)

Neemuch

Vikram Cement Works (VCW)

Nellor

iQuadra Information Services Pvt. Ltd. (IQUADRA-ISPL)

Noida

Bitcomm Technologies Pvt.Ltd (BITCOMM) Hyphen Supply Chain Solutions Pvt. Ltd (HSCSPL), Kalpataru Power Transmission Ltd. (KPTL), Unicloud (UNICLOUD)

Palghar

Spenta International Ltd. (SIL),

Panipat

Indian Oil Corporation Ltd., (IOCL)

Patna

Realty Advance Structure Enterprises Pvt Ltd (RASEPL)

Pilani

Birla Science Centre Pilani (BSCP), CEERI (CEERI), Cognix Technologies (CT), Pilani AtmaNirbhar Resources Center (PARC), Pilani Innovation and Entrepreneurship Development Society (PIEDS)

Powai

L&T Defence (L&T-D)

Pune

Apisero - An NTT Data Company (Apisero), Ascent Cyber Solutions Pvt. Ltd. (ACSPL), Bharat Forge Ltd. (BFL), Centre for Development of Advanced Computing (C-DAC), Chaob Technologies Pvt. Ltd (Carscan) (CTPL), Coditation Systems Pvt Ltd (CSPL), Forbes Marshall Pvt Ltd (FMPL), iLink (ILINK), Indian Meteorological Department (IMD), Integrated Active Monitoring Pvt. Ltd. (IAMPL), Johnson Controls (I) Pvt. Ltd. (JCIPL), Melux Control Gears Pvt. Ltd. (MCGPL), National Chemical Laboratory (NCL), RI Equation (RI-EQUATION), Shalaka Connected Devices (SCD), Suzlon Foundation (SUZLON), Tata Motors Ltd. (TML)

Rajkot

Western Irrigaation System Pvt. Ltd. (WISPL)

Ranchi

Arics Infrastructure (AI)

Rourkela

Rourkela Steel Plant (RSP)

Sahibzada Ajit Singh Nagar

Agnext Technologies Pvt. Ltd. (AGNEXT)

SaintCloudMN

MobileMSK LLC (MML)

Secunderabad

LightSpeed Photonics Pvt Ltd (LSPPL), Military College of Electronics and Mechanical Engineering (MCEME), Shris Infotech Services Pvt Ltd (SISPL)

Sharjah (USA)

Americana Restaurant (AR)

Solan (H.P.)

Baga Cement Works (BCW)

Talegaon

L&T Defence (L&T-D)

Thane

Eclipse Prism Medical Device Pvt. Ltd. (ECLIPSE)

Thiruvananthapuram

Cleareye.ai India Pvt. Ltd. (CIPL), Kerala Infrastructure and Technology for Education (KITE), State Council of Education Research and

Training (SCERT), UST Global (USTG)

Tirupathi

National Atmospheric Research Laboratory (NARL)

Tiruppur

District Administration (DA)

Udaipur

Pyrotech Electronics Pvt. Ltd. (PEPL)

Umiam

North Eastern Space Applications Centre (NESAC)

USA

STEM4ALL (STEM4ALL)

Vadodara

IOCL (IOCL), Sub-Chemie India Pvt. Ltd. (SCIPL)

Vijayapur

Kairos Integrated Solutions Pvt. Ltd. (KISPL),

Vijaynagar

JSW Steel(JSW-S)

Visakhapatnam

Sarda Metals & Alloys Ltd. (SMAL), HPCL (HPCL)

LIST OF PS-II STATIONS

Ahmedabad

Sigma Infosolutions Limited (SIL), Zyduslife (ZYDUSLIFE)

Arizona

ODE Holdings Inc (ODE-HI)

Atlanta (USA)

Spiralyze LLC (SPIRALYZE)

Bangalore

Altair Engineering (ALTAIR), Acceldata Technology Pvt. Ltd. (ACCELDATA), Accern AI Software Solutions Pvt Ltd (ASSPL), Acko Technology and Services Pvt. Ltd (ATSPL), Aerchain (AERCHAIN), Airmeet (AIRMEET), AMD India Pvt Ltd (AMD-IPL), American Express (AMEX), Apple India Private Limited (AIPL), ARM Embedded Technologies Private Limited (ARM), Aurigo Software Technologies (AURIGO), Autolytics Technology Private Limited (AUTOLYTICS), Avaamo (AVAAMO), Azalp Technologies Pvt. Ltd (ATPL), Bharosepe Technology Services Privated Limited (BHAROSEPE), Bigbasket (BIGBASKET), Biocon (BIOCON), Bizongo (BIZONGO), BlokTrek (BLOKTREK), Bloomreach Technologies Pvt. Ltd (BTPL), Blue Jeans Network India Pvt. Ltd. (BLUE-JEANS), Bluelearn (Clinify Pvt Ltd) (BLUELEARN), Bright Champs (BC), Bundl Technologies Private Limited (Swiggy) Tech (BTPL-T), Carscan (CARSCAN), Centre for Artificial Intelligence & Robotics (CAIR), Christie Digital Systems Inc. (CDSI), Cisco Systems (India) Pvt. Ltd (CISCO), Clientell Technologies Pvt Ltd (CLIENTELL), Cohesity Storage Solutions India Pvt. Ltd. (CSSIPL), CommerceIQ (C-IQ), Confluent India Pvt Ltd.(CIPL), Contlo (CONTLO), Couture AI (CA), CURB Technologies (subsidiary of OIVRT Inc) (CURB), DataZymes Analytics (DATAZYME), DealShare (DEALSHARE), Delightful Gourmet Pvt Ltd – Licious (DGPL), Dell R&D (DELL), DevRev Cloud India Pvt. Ltd. (DEVREV), DigiCert Security India Pvt Ltd (DIGICERT), Dover India Pvt Ltd (DIPL), DSLR Technologies Pvt. Ltd. (DSLR-TPL), e6data (E6DATA), eBay (eBay), EdgeQ (EDGEQ), Eightfold AI India Pvt. Ltd. (EIGHTFOLD), Eli Lilly (ELI-LILLY), Eltropy (ELTROPY), Equinix Inc (EQUINIX), Exeevo (EXEEVO), Faurecia (FAURECIA), Feedback Advisory Services Private Limited (FASPL), First Meridian OnSolve LLC (FM-OSL), Flint (FLINT), Flipkart Internet Pvt Ltd (FLIPKART), Fortanix (FORTANIX) GamesKraft Technologies Pvt Ltd (GAMESKRAFT), GE Healthcare (GE-H), GE India Technology Centre (GEITC), GeoIQ (Quantduo Technologies Pvt. Ltd. (GEOIQ), Glance (An InMobi Group Company) (GLANCE), Goldman Sachs India Pvt. Ltd. (GS), Goodera (GOODERA), Google India (GI, HAPPAY (VA Tech Ventures Pvt Ltd.) (HAPPAY), Harness (HARNESS), HDFC Credila Financial Services Limited (HDFC CREDILA), Heaps Health Solutions Pvt. Ltd. (HEAPS), HERE Technologies (HERE-TECH.), Hevo Technologies India Pvt. Ltd. (HTIPL), Hindustan Unilever Research Centre (HURC), HSBC (HSBC), IBM India Software Group (IBM), Infineon (INFINEON), Infinera (INFINERA), Informatica Business Solutions PVT. LTD. (IBSPL), InMobi (INMOBI), Intel - India Technology (INTEL), IUDX Program Unit Indian Institute of science - Data Kaveri (IUDX), JPMC (JPMC), Knolskape Solutions Pvt. Ltd. (KSPL), KPMG (KPMG), Leapus Technologies Pvt. Ltd (LTPL), Lemnisk Pvt. Ltd. (LEMNISK), Lyearn Software Development India Pvt. Ltd. (LSDIPL), M2P Fintech (M2P), Marvell (MARVELL), MathWorks India Pvt. Ltd. (MATHWORKS), Mavenir (MAVENIR), MBB Labs Pvt. Ltd. (MBB LABS), MediaTek Bangalore Pvt. Ltd. (MEDIATEK), MediBuddy (MEDIBUDDY), Mercedes Benz(MERCEDES), Mewt (MEWT), MIPS Embedded Technologies Pvt. Ltd (MIPS-

ETPL), Mobile Premier League (MPL), Monster India (MONSTER), National Centre for Biological Sciences (NCBS), National Instruments Systems (India) Pvt. Ltd. (NISPL), NetApp (NETAPP), Netradyne (NETRADYNE), Newton School (NS), nurture.farm (A Subisidiary of UPL Ltd.) (NURTURE FARM), Nutanix Technologies India Pvt. Ltd (NUTANIX), Nvidia Graphics (NVIDIA), NXP India Pvt. Ltd. (NIPL), Ontap Direct Pvt. Ltd. (ONTAP), Playment Inc (PI), Porter (PORTER), ProteanTecs (PT), PYOR Edge Inc (PEI), Qualcomm India Pvt. Ltd. (QUALCOMM), Razorpay (RAZORPAY), RetainIQ (RETAINIQ), Rocket Learning (RL), Rupeek Fintech (RF), Rupifi (RUPIFI) Samsung R & D Institute (SAMSUNG), Samsung Semiconductor India R&D Center (SAMSUNG-SEMI), Sandvine (SANDVINE), Schmooze (SCHMOOZE), Scienaptic Systems Pvt. Ltd. (SSPL), ShareChat (SHARECHAT), Siemens Technology (ST), Sigma Infosolutions Limited (SIL), SLICE (SLICE), Solutionec (SOLUTIONEC), Stocklite Gemms Private Limited (STOCKLITE), Strand Life Sciences Pvt. Ltd (SLSPL), Sundial Systems Pvt. Ltd. (SSPL), Synechron Technologies Pvt. Ltd. (STPL), Technicolor India (TI), Tenstorrent India Private Limited (TIPL), Texas Instruments (I) Pvt. Ltd. Systems (TEXAS-S), Thorogood (THOROGOOD), Tonbo Imaging (TONBO), Trane Technologies (TT), Udaan (UDAAN), VINJEY Software Systems Pvt. Ltd. (VSSPL), Wabtec Corporation (WABTEC), Walmart Global Technology Services(WALMART), Western Digital (SANDISK), William O Neil India Pvt Ltd (WONIPL), Wint Wealth (WINT WEALTH), Yubi (YUBI), Yugabyte (YUGABYTE), Zapcom Solutions Pvt. Ltd (ZSPL), Zeotap India Pvt. Ltd. (ZIPL)

Chennai

Apollo Tyres Ltd. Advanced Engineering centre (APOLLO-TYRES), Barclays (BARCLAYS), Central Leather Research Institute (CLRI), EConsystems (VIS AI Labs) (ECONSYSTEMS), M2P Fintech (M2P), Pfizer Ltd.(PFIZER), Rane Madras Ltd (RML), ZF Commerical Vehicle Control Systems (ZF-CVCS), ZoomRX (ZOOMRX)

Dehradun

Indian Institute of Petroleum(IIP)

Delhi

Central Road Research Institute (CRRI), CX Partneers (CX-P), Elucidata Data Consulting Pvt. Ltd. (EDCPL), Euler Motors (EULER MOTORS), Feedback Advisory Services Private Limited (FASPL), Intercontinental Consultants and Technolocrats Pvt. Ltd. (ICTPL), Jarvis Technology & Strategy Consulting Pvt. Ltd. (JARVIS), LEA Associates (LEA-A), Quality Coucil of India (QCI), Recur Club Technologies Pvt. Ltd. (RCTPL), Rusk Media (RUSK MEDIA)

Goa

CommScope (CS), Fintech Blue Solutions Pvt Ltd (Turtlemint) (FBSPL), IFB Industries (IFB-I), Putzmeister Concrete Machines Private Limited (PCMPL)

Greater Noida

Lohum Cleantech Pvt. Ltd (LOHUM), ST Microelectronics(I) Pvt.Ltd. (ST-MICRO)

Gurgaon

A.T. Kearney Consulting (India) Pvt. Ltd. (ATKCIPL), Alma Connect (ALMA-CON), American Express (AMEX), ANS Commerce (ANS-COM), Atkins (ATKINS), Axtria India Pvt Ltd (AIPL), BlackRock Services (BLACKROCK), Clarivate Analytics (CLARIVATE), Cogoport (COGOPORT), Ernst & Young L.L.P. (E&Y), GoKwik (GOKWIK), GreyOrange Ltd (GOL), Indus Insights and Analytical Services Pvt Ltd (IIASPL), iRasus Technologies Pvt Ltd (IRASUS), Jacobs (JACOBS), KPMG (KPMG), Lime. AI (Lectrix) (LIME-AI), MyHQ (MYHQ). OfBusiness (OFBUSINESS), Ramboll India Pvt. Ltd. (RIPL), Rivigo Tech (RIVIGO), Sagacious Research Pvt. Ltd. (SRPL), Sona Comstar (SONA-COM), Spyne (Eventila Technologies) (SPYNE), Syneos Health (SH), Times Internet - ETMoney (TI), Urban Company (UC), Viscadia Private Limited (VPL), Wobb.ai (WOBB-AI)

Hyderabad

AMD (AMD). Amphenol Advanced Sensors (AAS), Apple India Pvt Ltd. (AIPL), Arup India Pvt. Ltd. (ARUP-INDIA), Ceremorphic Technologies Private Limited (CTPL), Dell Securework (DELL-S), Dinero -NeoMercury Innovations Pvt. Ltd (DINERO), Electronic Arts Games Pvt Ltd (EAGPL), Freyr Solutions (FS), Furion Analytics Research and Consulting LLP (IndustrvARC) (FARC), Greenko Group (GREENKO), Grid Dynamics (GD), Innomagine (INNOMAGINE), Innovapptive Inc Innovapptive Global Solutions Pvt. Ltd. (IGSPL), Intel India Technology (INTEL), Jacobs (JACOBS), Kanerika Software Pvt. Ltd. (KSPL), Kinar AI Pvt. Ltd. (KINAR-AI), MathWorks India Pvt. Ltd. (MATHWORKS), Meritus Intelytics Private Limited (MERILYTICS), Micron Technologies India Operations (MICRON-TEC), Mindgraph Technologies Pvt Ltd (MINDGRAPH),

Nirmaan Organization (NIRMAAN), PragmaticPlay India Pvt. Ltd. (PPIPL), Qualcomm India Pvt. Ltd. (QUALCOMM), Silicon Laboratories Inc. (SI), Singlestore India Pvt Ltd (SINGLESTORE), Synchrony (SYNCHRONY), Tata Advanced Systems (TAS), Uber (UBER), Wavelabs Technologies (WAVELABS), WILP (WILP),

Indore

VECV (VECV)

Jaipur

Axestrack Software Solutions (ASS), CEG Limited (CEG), Finova Capital Private Limited (FCPL), Kugelblitz Pvt. Ltd. (KPL), NBC Bearings (NBCB)

Jodhpur

Sigma Infosolutions Limited (SIL)

Kalpakkam

Indira Gandhi Centre for Atomic Research (IGCAR)

Kanpur

CRUBN (CRUBN), Lohia Corp Limited (LCL)

Kolkata

Dorje Teas (DT), Hamilton Research & Technology Pvt. Ltd (HRTPL)

Mahape

Everest Industries (EI)

Mohali

ESH Value Technologies (EVT)

Mumbai

CASHe (CASHE), CEG Ltd. (GEG), Citi Bank (CITI BANK), CleverTap Pvt. Ltd. (CTPL), CohnReznick Capital LLC (CRCL), Credit Suisse (CREDIT SUISSE), DBOI (DBOI), Development Consultants Pvt. Ltd. (DCPL), Disney+ Hotstar (DH), Dorsch Consult (India) Pvt. Ltd. (DORSCH CONSULT), Elements financial solutions Pvt. Ltd. (EFSPL) FischerJordan LLC (FJL), FlexiLoans Technologies Pvt. Ltd. (FLTPL), Force Structural Engineers (FSE), Greenland Investment Management (GEM), HERE Technologies India Pvt. Ltd (HERE-TECH), IDFC First Bank (IDFC-FB), Jacobs (JACOBS), JPMC (JPMC), JPMS (JPMS), Karza Technologies Private Limited (KTPL), KiranaKart Technologies (Zepto) (KIRANAKART), L & T Infotech (L&T-I), Media.Net (MEDIA-NET), Morgan Stanley Advantage Services (MSAS), Morningstar (MORNING-STAR), MSCI (MSCI), Nomura (NOMURA), Piramal Group (PG), PricewaterhouseCoopers (PWC), Qrata (QRATA), Qure.ai (QURE.AI), RD Consultants (RD-C), Rusk Media (RUSK-MEDIA), Spectrum Techno Consultants Pvt. Ltd. (STCPL), Stratzy (STRATZY)Thornton Tomasetti (TT), UBS (UBS), Viacom18 Media Pvt. Ltd (VIACOM)

Nagda

Grasim Industries Ltd. (GIL)

Nagpur

Techture Structures Pvt Ltd. (TS)

Nanakaramguda

Microchip (MICROCHIP)

Noida

Acuvon Consulting Pvt. Ltd. (ACPL), Barclays (BARCLAYS), Biz2Credit (BIZ2CREDIT), NXP Semiconductor (NXPS), Qualcomm India Pvt. Ltd. (QIPL), Time Tooth (TT)

Pan India

Anand Group (AG), Chakr Innovations (CI), Dr. Reddys Lab (DRL), Havells (HAVELLS), IBM Hardware (IBM), JK Fenner (JK-F)

Pantnagar

Rane (Madras) Limited (RML)

Pune

AlphaSense (AS), Avalara Technologies (AT), Bharat Forge Ltd (BFL), BNY Mellon (BNY-MELLON), Credit Suisse (CREDIT SUISSE), CRIF (CRIF), DBOI (DBOI), Divgi TorqTransfer Systems Pvt. Ltd. (DIVGI), Druva Data Solutions Pvt. Ltd (DDSPL), Forvia (Faurecia) (FORVIA), HCL Technologies (HCL), iLink Digital (ILINK-DIGITAL), Lupin Ltd (LUPIN), National Chemical Laboratory (NCL), PharmaACE (PHARMAACE), Schlumberger (SCHLUMBERGER), SEDEMAC Mechatornics Pvt. Ltd. (SMPL), SS Supply Chain Solutions (SS-SCS), Synechron Technologies Pvt. Ltd. (STPL), Tata Motors Ltd. (TML), Tata Technologies (TT), UBS (UBS), vConstruct Private Limited (VCPL), WABTEC CORPORATION (WABTEC-CORP),

Singapore

Zluri (ZLURI)

Switzerland

Alby Inc. (ALBY-INC)

Texas (USA)

Voicegain (Resolvity Inc). (VOICEGAIN)

Trivandrum

UST Global- Trivandrum (UST-GLOBAL)

Vadodara

KMK Consulting (KMK-C)

PART III
ADMISSION MODALITY

ADMISSION MODALITY

Admissions are made on an all India basis. English is the medium of instruction for all the programmes in the Institute. Selection is based entirely on candidate's merit, his/her preferences, facilities available and availability of seats. Some details of admission modality for all the three tiers of education are described in the following paragraphs.

INTEGRATED FIRST DEGREE PROGRAMMES

There are four modes of admission in integrated First Degree programs at BITS Pilani: (A) Through the BITSAT Scheme, (B) Through the Board Topper's scheme, and (C) Through the International Students (D) Through the BITS-RMIT Higher Education Academy' admission Scheme. The details of these schemes are given below:

(A) Through BITSAT

Admissions will be made purely on merit. The candidate's merit position will be based on the score obtained by the candidate in a computer-based Online Test (BITSAT) conducted by BITS, Pilani.

This admission route is open to both Indian (domestic) and International (those with a Passport other than India) students. Indian and International students can get admission to BITS Pilani based on their BITSAT-2023 score. If a candidate does not have a passport other than India, this is the only route through which they can get admission to BITS Pilani.

Eligibility for admission:

For admission to all the integrated first-degree programmes candidates should have passed the 12th examination of 10+2 system from a recognized Central or State board or its equivalent with adequate proficiency in English. Except for admission to B. Pharm. the candidates should have Physics, Chemistry, and Mathematics as subjects. For admission to B. Pharm., candidates should have Physics, Chemistry, and either Biology or Mathematics as subjects.

The candidate should have obtained a minimum of aggregate 75% marks in Physics, Chemistry and Mathematics subjects (if he/she has taken Mathematics in BITSAT) or a minimum of aggregate 75% marks in Physics, Chemistry and Biology subjects (if he/she has taken Biology in BITSAT) in 12th grade examination, with at least 60% marks in each of the Physics, Chemistry, and Mathematics / Biology subjects.

For **BITSAT–2023,** candidates who fulfill the following conditions are eligible to appear:

- Students appearing for 12th grade examination in 2023.
- Students who have passed the 12th grade examination in 2022 provided they explain the reasons for the gap. The admissions committee will examine all such cases before taking a final decision on their eligibility.
- Students should have taken Physics, Chemistry, and either Mathematics or Biology (PCM/PCB) subjects in 12th class.

Note:

1. Students should have appeared in/ passed the 12th examination of the 10+2 system from a recognized Central/ State board.
2. Students who are presently studying in BITS at any of its campuses are NOT eligible to appear in BITSAT.
3. The Institute considers only the latest performance through a public examination for admission. If the results of the latest examination are not available within the due date for submission of application, the candidate will not be considered even if there are some earlier performances of the 12th class or its equivalent or any higher examination available with him/her. If a candidate has taken more than one attempt in 12th class or its equivalent, only his latest performance is considered, provided this attempt has been for the full component of subjects/courses prescribed.

The mechanism of admission procedure through BITSAT:

(i) Applying for admission:

All candidates who have appeared in BITSAT-2023 and are interested in admission will be required to submit application forms with 12th class marks and programme preferences from

2nd June to 27th June 2023.

(ii) Preparation of Merit List for Admission:

The merit position of all eligible candidates (i.e., those who have appeared in BITSAT-2023 and have submitted application form for admission in the prescribed format with 12th marks, preferences and the required fees) will be prepared on the basis of their total scores in BITSAT-2023.

When the BITSAT score of two candidates are the same:

- First their scores obtained in Mathematics/Biology in BITSAT will be considered for separating them.
- If the tie still exists, then their scores in Physics in BITSAT will be considered for separating them.
- Further tie is eliminated using their scores in Chemistry in BITSAT.
- Finally, their PCM total marks in 12th examination will be considered for their separation.

The candidates have to fill only a single application form for seeking admission to all MSc and Engineering degree programmes offered at Pilani, Goa and Hyderabad campuses. Candidates have to fill a separate form for seeking admission in B. Pharm. The candidate's order of preference for different programmes offered at Pilani, Goa, and Hyderabad campuses of the Institute is processed through a computer software and the offers are made accordingly. This may take a few iterations and at each stage, the status is made available to the candidates at the Institute's website www.bitsadmission.com through Internet.

For a candidate to remain in the race, it is mandatory that the following conditions are fulfilled and strictly adhered to by the candidate:

(i) The Data provided by the candidate in the application form with respect to the candidate's background, academic performance, and order of preference for various degree programmes etc. is final.

(ii) The required fees mentioned in the Institute communication are paid in advance and the candidate does not raise any new arguments in this connection.

(iii) A candidate, when offered provisional admission /placed on the waiting list, can choose to remain in the competition or withdraw from the competition within the stipulated deadline, details of which will be made available on the website.

Any candidate who seeks to alter the above conditions in the middle of this process is liable to disqualify himself/herself and forfeit the fee as per Institute rules. See the section on 'Advance Fees, Refund and Forfeiture of Fees' later in this part.

(iii) The Actual Mechanism of Admission:

The facilities of the Institute are pronounced invariably in terms of the ratio of seats allotted between the different programmes rather than in terms of a fixed number of seats. The total number of admissions made may vary from year to year. The change in the total number of seats takes place primarily to adjust to the requirements of a highly flexible system, which accommodates dual degree, transfer, etc.

In order to reduce the number of iterations, based on earlier experience and on a statistical projection of the responses received, the Institute might make admission offers to a larger number of candidates than the number of seats earmarked.

The computer is programmed to assign the seats starting from the first candidate on the merit list and going down the same until all seats are filled up. At any time when the computer considers a candidate, it first tries to accommodate the first preference of the candidate and goes to his/her second preference if his/her first preference could not be accommodated and so on. Assignments for all programmes are thus completed and immediate admission offers are made.

Based on our past experience, a certain number of candidates would be placed on the waiting list. Whenever vacancies arise, the procedure of assignment would be exactly the same as described above. During each iteration, a *de novo* assignment starting from the first candidate in the merit list will be made.

Of course, in this operation, candidates who have declined the offer and/or who have not paid fees would be removed from the merit list. It is now clear that in this process not only some of the candidates who are on the waiting list will get an assignment but also certain students who have already got an assignment may now get a new assignment to one of their higher preference if seats are now available. The waiting list of the Institute has the following characteristics namely:

(i) The cut-off point for the waiting list is arrived at by our past experience in terms of the responses from the candidates, the number and the quality of candidates who have applied in the current year with a view to complete the admissions and start the classes in time.

(ii) Those who are admitted to a programme will continue to be on the waiting list for their higher preferences.

(iii) The waiting list is for admission to the Institute and not for a particular programme, Hence, it will not be possible to assign a waiting list number for a student for a particular programme.

(iv) A student who has a higher BITSAT score may be on the waiting list while a student who has a lesser BITSAT score may have got admission because the former crossed out a programme which the later had opted for and seats were available in that particular programme.

(v) Those who cross out a programme not only cease to be candidates for admission to the programme but also for consideration on the waiting list of the programme.

(vi) Those who get offers on the waiting list must pay their fees in advance to remain on the waiting list.

Some tips on showing preferences and crossing out: The candidates are strongly advised to exercise their preferences after careful consideration. ***No candidate at any time of the operation can change his/her preferences or can change his/her order of preference from the closing of the application process till the entire admission process is completed.*** If a candidate wishes to join BITS irrespective of the programme so that he/she can float up until the admission process is complete or he/she can avail of certain unusual flexibilities like dual degree etc. it would not be in his/her interest to cross out any programme. The other extreme is where a candidate is absolutely sure of his/her inclination and such candidates would be advised to show preferences to those limited programmes only and cross out the rest.

Please note that once order of preferences are submitted by the due date, candidates will not be allowed to change the order of their preferences and the same order will be considered throughout during all the iterations.

Also, once offered admission to a particular programme after an admission iteration, a candidate can choose one of the following options:

Freeze: A candidate once offered admission to a particular programme, after an admission iteration, can utilize the “Freeze" option online by logging in with their credentials. If this option is chosen, the **candidate's current programme allocation at the respective campus will be locked in**, and they will be removed from consideration for all other programmes they ranked higher in their application. This option is to be exercised very carefully as this choice cannot be reversed under any circumstances; and therefore requires making the payment of a nominal fees (INR 10/-). To be abundantly clear, once a candidate has opted out of their programmes of all higher preferences (i.e. have chosen the “Freeze” option), he/she will not be considered for those programmes in any of the further iterations. Therefore, such candidates should exercise this option only after mature consideration.

Freeze the campus (i.e. slide up in the campus of currently allotted programme): After receiving an admission offer to a programme at a specific campus, a candidate has the option to "Freeze the campus”. By doing so, the candidate retains the opportunity to move up in further iterations within the frozen campus but effectively opts out of consideration for all higher preferences at other campuses. Once this decision is made, it cannot be

reversed under any circumstances. To be more clear about this option, once the candidate opts for this option then the higher preferences of other campuses of BITS Pilani will be removed and only the higher preferences of the same campus (in which he/she got the admission while exercising this option) will be considered for the subsequent iterations. While opting for this option the candidate has to pay a nominal fee.

If the candidate does not choose any of the above two options given above, then by default, he/she will be considered for all the higher preferences (as given in his/her application form) in the subsequent iterations.

Normally a candidate cannot change the preferences once submitted. However, if for any reason a candidate discovers a mistake in his/her preferences already submitted, he/she can edit his/her preferences during the editing window, from June 27-28, 2023.

Admissions at Pilani campus, K. K. Birla Goa Campus and Hyderabad Campus:

As already announced, admissions to BITS, Pilani- Pilani campus, BITS, Pilani – KK Birla, Goa campus, and BITS, Pilani – Hyderabad Campus will be made through a single admission process. In the different admission iterations mentioned in the earlier paragraphs, it is possible that a student who has got an admission offer for a programme in one campus gets slide up for a programme at the other campus in the next iteration. Once a student reports for admission at a particular campus, he/she remains in the waiting list for the programmes of his/her higher preferences at the other campuses, till all admissions are finalized.

In all the above matters, the Vice-chancellor's decision shall be final.

Dual degree for students of M.Sc. (Biology, Chemistry, Economics, Mathematics and Physics) programmes: The Institute has created facilities by which any student who is admitted to M.Sc. programmes is accommodated in a dual degree scheme for a second degree in B.E. programmes. This assignment is made by competition on their performance at BITS at the end of first year, separately in Pilani, Goa and Hyderabad campuses on the basis of Progressive Branching Index (PBI). Requirements of both the degrees are structured to be completed normally in five years. If a student is admitted to a second degree programme under dual degree scheme, he/she has to pay admission fees of the second programme at the time of such admission is made.

Note: There will be restriction on the availability of flexibility such as transfer and dual degree allotment for students admitted to B. Pharm. programme with PCB input. Since all the first degree programmes other than B. Pharm. programme requires PCM input, no transfer/dual degree allotment is possible with PCB input.

(B) Direct Admission to Board Toppers:

In the past, the admission process of the Institute always ensured guaranteed admission to all the students who obtained first ranks in their respective board examinations. This has given a very vital input of highly meritorious students from all over India. Continuing this tradition, the Institute will give direct admission to first rank students of all the central and state boards to the programme of their choice, irrespective of their BITSAT-2023 score.

While the first rank student in PCM stream will be considered for admission to any of the first degree programmes of his/her choice, the first rank holder of PCB stream will be considered for admission to B. Pharm. programme only.

Moreover, they should have obtained the minimum marks in PCM/PCB subjects in 12^{th} examination, as per the eligibility criteria described above. For more details, see the later sections in this part and also the BITS website.

Eligibility criteria for admission under 'Direct admission to Board toppers' scheme:

To be eligible for admission under the 'Direct admission to Board toppers' scheme, the candidate should be the topper from the science stream having taken Physics, Chemistry, Mathematics subjects in 12^{th} standard. To identify the topper, the following criteria will be adopted (see below for PCB students).

The topper is the student who fulfills the following criteria:

a) has taken Physics, Chemistry, and Mathematics subjects in 12th class and

b) has obtained the highest aggregate percentage of marks in 12th class among all the students who have taken Physics, Chemistry, and Mathematics subjects in 2023 from the Board. For the purpose of calculating the aggregate percentage, the aggregate marks should include the marks of Physics, Chemistry, and Mathematics subjects in addition to other subjects which are required to pass the 12th examination from the Board under consideration. Further, the Physics, Chemistry, Mathematics subject marks should be included in the aggregate, irrespective of whether the Physics, Chemistry, and Mathematics subjects are identified as main/optional/elective in his marksheet(s).

c) This offer of admission is open only to the student who has obtained the first rank in the board as per the announcement by the Board. If more than one candidate has been declared as the first rank holder by a Board, BITS Pilani will offer admission to a maximum of 4 candidates only under this scheme. If there are more than four candidates declared as first rank holders by a Board, the tie shall be eliminated using the following criteria:

I. First, their scores obtained in Mathematics in 12th grade examination will be considered for separating them.

II. If the tie still exists, then their scores in Physics in the 12th grade examination will be considered.

III. If the ties still exist, then they will be eliminated using their scores in Chemistry in the 12th grade examination.

IV. If the tie still exists, then the score in Mathematics in the 10th-grade will be considered for separation.

V. If the tie still exists, then the score in Science in the 10th grade will be considered for separation.

VI. If the situation warrants, the Admission committee reserves the right to add any additional criteria including a written test, to break the tie. Any such criteria will be announced to the candidates who have applied for admission under this scheme.

In the case of first rank candidate of Physics, Chemistry, Biology stream, the criteria are same as above, replacing the word 'Mathematics' with 'Biology' in the above paragraph. However, the first rank holder of PCB stream will be considered for admission to B. Pharm. programme only.

In the academic year 2023-24, BITS Pilani has invited views/information regarding the First Rank holder in the 12th Standard Examination (2023-batch) of the respective boards and were requested to share the details of the first rank holder of the 12th-grade board examination from them. If the board does not announce the first rank holder or they cannot list the first rank holder for this year, they have been requested to inform the institute accordingly in the prescribed format by June 2, 2023 so that the Admission Committee of BITS Pilani can review to take appropriate decisions on First Degree admissions under the 'Direct Admission to Board Toppers' scheme of the Institute.

Accordingly, applicants may be asked to attach documentary proof in support of their claim, along with the 12th mark sheet and a letter from the Board declaring the candidate as the topper in the specified stream. The Institute will also make efforts to get these data from the different boards on its own. In all cases, the Institute will be guided by the data provided by the concerned Board. In cases where for a particular board, the data available before the deadline is insufficient or inconclusive, the admission committee may decide not to make any offer under the scheme for that specified Board. In all such cases, the decision of the Vice chancellor will be final and binding on the applicants.

The applications of such cases (if any) are to be submitted online on or before **July 15, 2023**.

C) International students through 'International Students' Admission (ISA) Scheme':

Candidates holding foreign passports (Non-Indian passport) and having valid Scholastic Assessment Test (SAT) scores are eligible to apply for admission under "International

Students' Admission Scheme" at BITS Pilani-Pilani Campus, BITS Pilani-Goa Campus and BITS Pilani-Hyderabad Campus for Academic Year 2023-24. This is another mode of admission for integrated first degree programmes which does not require BITSAT-2023 score. Candidates who have taken SAT conducted by College Board (USA) can apply for admission to different first degree programmes at Pilani, Goa and Hyderabad Campuses of BITS Pilani for Academic Year 2023-24. Such international candidates should meet the following eligibility criteria.

- Only citizens (candidates holding foreign passports) of a country **other than India** can apply.
- For admission to all the integrated FD programmes under the ISA Scheme, candidates should have passed the 12th grade examination of the 10+2 system from a recognized board or conducted by the country's Board of Higher/ Senior Secondary Education, including those in India, or its equivalent examination such as the "A" levels (conducted by Cambridge International), the International Baccalaureate, etc. with adequate proficiency in English. Except for admission to B.Pharm, the candidates should have Physics and Mathematics as compulsory subjects along with one of Chemistry/Biotechnology/Biology/Technical Vocational subjects. For admission to B.Pharm programme, candidates should have Physics, & Biology/Mathematics as compulsory subjects along with one of Chemistry/Biotechnology/Technical Vocational subjects.
- In addition, the candidate under ISA Scheme should have obtained a minimum aggregate of 75% marks in Physics, Mathematics, & Chemistry / Biology / Biotechnology or any other technical vocational subjects with at least 60% marks in each of these subjects in the 12th grade examination for BE and MSc programmes OR a minimum aggregate of 75% marks in Physics, Biology/Mathematics, and Chemistry / Biology / Biotechnology or any other vocational subjects with at least 60% marks in each of these subjects in the 12th grade examination for the B.Pharm programme. Those who choose Biology as an alternate to Mathematics for applying to B.Pharm programme must choose from Chemistry / Biotechnology or any other technical vocational subjects as the third subject.
- Candidates who have not taken Chemistry in 10+2 curricula will be required to complete bridge course in Chemistry in their first semester.
- Candidate should have a minimum aggregate score of 1160 (out of maximum of 1600) in SAT (new format) which includes a Reading & Writing and Mathematics test.
- Scores of candidates who had written SAT as per the old format will be mapped using concordance tables available from College Board (USA).
- The candidate should have written the SAT **not earlier than** February 1, 2021.

Admissions will be made on merit determined by SAT score **which includes a Reading & Writing and Mathematics Test,** subject to candidate meeting above eligibility criteria. For more details on SAT visit website: www.collegeboard.com. SAT score need to be sent to BITS Pilani directly through College Board using the Designated Institution (DI) code: 7759 - BITS Pilani.

Candidates who have passed the qualifying 12th standard examination in 2022 or 2023 are eligible to apply under this scheme. Students who are appearing in the examination in 2023 are also eligible to apply. For more details, please visit http://www.bitsadmission.com/ois.

Preparation of Merit List for Admission (ISA):

The merit position of all eligible candidates will be prepared based on their SAT scores which include a Reading & Writing and Mathematics Test. If there is a tie, it would be eliminated using the following criteria:

I. First, the number of years of education spent by the candidate in a foreign country (outside India) shall be considered for resolving the tied scores.

II. If the tie still exists, their Physics, Mathematics and any one of (Chemistry/Biotechnology/Biology/any other technical vocational subject) total marks in the 10+2 examination shall be considered for separating them.

III. If the tie still exists, their scores obtained in Mathematics subject in the 12th-grade examination shall be considered for separating them.

IV. If the tie still exists, their Physics subject scores in the 12th-grade examination shall be considered.

V. If the tie still exists, their Chemistry/Biotechnology/Biology/any other technical vocational subject scores in the 12th-grade examination shall be considered to break the tie.

Advance fees, Refund and Forfeiture of fees:

For the International students the rules concerning payment of fees and refund thereof are as follows:

- Candidates offered admission (or provisional admission) to any programme have to pay the required fee within the deadline mentioned in the offer letter. This includes the admission fee, first semester fees, facilitation fee, etc.
- Please note that in addition to the above fees, on the day of reporting at Pilani / Goa / Hyderabad Campuses, candidates will be required to pay **an additional fee of INR 1,11,660/- (One Lakh Eleven Thousand Six Hundred Sixty in Indian Rupee (INR))** towards Institute Caution Deposit, Mess & Electricity Advance, Hostel Fees, Students' Union Fee, Other Advances (Per Semester) etc.
- While exercising the provision of withdrawal of your admission and availing refund of your fees, please note that at the time of admission, you are required to submit an undertaking that you have not taken admission in any other Institution and that you will inform BITS Pilani as soon as you receive an offer of admission from another Institute and choose to accept that offer. Please note that it is imperative that you inform the Institute promptly, and withdraw immediately on taking admission in another Institute. The fee refund policy against withdrawal request is presented below:

a) If a candidate, who is offered admission, accepts the offer by remitting the above fees but withdraws his or her application by during **May 28-May 31, 2023 OR July 11-July 13, 2023** (through an online withdrawal process, the details of which will be available on the website in due course of time), he or she will forfeit **INR 1000/-** and his/her admission will stand canceled, and the remaining amount of fee paid by the candidate will be refunded to him/her in due course of time as mentioned under item no. (g).

b) If a candidate who is offered the admission accepts the offer by remitting the above fees but fails to report at the Institute on **August 07, 2023***, he/she will **forfeit 10%** of the total fee (viz. admission fee, facilitation fees, and first-semester tuition fees) towards processing charges. While forfeiting, the fee waiver given to the candidate will also be included in the total fee.

c) If a candidate reports on the specified date, submits original documents, and completes all other admission formalities but subsequently withdraws **within 15 days** from the reporting date (August 07, 2023*), he/she will **forfeit 20%** of the total fees (viz. admission fee, facilitation fees, and one-semester tuition fees. While forfeiting, the fee waiver given to the candidate will also be included in the total fee) plus hostel fee (in proportion of the stay at the Campus) plus actual expenses incurred towards mess and electricity usage.

d) If a candidate reports on the specified date, submits originals documents, but subsequently withdraws within the **16th to 30th day** from the date of reporting (August 07, 2023*), he/she will **forfeit 50%** of the total fees (viz. admission fee, facilitation fee, and one-semester tuition fees. While forfeiting, the fee waiver given

to the candidate will also be included in the total fee) plus hostel fee (in a proportion of the stay at the Campus) plus actual expenses incurred towards mess and electricity usage.

e) If a candidate reports on the specified date and submits original documents, but subsequently withdraws **after 30 days** from the date of reporting (August 07, 2023*), he/she will **forfeit 100%** of the total fees (viz. admission fee, facilitation fee, and one-semester tuition fees. While forfeiting, the fee waiver given to the candidate will also be included in the total fee) plus hostel fee (in a proportion of the stay at the Campus) plus actual expenses incurred towards mess and electricity usage. Caution Deposit will be refunded.

f) While remitting fees, no candidate can stipulate any conditions such as changing the order of preferences, addition/deletion of preferences, etc. Even if any such conditions are mentioned while remitting fees, these will be ignored and the fees will be accepted only as per the conditions mentioned in this admission letter.

g) All applicable refunds will be completed within **30 working days** from the admissions closing date.

* The reporting date is tentative. The exact date of reporting will be informed to you well in advance.

Refund requests will be accepted only through an online withdrawal portal at the admission website.

Note: Scholarship policy for International students admitted through ISA Scheme is given in the later part of this document.

(D) BITS-RMIT Higher Education Academy:

BITS Pilani (an Institution of Eminence in India) has entered a partnership with RMIT University, Australia, to develop a Higher Education Academy called BITS-RMIT Higher Education Academy. The BITS-RMIT Academy offers collaborative degree programmes at the international level.

Students admitted under this collaboration will have the unique opportunity to immerse themselves in diverse cultures and gain a truly global perspective. In this 4-year collaborative 'dual degree' programme, students will spend the first two years along with a summer term at BITS Pilani campuses before getting transferred to RMIT campuses in Australia for the remaining two years (i.e., years 3 and 4) of their study period.

Admissions will be made purely on merit. The merit position of the candidate for admission will be based on the score obtained by the candidate in the BITSAT-2023. Thus it is essential that applicant undertakes the BITS Admission Test (BITSAT) and achieves a score that meets or exceeds the relevant cut-off score for admission to the BITS-RMIT programmes.

Eligibility Requirement for Admission:

A. BITS Pilani minimum eligibility requirement

I. The applicant has passed the 12th examination of 10+2 system from a recognized Central or State board or its equivalent with Physics, Chemistry and Mathematics (PCM) and adequate proficiency in English; Also, the applicant has obtained a minimum of aggregate 75% marks in PCM in 12th examination, with at least 60% marks in each of the PCM subjects.

II. The applicant undertakes the BITS Admission Test (BITSAT) and achieves a score that meets or exceeds the relevant cut-off score for admission to the BITS Award, as determined by BITS from time to time.

B. RMIT Australia minimum eligibility requirement

I. One of the following must be achieved:

Successful completion of one of the following secondary qualifications in India:

a. All India Senior School Certificate (AISSC) 10+2 with a minimum average of 65%*

b. Indian School Certificate (ISC) with a minimum average of 65%*

c. State Boards of Education Higher Secondary Certificate, (HSC) with a minimum average of 70%*

**Overall average for graded academic subjects, excluding work experience, physical and health*

education, art, religious and general studies.

II. Successful completion of the AISSC; ISC; State Board HSC Mathematics/ HSC Mathematics with a minimum grade of 60%.

III. Where an applicant does not have an Indian secondary qualification, they must meet the RMIT criteria for their respective country of secondary education study as approved by RMIT and notified to BITS by RMIT (listed on the RMIT website under entry requirements by country, from time to time).

IV. English Language Entry Requirements

Applicants must meet RMIT's English Language proficiency requirements as follows:

a. Applicants are required to provide evidence of English language proficiency for admission into this Academy Program in accordance with the requirements published on RMIT's website from time to time.

b. Where an English language proficiency test is used for admission, the test must be taken no more than 2 years prior to the applicant's Commencing Date for the Academy Program.

c. Where an RMIT English Worldwide (REW) proficiency certificate is used, the REW certificate must be obtained no more than 2 years prior to the applicant's Commencing Date for the Academy Program.

d. Applicants who have not completed one of the English proficiency tests listed above or as published on the RMIT website from time to time can be deemed to have met the English language entry requirements if they can provide evidence of one of the following:

i. Completion of the equivalent of 1-year full-time study of a bachelor's degree within the last 2 years where English is the language of teaching and assessment;

ii. An RMIT recognised senior secondary qualification within the last 2 years unless stated otherwise;

iii. The equivalent of 1 semester full-time study of a university postgraduate qualification within the last 2 years where English is the language of teaching and assessment;

iv. Completion of a bachelor degree or higher within the last 5 years where English is the language of teaching and assessment;

v. **Where applicants have completed at least 6 years of primary and/or secondary education taught and assessed entirely in English in a recognised English-speaking country with at least 2 years of this education at secondary or senior secondary level (or overseas equivalent), they can meet the English language requirements with one of the following:

(i) at least 2 courses (subjects) or 24 RMIT credit points at Australian undergraduate level (or overseas equivalent),

(ii) an Australian Qualifications Framework (AQF) accredited award at certificate IV or higher (or overseas equivalent).

**Note: For applicants who meet these criteria, time limitations as specified above do not apply.

Procedure to Apply for admission in BITS-RMIT Academy

In addition to applying and appearing for BITSAT-2023, interested candidates have to also apply for admission to BITS-RMIT Academy giving details of their 12th marks and preferences to different degree programmes offered at two Indian campuses of BITS and RMIT Australia. The prescribed application form for admission, the detailed application procedure was made available at the BITS admission website. The completed application form with the details of their 12th marks and preferences to different degree programmes along with the required application fee had to be submitted online at the BITS admission website on or before 27th June, 2023.

Advance fees, Refund and Forfeiture of fees:

The Policy of Refund, and Forfeiture of Fees for the applicants admitted to BITS-RMIT Higher Education Programs during academic year 2023-2024 is given below.

a. If a candidate, who is offered admission, accepts the offer by remitting the above fees but withdraws his or her application during

July 19, 2023 (through an online withdrawal process, the details of which will be available on the website in due course of time), he or she will forfeit INR 1000/- and his/her admission will stand cancelled, and the remaining amount of fee paid by the candidate will be refunded to him/her her in due course of time as mentioned under item no. (h).

b. If a candidate who is offered the admission accepts the offer by remitting the above fees but fails to report at the Institute on August 07, 2023, he/she will forfeit 10% of the total fee (viz. admission fee and first-semester tuition fees). The remaining fee paid by the candidate will be refunded to him/her in due course of time as mentioned under item no. (h).

c. If a candidate reports on the specified date, submits original documents, and completes all other admission formalities but subsequently withdraws within 15 days from the reporting date (August 07, 2023), i.e. by August 21, 2023, he/she will forfeit 20% of the total fees (viz. admission fee and first-semester tuition fees) plus the prorated hostel fee (in proportion to the stay at the Campus) plus actual expenses incurred towards mess and electricity usage. The remaining fee paid by the candidate will be refunded to him/her in due course of time as mentioned under item no. (h).

d. If a candidate reports on the specified date, submits originals documents but subsequently withdraws within the 16th to 30th day from the reporting date (August 07, 2023), i.e. during August 22 to September 05, 2023, he/she will forfeit 50% of the total fees (viz. admission fee and first-semester tuition fees plus the prorated hostel fee (in proportion to the stay at the Campus) plus actual expenses incurred towards mess and electricity usage. The remaining fee paid by the candidate will be refunded to him/her in due course of time as mentioned under item no. (h).

e. If a candidate reports on the specified date and submits original documents but subsequently withdraws after 30 days from the reporting date (August 07, 2023), i.e. from September 06, 2023 onwards, he/she will forfeit 100% of the total fees (viz., admission fee and first-semester tuition fees plus the prorated hostel fee (in proportion to the stay at the Campus) plus actual expenses incurred towards mess and electricity usage. While forfeiting, the fee waiver (if any) given to the candidate will also be included in the total fee). Caution Deposit will be refunded. The remaining fee paid by the candidate will be refunded to him/her in due course of time as mentioned under item no. (h).

f. While remitting fees, no candidate can stipulate any conditions such as changing the order of preferences, addition/deletion of preferences, etc. Even if any such conditions are mentioned while remitting fees, these will be ignored, and the fees will be accepted only as per the conditions mentioned in this admission letter.

g. Candidates in Waiting List cannot apply for withdrawal during different withdrawal windows. If a candidate is left in the Waiting List after the last iteration also, their refund would be processed as per clause (h). Please note that in such case their total deposited fees would be refunded.

h. All applicable refunds will be completed within 30 working days from the admissions closing date.

Note:

1. While exercising the provision of withdrawal of the admission and availing refund of the fees, please note that at the time of admission, candidate is required to submit an undertaking that he/she has not taken admission in any other Institution and that he/she will inform BITS Pilani as soon as he/she receive an offer of admission from another Institute and choose to accept that offer. Please note that it is imperative that the candidate inform the Institute promptly, and withdraw immediately on taking admission in another Institute.
2. Students have to apply online for the withdrawal. Withdrawal requests through email or telephonic modes will not be entertained.

Higher Degree (PG) Programmes

To all the higher degree programmes, admissions will be made, on the basis of merit, as per the modalities explained below:

I. Admissions based on GATE (for M.E.)/ GPAT (for M. Pharm.) score and

II. Admissions based on the marks obtained in the online HD test conducted by BITS and/or written test, group discussions and interviews conducted by BITS at its campuses/any other places. Further details are available at the BITS website, http://www.bitsadmission.com.

Ph.D. Programmes

For admission to the on-campus Ph.D. programme of the Institute, the marks/grades of the candidate in the latest examination as well as his/her performance in a specially designed admission test and/or interview would be considered.

Off-Campus Ph.D. Under Ph.D. Aspirant Scheme

The Institute offers a unique opportunity for employed professionals working in Industries and R&D organizations and having long experience and proven competence in various fields to work towards Ph.D. degree of the Institute in the settings of their respective work environments. Candidate holding any of the BITS degree or working in an organization collaborating with BITS will normally be considered under this scheme. Industries interested for the development of their manpower at the doctoral level are invited to seek collaboration with BITS and sponsor their suitable candidates along with their applications in the prescribed format.

Foreign Students or Indian Students Having Qualifications from Foreign Countries

The Institute welcomes foreign students but the admission is strictly made on the basis of merit. There is no separate provision for admission of such candidates and they have to compete with all other candidates, as per the procedure already described above for various degree programmes.

In order to verify the eligibility for admissions, the candidates should enclose, with their application, documents explaining grading/marking system and calculation of cumulative grade point average/ aggregate percentage of marks along with their transcript/ mark sheet. Further, the candidates must send a copy of the syllabus of courses and rules and regulations for the examinations they have passed well in advance.

Students should request their examining authorities to send the transcript/ mark sheet with relevant documents directly to Dean Academic and Undergraduate Studies, BITS, Pilani - 333031, Rajasthan-India so as to reach him before the deadline.

A specially appointed committee examines all applicants with foreign qualifications regarding their eligibility for admissions.

Graduates of BITS

Candidates who come with a degree where the structure and the features of the programme are similar to that of BITS are naturally ready to fit more effectively into the BITS educational system. This experience prompts the Institute often to describe the prior preparation for another degree in the same tier or a degree in a higher tier in terms of not only a minimum qualification but also specific courses which they should have done.

Admission with marginal deficiency

For details refer to the section on flexibilities in the previous part.

Casual Students

Persons, other than regular students of BITS who desire to register for some courses to update their knowledge are designated as casual students. Casual students can register for courses on audit only and cannot enroll for a degree. The facility of taking a course on audit is principally conceived to give an opportunity to a person to update his/her knowledge and he cannot claim acceptance of such a course for the fulfillment of requirements of any programme, current or future.

This scheme has been devised to take care of professionals from various industries and organizations who express a desire to update their knowledge, although they, ipso-facto, have no desire to work for a degree.

Persons desiring to register as casual students should apply on the prescribed form within the last date.

Whenever such a student is admitted he may be allowed to continue as a student for a maximum period of eight registered semesters. However, he should request at the end of every semester for permission to continue him as a casual student in the succeeding semester.

The Institute may offer direct admission to a limited number of children of the staff of BITS and BET and also to some meritorious students from the schools of BET in Pilani to non-professional programmes with a proviso that the students admitted to these programmes will not be eligible for any of the flexibilities like transfer to and dual degree in any of the professional programmes.

INFORMATION FOR CANDIDATES

(To be read in conjunction with the instructions given in the application form and any other communications sent from the Institute).

APPLICATION PROCEDURE

Application for admission should be made on the prescribed form. Separate application forms are prescribed for (i) Integrated First Degree Programmes (ii) Higher Degree Programmes (iii) MBA Programme (iv) Doctoral Programmes.

(i) Integrated First degree Programmes:

In order to apply for admission to the Integrated First Degree programmes, the candidate should have appeared in the online computer-based test (BITSAT) as per the announcement made by the Institute through separate advertisement and brochures. The last date for registering for BITSAT-2023 was 15th April, 2023. BITSAT-2023 Session-I was scheduled between 21st to 26th May, 2023 and Session-II was scheduled between 18th to 22ndJune, 2023.

Following are a few salient points of BITSAT-2023:

- A candidate had a chance to appear a maximum of two times in BITSAT 2023.
- The examination was organized in two sets of dates, BITSAT Session-I and BITSAT Session-II, separated by a gap of a few weeks. The candidate had an option to choose the Center, the Day, and slot of his/her convenience to take the test.
- A candidate may opt to appear for BOTH the sessions even at the time of the first application. Such a candidate is supposed to choose one slot from the first set of dates and another from the second during the test date and slot reserve window.
- A candidate may also choose to appear for the Session-II after the first appearance. To facilitate this process, the application window was opened during 22nd May to 12th June, 2023.
- Candidate who did not apply for Session-I had an option to apply for Session-II during 22nd May to 12th June, 2023
- For a candidate who appears twice in BITSAT 2023, and then seeks admission to any of the First Degree programmes in BITS Pilani, the higher of the two scores is to be considered for admission.

In addition to the application made earlier for registering for BITSAT-2023, the candidate should apply for admission by submitting the prescribed form, complete in all respect, to register before the deadline, i.e., 27th June, 2023.

The online application form available at the BITS admission website (i.e. www.bitsadmission.com) and are to be filled online only along with the prescribed fee to be paid online.

Last Date for Submission of Completed application for Integrated First degree Programmes: June 27th, 2023.

(ii) Higher Degree, MBA and Ph.D. programmes:

Interested and eligible candidates should apply through the prescribed application form available online at **http://www.bitsadmission.com/**. Further details are also available on this site.

Last Date for Submission of Completed applications:

MBA:

First Semester: 28th February 2023

Higher Degree:

First Semester: 30th April 2023

Ph.D.:

First Semester: 30th June 2023

Second Semester: TBA

(Refer to section on Flexibilities in the previous part).

Some Important Instructions

1. The application process, announcement of results after each iteration, detailed instructions etc. are all announced at BITS website during the various stages of the admission process. It is the responsibility of the candidate to follow these announcements and instructions.
2. The number on the application form is unique. A candidate has to quote this application number in all subsequent correspondence with the Institute.
3. If the candidate is accepting the offer of admission/accepting to be placed on the waiting list, he/she shall be required to pay fees in advance, as per the instructions mentioned along with the offer.
4. Whenever admissions are made in the second semester a separate notification to this effect will be issued. Applications for second semester admission should be submitted only after such a notification.
5. If a candidate desire to be considered for the award of Institute merit-cum-need scholarships, he/she will be required to submit an income certificate showing gross income of his/her Parents/Guardian, duly signed by the 1st Class Magistrate/Notary Public. Persons in service should submit a certificate from employer showing separately basic salary and other allowances.

Enclosures with Application

Applications for admission to integrated first degree programmes should be accompanied by the following documents:

1. An attested photocopy of the X pass/ Matriculation/Secondary School certificate issued by the Board. (to be uploaded online)
2. An attested photocopy of the mark sheet of the qualifying and any other higher University/Board examinations passed. (to be uploaded online)

The BITSAT score for each of the candidate will be taken from the Institute records.

SELECTION FOR ADMISSION

Candidates are finally admitted to the Institute subject to the following conditions:

1. They have paid the requisite fees asked for in their admission/waiting list letters.
2. They are declared medically fit by a registered medical practitioner.
3. They have submitted all required original mark sheets & certificates, with photocopies, and the statements made in their application forms are verified against their originals.
4. They fulfill all the eligibility requirements.

For Integrated first degree programmes, on the reporting day at Pilani/Goa/Hyderabad, a Dean/Senior faculty member of the Institute will interact with the candidates. If any candidate fails to be personally present on that day, his admission will stand automatically cancelled.

Every admitted student is required to undergo a registration process on the day announced for the purpose. One of the objectives of the registration process is to name the courses to be pursued during a given semester, after allowing for the student's options within the prescribed rules and regulations. By this process, each student makes his own Time Table at his own responsibility, to be followed in that semester. No student will be permitted to attend classes or use any of the Institute facilities without completing the registration process.

Advance fees, Refund, and Forfeiture of fees:

In the Integrated First Degree programmes, a candidate selected for admission/placed on the waiting list through BITSAT will be required to pay fees in advance subject to the following conditions:

a) If a candidate, who is offered admission, accepts the offer by remitting the above fees but withdraws his or her application during July 13-15, 2023 (through an online withdrawal process, the details of which will be available on the website in due course of time), he or she will forfeit INR 1000/-, his/her admission will stand cancelled, and the remaining amount of fee paid by the candidate will be refunded to him/her by August 5, 2023.

b) If a candidate, who is offered admission, accepts the offer by remitting the above fees but withdraws his/her application during July 25-26, 2023 (through an online withdrawal process, the details of which will be available on the website in due course of time), he or she will forfeit INR 1000/-, his/her admission will stand cancelled, and the remaining amount of fee paid by the candidate will be refunded to him/her in due course of time as mentioned under item no. (i).

c) If a candidate who is offered the admission accepts the offer by remitting the above fees but fails to report at the Institute on August 09, 2023, he/she will forfeit 10% of the total fee (viz. admission fee and first-semester tuition fees). The remaining fee paid by the candidate will be refunded to him/her in due course of time as mentioned under item no. (i).

d) If a candidate reports on the specified date, submits original documents, and completes all other admission formalities but subsequently withdraws within 15 days from the reporting date (August 09, 2023), i.e. by August 23, 2023, he/she will forfeit 20% of the total fees (viz. admission fee and first-semester tuition fees) plus the prorated hostel fee (in proportion to the stay at the Campus) plus actual expenses incurred towards mess and electricity usage. The remaining fee paid by the candidate will be refunded to him/her in due course of time as mentioned under item no. (i).

e) If a candidate reports on the specified date, submits originals documents but subsequently withdraws within the 16th to 30th day from the reporting date (August 09, 2023), i.e. during August 24 to September 07, 2023, he/she will forfeit 50% of the total fees (viz. admission fee and first-semester tuition fees plus the prorated hostel fee (in proportion to the stay at the Campus) plus actual expenses incurred towards mess and electricity usage. The remaining fee paid by the candidate will be refunded to him/her in due course of time as mentioned under item no. (i).

f) If a candidate reports on the specified date and submits original documents but subsequently withdraws after 30 days from the reporting date (August 09, 2023), i.e. from September 08, 2023 onwards, he/she will forfeit 100% of the total fees (viz., admission fee and first-semester tuition fees plus the prorated hostel fee (in proportion to the stay at the Campus) plus actual expenses incurred towards mess and electricity usage. While forfeiting, the fee waiver (if any) given to the candidate will also be included in the

total fee). Caution Deposit will be refunded. The remaining fee paid by the candidate will be refunded to him/her in due course of time as mentioned under item no. (i).

g) While remitting fees, no candidate can stipulate any conditions such as changing the order of preferences, addition/deletion of preferences, etc. Even if any such conditions are mentioned while remitting fees, these will be ignored, and the fees will be accepted only as per the conditions mentioned in this admission letter.

h) Candidates in Waiting List cannot apply for withdrawal during different withdrawal windows. If a candidate is left in the Waiting List after the last iteration also, their refund would be processed as per clause (i). Please note that in such case their total deposited fees would be refunded.

i) All applicable refunds will be completed within 30 working days from the admissions closing date.

Students have to apply online for the withdrawal. Withdrawal requests through email or telephonic modes will not be entertained.

Note: Dates given above are tentative which may be revised further and announced on the BITS admissions website based on admission information of other leading institutes.

Whenever a candidate is admitted to a programme, he/she is kept on a waiting list for programmes of his/her higher preferences. Until all admissions for First Semester 2023-2024 are completed, any vacancy in any programme caused by non-acceptance of the offers will be filled by offering the vacant seat to the next candidate in the order of merit. This process is called '**Sliding-Up'**. According to the Institute rules, your acceptance of the admission offer implies that you will be automatically considered for sliding up to programme of higher preference as indicated in your application form, under the above circumstances. Also, a candidate once offered admission to a particular programme, after an admission iteration, can choose one of the following option.

Freeze : A candidate once offered admission to a particular programme, after an admission iteration, can utilize the "Freeze" option online by logging in with their credentials. If this option is chosen, the **candidate's current programme allocation at the respective campus will be locked in**, and they will be removed from consideration for all other programmes they ranked higher in their application. This option is to be exercised very carefully as this choice cannot be reversed under any circumstances; and therefore requires making the payment of a nominal fees (INR 10/-). To be abundantly clear, once a candidate has opted out of their programmes of all higher preferences (i.e. have chosen the "Freeze" option), he/she will not be considered for those programmes in any of the further iterations. Therefore, such candidates should exercise this option only after mature consideration.

Freeze the campus (i.e. slide up in the campus of currently allotted programme): After receiving an admission offer to a programme at a specific campus, a candidate has the option to "Freeze the campus". By doing so, the candidate retains the opportunity to move up in further iterations within the frozen campus but effectively opts out of consideration for all higher preferences at other campuses. Once this decision is made, it cannot be reversed under any circumstances. To be more clear about this option, once the candidate opts for this option then the higher preferences of other campuses of BITS Pilani will be removed and only the higher preferences of the same campus (in which he/she got the admission while exercising this option) will be considered for the subsequent iterations. While opting for this option the candidate has to pay a nominal fee.

If the candidate does not choose any of these options, then by default, he/she will be considered for all the higher preferences (as given in his/her application form) in the subsequent iterations.

1. If the Institute is not able to offer admission to a wait-listed candidate in any of programmes of his/her preferences as specified in his/her application form, the total amount of fee paid will be refunded to him/her in due course of time.
2. A candidate who accepts an offer of admission or who accepts to be placed on waiting list by paying the requisite fees (as above) can choose to remain in the competition or withdraw from the race within the stipulated deadline, details of which will be made available on the website.
3. While remitting fees, no candidate can stipulate any conditions such as changing order of preferences, addition/deletion of preferences etc. Even if any such conditions are mentioned while remitting fees, these will be ignored.

For higher degrees, conditions stipulated in the Instructions sheet sent to the shortlisted candidates, will be applicable.

The Institute reserves the right to refuse admission to any candidate without assigning any reason. The decision of the Vice-chancellor in the matter of admission and allotment of programmes of study shall be final.

Instructions for Payment

1. The schedule of fees given below is for a normal situation. Wherever a student's programme gets modified or his/her progress is delayed beyond the maximum permissible time, such a student is advised to consult the appropriate authority before registration.
2. The below mentioned schedule of fees is applicable for all the students admitted in academic year 2023-2024. All students admitted earlier than academic year 2023-2024 will continue to be governed by the schedule of fees as shown in the bulletin corresponding to their year of admission. However, it should be clear that they will have to pay along with the new students the same amount of fees for students' union fee, students' aid fund, hostel fee and mess & electricity advance.
3. The fees and other charges are payable in advance in each semester/term on the notified dates before registration. No withdrawal from a course or courses will entitle a student for refund of fees.
4. Students who go for Practice School II will be charged semester fees and the summer term fees because the practice school is longer than a semester and extends into summer.
5. Casual students will pay fees prescribed for regular students.
6. Institute caution deposit is refundable only at the time of graduation or withdrawal from the Institute.
7. If there are dues outstanding from a student, his grades will be withheld.

Mess dues are to be cleared by each student every month. Students who accumulate mess arrears would be required to pay a prescribed additional advance at the time of next registration.

SCHEDULE OF FEES

A. The following is the details of the fees in INR payable by all students admitted in the academic year 2023-2024 at **BITS-Pilani, Pilani Campus.**

Fees	Integrated First Degrees	Higher Degrees	Ph.D. Programme	
			Full Time	Part Time
Admission Fees	53,900/-	53,900/-	10,000/-	10,000/-
Semester/Term Fees First Semester Second Semester Summer term	 2,45,000/- 2,45,000/- 85,700/-	 2,45,000/- 2,45,000/- 85,700/-	 24,500/- 24,500/- 8, 570/-	 49,000/- 49,000/- 17,140/-
Students' Union fee	450/- pa	450/- pa	—	—
Students' Aid Fund	225/- pa	225/- pa	225/- pa	225/- pa
Hostel fee (for on-campus students only) First Semester Second Semester Summer term	 18,800/- 18,800/- 9,400/-	 18,800/- 18,800/- 9,400/-	 18,800/- 18,800/- 9,400/-	—
Ph.D. thesis examination fees	-	-	15,000/-	15,000/-
Mess & Electricity advance First Semester Second Semester Summer term *(Payable at the beginning of each semester/term and adjustable at the end of the same)*	 10,000/- 10,000/- 5,000/-	 10,000/- 10,000/- 5,000/-	 10,000/- 10,000/- 5,000/-	—
Other Advances First Semester Second Semester ***(Payable at the beginning of each semester/term and adjustable at the end of the same)***	 12,000/- 12,000/-	 12,000/- 12,000/-	—	—
Institute Caution Deposit	3,000/-	3,000/-	3,000/-	3,000/-
Fee for Eligibility Test(s)/Ph.D. Qualifying Examination	Institute reserves its right to charge such a fee, which would be adjustable against admission fees if the candidate secures admission			

Also, please refer to Notes at the bottom of table C for further information.

B. The following is the details of the fees payable by all students to be admitted in the academic year 2023-2024 at **BITS-Pilani, K. K. Birla Goa Campus.**

Fees	Integrated First Degrees	Higher Degrees	Ph.D. Programme	
			Full Time	**Part Time**
Admission Fees	53,900/-	53,900/-	10,000/-	10,000/-
Semester/Term Fees				
First Semester	2,45,000/-	2,45,000/-	24,500/-	49,000/-
Second Semester	2,45,000/-	2,45,000/-	24,500/-	49,000/-
Summer term (if Registered)	85,700/-	85,700/-	8,570/-	17,140/-
Students' Union fee	450/- pa	450/- pa	—	—
Students' Aid Fund	225/- pa	225/- pa	225/- pa	225/- pa
Hostel fee (for on-campus students only)				
First Semester	25,250/-	25,250/-	25,250/-	
Second Semester	25,250/-	25,250/-	25,250/-	—
Summer term (if Registered)	12,625/-	12,625/-	12,625 /-	
Ph.D. thesis examination fees*			15,000/-	15,000/-
Mess & Electricity advance				
First Semester	10,000/-	10,000/-	10,000/-	—
Second Semester	10,000/-	10,000/-	10,000/-	
Summer term (if Registered)	5,000/-	5,000/-	5,000/-	
(Payable at the beginning of each semester/term and adjustable at the end of the same)				
Other Advances				
First Semester	12,000/-			
Second Semester	12,000/-	12,000/-		—
Summer term		12,000/-	—	
(Payable at the beginning of each semester/term and adjustable at the end of the same)				
Institute Caution Deposit	3,000/-	3,000/-	3,000/-	3,000/-
Fee for Eligibility Test(s) / Ph.D. Qualifying Examination	Institute reserves its right to charge such a fee, which would be adjustable against admission fees if the candidate secures admission			

Also, please refer to Notes at the bottom of table C for further information.

C. The following is the details of the fees payable by all students to be admitted in the academic year 2023-2024 at **BITS-Pilani, Hyderabad Campus.**

Fees	Integrated First Degree	Higher Degree	Ph.D. Programme	
			Full Time	**Part Time**
Admission Fees	53,900/-	53,900/-	10,000/-	10,000/-
Semester/Term Fees				
First Semester	2,45,000/-	2,45,000/-	24,500/-	49,000/-
Second Semester	2,45,000/-	2,45,000/-	24,500/-	49,000/-
Summer term	85,700/-	85,700/-	8,570/-	17,140/-
Students' Union fee	450/- pa	450/- pa	—	—
Students' Aid Fund	225/- pa	225/- pa	225/- pa	225/- pa
Hostel fee (for on-campus students only)				
First Semester	25,250/-	25,250/-	25,250/-	
Second Semester	25,250/-	25,250/-	25,250/-	—
Summer term	12,625/-	12,625/-	12,625/-	
Ph.D. thesis examination fees	-	-	15,000/-	15,000/-
Mess & Electricity advance				
First Semester	10,000/-			
Second Semester	10,000/-	10,000/-	10,000/-	—
Summer term	5,000/-	10,000/-	10,000/-	
(Payable at the beginning of each semester/term and adjustable at the end of the same)		5,000/-	5,000/-	
Other Advances				
First Semester				
Second Semester	12,000/-	12,000/-	—	—
(Payable at the beginning of each semester/term and adjustable at the end of the same)	12,000/-	12,000/-		
Institute Caution Deposit	3,000/-	3,000/-	3,000/-	3,000/-
Fee for Eligibility Test(s) / Ph.D. Qualifying Examination	Institute reserves its right to charge such a fee, which would be adjustable against admission fees if the candidate secures admission			

Notes: (Applicable to Pilani, Goa and Hyderabad Campus candidates):

1. The above prescribed semester fees is for the Integrated First Degree, Higher Degree, PhD students admitted in the academic year 2023-24. For these students, the semester, summer term and admission fees will be revised upward every year. The details of semester tuition fee and summer term fee is given below (unless the government announces any new levy/tax, which will be passed on to all existing students irrespective of their year of entry).

Tuition fees per semester & summer term fee (if it is required to register in summer) for the students admitted in academic year 2023-24 [for Domestic students] (Amount in INR)					
Academic Year of admission	**AY 2023-24**	**AY 2024-25**	**AY 2025-26**	**AY 2026-27**	**AY 2027-28**
Semester Tuition Fee[#]	2,45,000	2,57,000	2,69,500	2,82,500	2,96,500
Summer Term Fee*, [#]	85,700	89,900	94,300	98,800	1,03,700

2. Summer Term Tuition Fee will be about 35% of the Semester Tuition Fee in Corresponding Academic Year. All three Indian campuses will have the same summer term fee in an academic year. It is to be noted that every summer term is not part of the academic calendar except where specifically stated in the Semester-wise pattern of a given programme. Though the prescribed summer term fee for domestic students is mentioned above, depending on the requirement of registration of a student in a given summer term, he/she will be required to pay summer term fee for that particular academic year only.

[#] The tuition fees per semester for full time and part time PhD students will be 10% and 20% of the amount mentioned in the above table respectively.

3. If a student is admitted to a second degree programme under dual degree scheme, he/she has to pay admission fees of the second programme at the time such admission is made.
4. If a single degree student registers for PS II in a Semester, he/she has to pay the semester fees of the batch for that semester plus additional fees of summer term of previous academic year (i.e. about 35% of the Semester fees of the previous Academic Year).

   For example: If a single degree FD student registers in Practice School II (PS II) in his/her fourth yer, the PS II fees will be Semester Fees of the batch for his/her corresponding Academic Year in which he/she registering for PS II plus summer term fees of the previous year (i.e. summer term fees of his/her third year). Similarly, if a dual degree FD student registers in PS II in his/her fifth year, the PS II fees will be Semester Fees of the batch for his respective Academic Year in which he/she registering for PS II plus summer term fees for that batch as per their third year of study.
5. Course-wise Fees (Per Course): Rs. 4,620/- (Applicable to only certain limited courses outside academic requirement after paying full semester fees. No semester fee is computable on the basis of course wise fees).
6. If any continuing student is also admitted to a minor programme, he/she has to pay a fee of Rs. 28,000/- for AY 2023-24 in addition to fees for the semesters / summer terms enrolled in. The fee is payable in two installments – Rs. 14,000/- at the time of admission as minor application fee and Rs. 14,000/- on completion of requirements as minor certificate fee. Admission fees for minor programme will be revised in subsequent years as per Institute norms.
5. All fees are to be paid in advance. Only caution deposit and mess advance are refundable after adjustment of dues at the time of graduation or withdrawal from the Institute. This applies to prospective candidates who are seeking admission as well as ongoing students of the Institute.
6. For some specific programs requiring special treatment, fees and mode of their payment will be determined by the Vice-Chancellor in consultation with the Chancellor**.**

International Students' Admission Scheme, BITS Pilani

Pilani, Goa and Hyderabad Campuses

For Academic Year 2023-2024

Tentative Fee structure of students admitted through ISA-2023 (All figures are in INR)						
Non-SAARC Students				***SAARC students***		
	One Time	**Semester 1**	**Semester 2**	**One time**	**Semester 1**	**Semester 2**
Application Fee	6,750	-	-	6,750	-	-
One Time Fees (Payable at the time of Admission)						
Admission fees	1,31,200	-	-	1,31,200	-	-
Facilitation fee (covering charges for local travel, room and board during "orientation" in 1st month)	16,130	-	-	16,130	-	-
Institute Caution Deposit (Refundable on graduation or leaving the Institute, after adjusting all dues).	32,000	-	-	32,000	-	-
Annual Fees (Payable along with First Semester Fees)						
Students' Union, Student Aid Fund	-	4,160	-	-	4,160	-
Semester Fees (Payable before the beginning of Semester)						
Tuition Fees	-	6,23,500	6,23,500	-	3,67,500	3,67,500
Hostel Fees and Internet Charges	-	53,500	53,500	-	53,500	53,500
Mess and Electricity Advance (this is adjusted against mess and electricity bills at the end of each semester).	-	10,000	10,000	-	10,000	10,000
Totals	**1,86,080**	**6,91,160**	**6,87,000**	**1,86,080**	**4,35,160**	**4,31,000**

In addition to the above, students may be required to pay for food, electricity; Medical/Health and other insurance; Visa (Application Fees/Renewal Fees) etc.

Scholarships - Tuition fee waiver is based on merit: Top 4% students will get 80% waiver, next 10% will get 50%, next 20% will get 30% waiver, and remaining will get 15% Tuition fee waiver. All fee waiver decisions will be announced after admissions are completed.

For further scholarship eligibility during subsequent semesters while studying in BITS Pilani, a student has to score a Minimum CGPA of 8.0 to claim 80% tuition fee waiver, and a minimum of 6.0 CGPA for claiming any other scholarship level (50, 30, or 15%) while remaining in top 4, 10, 20, and remaining 66% percentage.

The above semester fee is for foreign students to be admitted in academic year 2023-2024 for undergraduate programmes. 2024 onwards, fees will be revised upwards every year.

Other Fees (based on options selected), payable as and when required:

Summer Term Tuition Fees	35% of Semester Tuition Fee in corresponding Academic Year
Summer Term Hostel Fees	50% of Semester Hostel Fee in corresponding Academic Year
Practice School I	35% of Semester Tuition Fee in corresponding Academic Year
Practice School II	Summer Term Fees (as applicable) plus the Semester Fees of the batch for that semester
Minor Certificate Fee	6% of Semester Tuition Fee in corresponding Academic Year
Placement Charges	3% of Semester Tuition Fee in corresponding Academic Year

Fees required to be paid at the time of Admission through ISA-2023 (in INR)

In AY 2023-2024

	Non-SAARC	SAARC
Admission fees	1,31,200/-	1,31,200/-
Facilitation fee (covering charges for local travel, room and board during 'orientation' in 1st month)	16,130/-	16,130/-
Institute Caution Deposit (Refundable on graduation or leaving the Institute, after adjusting all dues).	32,000/-	32,000/-
Students' Union, Student Aid Fund for AY 2023-24	4,160/-	4,160/-
First Semester Tuition Fees	6,23,500/-	3,67,500/-
First Semester Hostel Fees and Internet Charges	53,500/-	53,500/-
First Semester Mess and Electricity Advance (this is adjusted against mess and electricity bills at the end of semester).	10,000/-	10,000/-
Other Advances (Per Semester)	12,000/-	12,000/-
Total	8,82,490/-	6,26,490/-

Note: Students are expected to pay their Fees in INR. The USD payment is to be made if any, using the conversion rate on the day of payment.

The above prescribed semester fees are for the FD students admitted through ISA scheme in the academic year 2023-24. For the students, the semester, term and admission fees will be revised upward every year. The details of semester tuition fee and summer term fee is given below (unless the government announces any new levy/tax, which will be passed on to all existing students irrespective of their year of entry).

Tuition fees per semester & summer term fee (if it is required to register in summer) for the students admitted in academic year 2023-24 [for International Students] (Amount in INR)						
Academic Year of admission		**AY 2023-24**	**AY 2024-25**	**AY 2025-26**	**AY 2026-27**	**AY 2027-28**
Semester Tuition Fee	Non-SAARC	6,23,500	6,54,500	6,87,000	7,21,000	7,57,000
	SAARC	3,67,500	3,85,500	4,04,500	4,24,500	4,45,500
Summer Term Fee*	Non-SAARC	2,18,200	2,29,000	2,40,400	2,52,300	2,64,900
	SAARC	1,28,600	1,34,900	1,41,500	1,48,500	1,55,900

*Summer Term Tuition Fee will be about 35% of Semester Tuition Fee in Corresponding Academic Year. All three Indian campuses will have the same summer term fee in an academic year. It is to be noted that every summer term is not part of the academic calendar except where specifically stated. Though the prescribed summer term fee for International students is mentioned above, depending on the requirement of registration of a student in a given summer term, he/she will be required to pay summer term fee for that academic year only.

1. If a student is admitted to a second-degree programme under dual degree scheme, he/she has to pay admission fees of the second programme at the time of such admission is made.

2. International Students admitted in AY 2023-24 will pay tuition fee of 6,23,500/- (for non-SAARC students) & 3,67,500/- (for SAARC students) per Semester in AY 2023-24. In subsequent years (AY 2024-25, 2025-26, 2026-27, 2027-28 etc.) tuition fee will increase @5% every year in INR for 2023-24 batch.

3. If a single degree student registers for PS II in a Semester, he/she has to pay the semester fees of the batch for that semester plus additional fees of summer term of previous academic year (i.e. about 35% of the Semester fees of the previous Academic Year). For example: If a single degree FD student registers in Practice School II (PS II) in his/her fourth year, the PS II fees will be Semester Fees of the batch for his/her corresponding Academic Year in which he/she registering for PS II plus summer term fees of the previous year (i.e. summer term fees of his/her third year). Similarly, if a dual degree FD student registers in PS II in his/her fifth year, the PS II fees will be Semester Fees of the batch for his respective Academic Year in which he/she registering for PS II plus summer term fees for that batch as per their third year of study.

4. If any continuing international student is also admitted to a minor programme, then he/she has to pay the minor fee and in two instalments. The first instalment of the fee will be paid at the start of the minor program and it will be 3% of semester tuition fee in the corresponding academic year. The second instalment will be paid at the completion of minor program and it will be 3% of tuition fee in the semester when he /she complete minor program. This fee will be in addition to the semester/term fees. Admission fees for minor programme will be revised in subsequent years as per Institute norms.

5. All fees are to be paid in advance. Only caution deposit and mess advance are refundable after adjustment of dues at the time of graduation or withdrawal from the Institute. This applies to prospective candidates who are seeking admission as well as ongoing students of the Institute.

6. For some specific programs requiring special treatment, fees and mode of their payment will be determined by the Vice-Chancellor in consultation with the Chancellor**.**

The following is the details of the fees in INR payable by all students admitted in the academic year 2023-2024 at BITS-RMIT Higher Education Academy.

The following is the details of the fees payable to BITS Pilani by all students to be admitted in the academic year 2023-2024 in the First Degree Program (B.E. Civil, B.E. Mechanical, B.E. Electrical and Electronics and B.E. Electronics and Communication) at BITS-Pilani through BITS-RMIT Higher Education Academy:

Fees	Pilani Campus	Hyderabad Campus
Admission Fees	53,900/-	53,900/-
Semester/Term Fees		
First Semester	3,75,000/-	3,75,000/-
Second Semester	3,75,000/-	3,75,000/-
Summer term (if Registered)	1,31,250/-	1,31,250/-
Student's Union fee (Annual)	450/-	450/-
Student's Aid Fund (Annual)	225/-	225/-
Hostel fee (for on-campus students only)		
First Semester	18,800/-	25,250/-
Second Semester	18,800/-	25,250/-
Summer term (if Registered)	9,400/-	12,625/-
Mess & Electricity advance		
First Semester	10,000/-	10,000/-
Second Semester	10,000/-	10,000/-
Summer term (if Registered)	5,000/-	5,000/-
(Payable at the beginning of each semester/term and adjustable at the end of the same)		
Other Advances		
First Semester	12,000/-	12,000/-
Second Semester	12,000/-	12,000/-
(Payable at the beginning of each semester/term and adjustable at the end of the same)		
Institute Caution Deposit	3,000/-	3,000/-

Notes: (Applicable to Pilani and Hyderabad Campus candidates admitted under BITS-RMIT Higher Education Academy)

1. The above prescribed semester fees is for the Integrated First Degree students admitted in the academic year 2023-24 (For **BITS-RMIT Higher Education Academy students at BITS Pilani only**). For these students, the Semester Tuition, Summer Term and Hostel fees will be revised upward every year. The details of semester tuition fee and summer term fee is given below (unless the government announces any new levy/tax, which will be passed on to all existing students irrespective of their year of entry).
2. Summer Term Tuition Fee will be 35% of Semester Tuition Fee in corresponding Academic Year. All three Indian campuses will have the same summer term fee in an academic year. It is to be noted that every summer term is not part of the academic calendar except where specifically stated. Though the prescribed summer term fee for domestic students is mentioned above, depending on the requirement of registration of a student in a given summer term, he/she will be required to pay summer term fee for that particular academic year only.
3. All fees are to be paid in advance. Only caution deposit and mess advance are refundable after adjustment of dues at the time of graduation or withdrawal from the Institute. This applies to prospective candidates who are seeking admission as well as ongoing students of the Institute.
4. The fees payable to RMIT University for the study period of years 3 and year 4 by all students to be admitted in the academic year 2023-2024 in the First Degree Program (BE Civil, BE Mechanical, BE Electrical and Electronics and BE Electronics and Communication) through BITS-RMIT Higher Education Academy can be found at bitsrmit.in.
5. **The summary of the Tuition fees per semester & summer term tuition fee (as if applicable to register in summer term depending on the completion of course requirement of a given program) for the students admitted in academic year 2023-24 [for BITS-RMIT Higher Education Academy students] (Amount in INR) is given below:**

Academic Year of admission	**Tuition fees payable at BITS Pilani (Indian Campuses)**		**Tuition fees payable at RMIT Australia (Melbourne Campus)***	
	Year 1 (AY 2023-24)	**Year 2 (AY 2024-25)**	**Year 3 (AY 2025-26)**	**Year 4 (AY 2026-27)**
First Semester Tuition Fee	3,75,000	3,93,750	43,200AUD **(2024 rate) ***	43,200AUD **(2024 rate) ***
Second Semester Tuition Fee	3,75,000	3,93,750		
Summer Term Fee	1,31,250#	1,37,800#		

 # The summer term fee will be charged either for the summer term of AY 2023-24 or the summer term of AY 2024-25 only depending on the completion of course requirement of a given program.

*** AUD means Australian Dollar. RMIT may adjust tuition fees at the beginning of each calendar year. RMIT may increase tuition fees by no more than 7.5% each calendar year (subject to rounding). Information regarding other costs such as amenities fees, Overseas health insurance and costs of living can be found on the RMIT Australia program guide.**

Scholarship policy for First Degree students admitted through BITSAT and Board Topper's Schemes

A large number of scholarships, fellowships and other financial assistance are available to the students of the Institute who are admitted through BITSAT and Board Topper's schemes (Scholarship details of students admitted through International Students scheme is given in later part of this section). Past experience shows that about 30% of the these students receive some form of financial assistance or other. For continuance of scholarships, scholarship holders are required to maintain good scholastic standing and good conduct.

Some of the scholarships/financial assistance normally available are listed below:

1. Institute's own merit or merit-cum-need awards for students:

a) For FD students: Every year about 30% of students admitted to First Degree Programs get semester tuition fee waivers in the range between 15% to 100% in the form of either merit or merit-cum need scholarships as tabulated below:

Under Institute's own merit award scheme	**Amount of scholarship**
Top 1% Students	100% of total tuition fee
Top 2% Students	40% of total tuition fee
Under Institute's own merit-cum-need awards scheme	**Amount of scholarship**
3% Students	80% of total tuition fee
6% Students	40% of total tuition fee
12% Students	25% of total tuition fee
6% Students	15% of total tuition fee

Note: There will be no waiver of admission fee.

b) All awards are made for one semester only and their continuance in the subsequent semesters(s) will depend on the candidate's performance in the Institute and his/her needs.

2. Scholarships under National Talent Search/ National Science Talent Search Schemes.
3. Government of India National Scholarships.
4. Merit Scholarships, Merit-cum-need Scholarships and Need-cum-Merit Scholarships awarded by State Governments.
5. Government of India Scholarships for Scheduled Caste and Scheduled Tribe students.
6. National Scholarships to the children of Primary and Secondary School teachers.
7. Scholarships from various charitable trusts.
8. Financial assistance from Students Aid Fund.
9. The Ministry of Non-Conventional Energy Sources (MNES), Govt. of India has sanctioned two research fellowships to the Institute for advanced study in the area of Renewable Energy.
10. Students can also participate in the nationwide competitions for prestigious scholarships such as Aditya Birla Scholarship, Lucent Global Science Scholars Program and GE Fund India Scholarship.
11. Financial Assistance from BITS Alumni. BITS and BITSAA International Travel Fellowship is co-sponsored by the Institute and BITSAA International. Meritorious students are supported with 75% of travel cost for traveling abroad for presenting selective papers at international conferences.

Scholarship policy for First Degree International students admitted through ISA Scheme

All International students admitted under the scheme will be provided merit scholarships in the form of tuition fee waiver as follows:

Tuition fee waiver is based on merit: Top 4% students will get 80% waiver, next 10% will get 50%, next 20% will get 30% waiver, and remaining will get 15% Tuition fee waiver. All fee waiver decisions will be announced after admissions are completed. The number of scholarships will depend on the total number of seats for the particular Academic Year in a campus.

Scholarships will be for one semester at a time. Scholarships for the first semester will be decided based on the position in the merit list within foreign students (admitted under International Students Admission scheme). Scholarships will be reviewed in each subsequent semester and will be awarded based on the academic performance of the student at BITS. For further scholarship eligibility during subsequent semesters while studying in BITS, a student has to score a Minimum CGPA of 8.0 to claim 80% tuition fee waiver, and a minimum of 6.0 CGPA for claiming any other scholarship level (50, 30, or 15%) while remaining in top 4, 10, 20, and 66% percentage respectively. These students will not be eligible for any other scholarship/aid offered by BITS Pilani but may avail other scholarships. The student must maintain the absolute minimum academic performance to be eligible to receive any form of tuition fee waiver in the subsequent semesters, viz.

The student should not have obtained more than one 'E grade' or one 'NC report' in the registered courses in the previous semester.

Further, scholarships will be provided only for the normal duration of the programme.

Scholarship policy for First Degree students admitted through BITS-RMIT Higher Education Academy

Future Leaders Scholarship

BITS-RMIT Higher Education Academy students are eligible for the RMIT Future Leadership Scholarship for components of the programme delivered at RMIT Australia. The scholarship value is a 20% tuition fee reduction for the programme duration outlined in the offer letter for courses delivered at RMIT in Melbourne.

Scholarship policy for Higher Degree and PhD students

1. Full-time PhD students admitted into the PhD programme are eligible to be considered for fellowship of ₹28,000 or ₹31,000 per month as per intake qualifications. Consideration for fellowship will be as per Institute norms, details of which are available in the PhD brochure on the admission website. It will be obligatory on the part of every admitted full time student to undertake 8 to 10 hours (per week) of work as assigned to her/him by the Institute.

The Institute's decision on these awards/ stipends is entirely worked out by the Institute's own pre-declared procedure and is not dependent on the nationally conducted tests such as GATE, GPAT etc.

2. Students admitted to Higher degrees and Ph.D. will also be recommended for award of scholarships /Fellowships from various sources like UGC, CSIR, DST, DBT, ICMR, etc. These Scholarships are operated as per rules & regulations stipulated by the awarding authorities. Students admitted to higher degree programmes and who are qualified in GATE may apply to the UGC for the GATE scholarship and the Institute will forward such applications to the UGC. It should be noted that the decision regarding award of the GATE / GPAT scholarship to admitted students is made by UGC as per its existing norms and the Institute cannot guarantee such awards.

Student Record

The students' records are computerized and a grade sheet for each semester is issued to the student normally within one week after the comprehensive examination.

The grade sheet will be withheld when a student has not paid his dues or when there is a pending case of breach of discipline or a case of unfair means against him.

The Institute issues a transcript (an up-to-date performance of a candidate from the date of his entry to the date of his leaving the Institute) to all the passing out candidates at the end of each semester/summer term normally within four weeks of the last examination. The provisional certificate is issued and refund of the positive balance and caution money by RTGS is made at the same time. This estimate is based on an assumption that each candidate has ensured by prior initiative that there is nothing pending against him on academic, financial and disciplinary matters.

Since all student records are computerized, each student is assigned a unique identification number (ID No.) which is constructed by building in the number certain information to assist in data storage and data retrieval. No two

ID numbers are ever identical.

Degree programmes are assigned codes as below and the ID No. carries the degree programme code(s) along with other information such as year of admission, whether in Practice School (PS), Thesis (TS) stream, or BITS-RMIT Higher Education Academy (CP) and the last character indicates the campus which a student belongs to. For example, 2023A1PS350P refers to a student admitted in 2023-24 to B.E. Chemical Engineering (with Practice School) programme at Pilani Campus. The Higher Degree students are assigned ID No. indicating whether the candidate is in PS stream (K1) or in the Dissertation (H1) stream. For example, 2023K103350P refers to a student admitted in 2023-24 to M.E. Computer Science (with Practice School) programme at Pilani Campus.

Programme Codes

First Degree Programmes	
B.E. Chemical	A1
B.E. Civil	A2
B.E. Electrical & Electronics	A3
B.E. Mechanical	A4
B.Pharm.	A5
B.E. Computer Science	A7
B.E. Electronics and Instrumentation	A8
B.E. Biotechnology	A9
B.E. Electronics & Communication	AA
B.E. Manufacturing Engineering	AB
M.Sc. Biological Sciences	B1
M.Sc. Chemistry	B2
M.Sc. Economics	B3
M.Sc. Mathematics	B4
M.Sc. Physics	B5
M.Sc. General Studies	C2
M.Sc. Engineering Technology	C5
M.Sc. Information Systems	C6
M.Sc. Finance	C7
Higher Degree Programmes	
M.E. Biotechnology	29
M.E. Chemical	01
M.E. Chemical with specialization in Petroleum Engineering	32
M.E. Civil with specialization in Structural Engineering	43
M.E. Civil with specialization in Transportation Engineering	30
M.E. Civil with specialization in Infrastructure Engineering & Management	44
M.E. Civil with specialization in Water Resources	11
M.E. Communication Engineering	24
M.E. Computer Science	03
M.E. Design Engineering	41
M.E. Electrical with specialization in Power Electronics & Drives	31
M.E. Embedded Systems	40
M.E. Information Security	13
M.E. Manufacturing Systems Engineering	42
M.E. Mechanical	06
M.E. Mechanical with specialization in Thermal Engineering	48
M.E. Microelectronics	23
M.E. Sanitation Science, Technology and Management	51
M.Phil.in Liberal Studies	52
M.E. Software Systems	12
M.Pharm.	08
M.Pharm. with specialization in Pharmaceutics	46
M.Pharm. with specialization in Pharmaceutical Chemistry	47
M.Pharm. with specialization in Pharmacology	53
M.B.A.	49
MBA in Business Analytics	54
MPH	37
M.E. Environmental Engineering	55

RULES AND REGULATIONS

All students admitted to the Institute will be governed by the Rules and Regulations that are prescribed from time to time.

Anti-Ragging

The Institute has formulated strict anti-ragging guidelines and all students are required to sign an undertaking to abide by these guidelines. Students, if found violating these guidelines are

liable to disciplinary action including expulsion from the Institute and also possible legal action as per the directive from the Honorable Supreme Court of India.

The Institute has formed a committee and anti-raging squads at hostel and institute level to combat raging. The students can also communicate directly with the Dean, Students Welfare, through the Institute website

Information for Candidates for all Work Integrated Learning Programme

Prospective candidates must consult the separate section in the Institute Bulletin. They should note that a separate application form is provided for admission to Work Integrated Learning programmes. It is further to be noted that all rules, regulations will automatically apply in the Work Integrated Learning programmes. Information about these can also be obtained at https://bits-pilani-wilp.ac.in.

INFORMATION FOR CANDIDATES APPLYING FOR BITS PILANI, DUBAI CAMPUS

Admissions to Dubai Campus are based on the merit in the qualifying examination. The admissions are open to students from all the countries and having qualifications from various recognized international boards. For candidates admitted from countries other than UAE, student residence visa is facilitated.

For educational process and programmes of studies, refer section II.

APPLICATION PROCEDURE

Application for admission to Dubai Campus should be made in the prescribed form available at: www.bits-pilani.ac.in/dubai. Separate application forms are prescribed for (i) First Degree Programmes (ii) Higher Degree Programmes (iii) Doctoral Programme

INTEGRATED FIRST DEGREE PROGRAMMES

Admissions are made purely on overall aggregate in the qualifying examination (12^{th} Grade or its equivalent examination), secured by the candidate. There is no separate admission test. Admission is offered based on merit, seats in the preferred discipline and facilities available.

Eligibility for admission

For admission to all integrated first degree programmes, the eligibility requirement is a minimum of 60% overall aggregate* marks in the qualifying examination and a minimum aggregate of 60% in the Physics, Mathematics and Chemistry/ Biology/Computer Science or any other vocational subjects with at least 50% marks in each subject in the Senior School Certificate Examination of the Central Board of Secondary Education (CBSE-12th grade), New Delhi, India, or its equivalent from any recognized International, National, or State examination with adequate proficiency in English. However, for admission to B.E Biotechnology, candidates without Mathematics in Grade 12 will be accepted with a minimum aggregate of 60% in Physics, Biology and Chemistry or any other vocational subject with at least 50% marks in each subject.

** Aggregate: Aggregate is the total marks of all subjects in the Qualifying Examination, considered essential by the Board/University for passing the examination. The Aggregate must compulsorily contain the required subjects, namely, Physics and Mathematics or Biology (for Biotechnology only)*

Candidates opting for a programme in Biotechnology who have not taken Chemistry and Mathematics in the high school (Grade 12 or equivalent) will be required to complete bridge courses in Mathematics and Chemistry in the first semester. Candidates opting for any other programme, who have not taken Chemistry in higher secondary curricula will be required to complete bridge course in Chemistry in their first semester.

English is the medium of Instruction. Therefore, good proficiency in English is essential for admission. Candidates who have completed their qualifying examination from Non-English medium must have secured a minimum TOEFL Score of 500 in Paper based test/ 61 in internet based test or a minimum IELTS score of 6 or a minimum EmSAT score of 1250-1600. If necessary, they will also be assessed by a campus committee for English Comprehension.

The mechanism of admission for Dubai Campus:

Applying for admission:

(i) In order to apply for admission to the Integrated First Degree programmes, the candidate should submit the application in prescribed form. The application form is available at the website: www.bits-dubai.ac.ae/admission and must be filled online.

(ii) The candidate must fill only a single application form for seeking admission to all the first degree programmes offered at Dubai Campus.

Preparation of Merit List and Admission process:

(i) The merit list will be prepared on the basis of overall aggregate percentage of marks obtained by the candidates in the Qualifying Examination (12th grade or equivalent), for all eligible candidates, whose application, complete in all respects with 12th marks, preferences and required fees, is received till last date.

(ii) If a candidate with a higher merit position is not able to get any of his/her programme preference due to non-availability of seats in the indicated preferences, such a candidate is kept in Waiting List. For a candidate to secure the seat or remain in the race, it is mandatory to pay the required fees in advance as mentioned in the Admission/Wait list letter.

(iii) Normally a candidate cannot change the preferences once submitted. Candidates are strongly advised to exercise their preferences after careful consideration and give preference for all programmes to better the chances of admission.

(iv) Admission Offer letter is sent to candidates above the cut-off of merit. To accept the offer of admission, candidate must comply with all the requirements specified in the Admission Offer letter including submission of various documents and payment of fee on or before the date mentioned in the Admission Offer letter. If the requirements are not met by the specified due date, the admission offer will be deemed to be cancelled and the seat will be allotted to Wait Listed candidates.

HIGHER DEGREE PROGRAMMES

The Higher Degree Programmes offered at Dubai Campus are uniquely designed and structured to meet the learning aspirations of Engineers, who are employed Executives, Entrepreneurs and Professionals. The admission is based on the performance of the candidate in the qualifying degree and Admission test.

Admissions to Higher Degree Programmes are done in both the semesters. Candidates interested in applying can fill the application form online. Deadline for submission of Application form is given on the website.

DOCTORAL PROGRAMME (Ph.D.)

The Doctoral programme is offered in Engineering and allied interdisciplinary areas. A candidate with a higher degree: namely M.E./M.S./M.B.A./ M.Phil. of BITS Pilani or its equivalent from any other recognized university can apply for the doctoral programme.

For admission to the Ph.D. programme, the marks/grades of the candidate in the latest examination as well as the performance in a specially designed admission test and/or interview would be considered.

Admissions to Doctoral Programme are done in both the semesters. Candidates interested in applying for Doctoral Programmes can apply online at the website: www.bits-dubai.ac.ae/admission. Deadline for submission of Application form is is given on the website.

FLEXIBILITIES FOR FIRST DEGREE PROGRAMMES AT DUBAI CAMPUS

The educational process permits multiple entry points into the programmes and allows several other flexibilities. As in the admission process, the decision for use of flexibilities is guided by the principle of merit, preferences and facilities available.

Practice School, Dual Degree and Transfer

For details, refer to the section on flexibilities in the previous part.

Admission with Advanced Standing

For details, refer to the section on flexibilities in the previous part and the website: www.bits-pilani.ac.in/admission.

Second Semester Admission

The structural flexibilities available in the Institute make it possible to admit students in both the semesters. However, most of the admissions are made during the first semester itself. The second semester admissions provide opportunity to candidates who could not apply in time for the first semester admissions.

The second semester admission students are merged with the students admitted in the first semester. They may be doing courses with the students admitted in the same academic year or in the next academic year. The total normal duration of programme will be eight semesters.

A separate admission notification for second semester admissions is issued in October every year.

Other Flexibilities

For details, refer to the section on flexibilities in the previous part

Some Important Instructions

1. The application process, announcement of admission, detailed instructions, etc., will be available at Dubai Campus website.
2. Application forms will only be accepted online and not through any other mode.
3. The application number allotted to you on submission of application form is unique. Quote this application number in all subsequent correspondence.
4. To accept the offer of admission/provisional admission/ accepting to be placed on the waiting list, you are required to pay fees in advance, as per the instructions mentioned along with the offer.

SELECTION FOR ADMISSION

Candidates are finally admitted to the Dubai Campus of BITS Pilani subject to the following conditions:

1. They have paid the requisite fees as specified in their admission/provisional admission/ waiting list letters.
2. They are declared medically fit by a registered medical practitioner and local medical examination, if required.
3. They have submitted all required original marksheets & certificates, with photocopies, and the statements made in their application forms are verified against their originals.
4. They fulfil the eligibility requirements.
5. They have a valid UAE Residence Visa or shall get a UAE residence visa facilitated by the Institute. Any student not having a valid residence visa, at any time during the study, will not be permitted to register.
6. For Integrated first-degree programmes, on the reporting day at Dubai, a Dean/Senior faculty member of the Institute will interact with the candidates.
7. Every admitted student is required to undergo a registration process every semester, on the day announced for the purpose. One of the objectives of the registration process is to name the courses to be pursued during a given semester, after allowing for the student's options within the prescribed rules and regulations. By this process, students make their own Timetable at their own responsibility, to be followed in that semester. No student will be permitted to attend classes or use any of the Dubai Campus facilities without completing the registration process.

Advance fees, Refund and Forfeiture of fees

1. A candidate admitted/placed on the waiting list will be required to pay all requisite fees in advance.
2. If a candidate is admitted either directly, provisionally or from the waiting list but

does not join the Institute, then the refund will be based on the following:

i. If a candidate completes the admission formalities but withdraws before the date of registration, the admission will automatically stand cancelled and 80% of first instalment of first semester tuition fees is refundable.

ii. If a student withdraws within one week of the date of registration irrespective of whether the student registers or not, 50% of the first instalment of first semester tuition fee will be refundable.

iii. If a student withdraws after one week of the date of registration irrespective of whether the student registers or not, the entire first instalment of first semester tuition fees paid is non-refundable.

iv. If the Institute is not able to offer admission to a Waitlisted candidate to any programme of preferences as shown in his application form, the total amount of advance tuition fees will be refunded.

v. While remitting advance fees no candidate can stipulate any conditions such as changing order of preferences, addition/ deletion of preferences etc. Even if any such conditions are mentioned while remitting fees, they will be ignored.

vi. Application Fee, Admission Fee and all Visa related fees are non-refundable.

vii. Activity fee is fully refundable if the student withdraws before the date of registration. If the student withdraws within 4 weeks from the date of registration, 75% of the activity fee is refundable. If the student withdraws after 4 weeks from the date of registration, the entire activity fee is non-refundable.

For refund of hostel, transport and other fees, conditions stipulated in the Admission Bulletin will be applicable.

SCHEDULE OF FEES

D. The following are the details of the fees payable by all students to be admitted in the academic year 2023-24 at **BITS Pilani, Dubai Campus** (all figures are in AED).

One - Time Fee (Payable at the time of Admission)			
	Integrated First Degree	**Higher Degree**	**Ph.D. Programme**
Application Fee**	220	220	220
Admission Fee*	2,000	2,000	2,000
Activity Fee*	1,200	1,200	1,200
Caution Deposit$	5,000	2,000	2,000
Tuition Fee*			
First Semester (Payable in 2 installments)	24,900	16,000	2,400# (On-Campus)
Second Semester (Payable in 2 installments)	24,900	16,000	6000# (Part-Time & Off-Campus per semester)
Summer Term (Payable for PS 1 after second year)	5,750	-	
Hostel fee (For Students Availing Hostel)			
First Semester***	15,000		
Second Semester***	15,000		
Summer Term***	5,200		
Hostel Caution Deposit$	2,000		
Facility Fee*	750 per annum		
Laundry charges and services charge for using refrigerator in room are additional			
Visa and Insurance Fee (For Students availing Visa/Insurance)			
Fresh Visa Fee**	2,900		
Visa Renewal Fee**	2,150		
Medical Insurance Fees*	2, 400		
Current prevailing Visa and Insurance Fee, subject to change)			
Transport Fees(For day scholars availing Institute Transport)**			
For Dubai	2,500		
For Sharjah & Ajman	2,800		

*VAT of 5% is applicable on this fee
**VAT of 5% is included on this fee
***VAT of 5% will be charged on the food cost of the hostel fee
$ Refundable after adjustment of all dues on graduation or on leaving the institute, after due adjustment for damages, breakages caused by the student, if any.
# Fee after providing a fee waiver of 80% of tuition fee for On-Campus scholars and 50% of tuition fee for Part-Time and Off-Campus scholars.

Notes:

1. A fee of AED 4000+vat per course is applicable for casual students registering for any course on audit only during any semester apart from a one-time admission fee.
2. Visa fee payable annually and is subject to change by Government of U.A.E.
3. If a student is admitted to a second-degree programme under dual degree scheme, he/she has to pay admission fees of the second programme at the time such admission is made.
4. The fees and other charges are payable in advance in each semester/term on the notified dates before registration. Non-payment of fees and dues may result in semester registration cancellation. No withdrawal from a course or courses will entitle a student for refund of fees.
5. If there are dues outstanding grades will be withheld.
6. Refunds, if any, will be made through Bank Transfers/ Bank drafts

SCHOLARSHIPS AT DUBAI CAMPUS

A large number of scholarships, fellowships and other financial assistance are available to the students admitted to Dubai Campus. For continuance of scholarships, scholarship holders are required to maintain good scholastic standing and good conduct.

Some of the scholarships/financial assistance normally available are listed below:

Merit Scholarships for First Degree Students

(a) New Admission students

1. **Board Toppers:** Candidates who have secured the top position in 12th standard in their respective boards (General Secondary Education Certificate Examination of Ministry of Education, UAE or CBSE-India or any other State, National or International Board) are given merit scholarship of 50% of the first year tuition fee. The minimum overall aggregate of the candidate must be a minimum of 90% or equivalent in the qualifying exam to avail the scholarship.

2. **Merit in Qualifying Examination:**

   i) Students who have obtained 95% or above in the aggregate of the Qualifying Examination are given a merit scholarship of 40% of first year tuition fee.

   ii) Students who have obtained 90% or above but less than 95% in the aggregate of the Qualifying Examination are given a merit scholarship of 25% of first year tuition fee.

   iii) Students who have obtained 80% or above but less than 90% in the aggregate of the Qualifying Examination are given a merit scholarship of 15% of first year tuition fee.

   iv) Candidates who have obtained 70% or above but less than 80% in the aggregate of the qualifying examination are given a merit scholarship of 10% of the first year tuition fee.

3. **Merit in BITSAT:** Students with **2023 (or BITSAT 2022)** score of 175 or above are given merit scholarship of 25% to 75% of tuition fees based on the BITSAT score for the first year.

4. **Hostel Fee Concession**: Admitted students with BITSAT 2023/2022 score of 150 or above or an aggregate of 70% or above in the qualifying examination will be offered a 25% concession in the Hostel fee for the normal duration of the programme (four years).

5. **Sports Excellence**

- Entry Level: Students who have participated and won medals in International championship by representing their Country are given scholarship of 50% of the first year tuition fee and students who have participated in the International Championships are given scholarships of 20% of first year tuition fee. The Sport and the eligibility criteria of all applicants will be evaluated on a case by case basis and the scholarship will be awarded based on committee's recommendation.
- Continuing Students: Students who participate and win in three inter-university tournaments at the end of one academic year will be considered for a scholarship of 20% of tuition fee for the current year for the normal duration of the programme based on committee's recommendation.

(b) Merit Scholarship for continuing students

All Students with a CGPA of 8.00 or above on a 10.00-point scale at the end of a previous semester are given a merit scholarship of up to 25% of tuition fee for the current semester based on the CGPA.

(c) Other Special Concessions (First Degree Programmes)

1. **Arab Nationals:** Meritorious GCC/Arab Nationals will be offered a scholarship of up to 100% on the tuition fee for the normal duration of the programme based on their performance in the qualifying exam (Grade 12 or equivalent) and continuity of a minimum CGPA of 4:5 on a 10:00 scale during the programme. This will be restricted to specific number of students.
2. **For Sudden bereavement of earning member of the family:** Such students are helped by waiving off up to 100% tuition fee for that semester followed by up to 75% in the subsequent semesters on a case to case basis, depending on means and need.
3. **For Physically Challenged Students:** All physically challenged students satisfying the conditions laid out in the Bulletin are given 15% concession on the tuition fee throughout the programme subject to satisfactory academic performance in each semester.
4. **For Sibling:** For families that have more than one child enrolled concurrently, a concession of 25% on the tuition fee is offered to the second child until the first child graduates.

Scholarships for Higher Degree Programmes

1. **Merit in Qualifying Examination:** Students who have obtained aggregate marks of 75% or above in the Qualifying Examination (B.E./B.Tech.) are given a merit scholarship of 20% of first semester tuition fee.
2. Students who are UAE Nationals will be offered 50% tuition fee scholarship for the normal duration of the programme based on their performance in the qualifying exam and continuity of a minimum CGPA of 6:00 on a 10:00 scale during the programme.
3. BITS Alumni, Employees of Collaborative Organizations and Siblings/Parents of continuing students will be offered a 10% concession on the tuition fee, during the normal duration of the programme.
4. **Merit Scholarship for continuing students:** All Students with a CGPA of 9.00 or above on a 10.00-point scale at the end of a previous semester are given a merit scholarship of 20% of tuition fee for the current semester
5. **Hostel Fee Concession:** Higher degree students who have obtained aggregate marks of 80% or above in the Qualifying Examination (B.E./B.Tech) are given a concession of 25% on the hostel fee for the normal duration of the programme.

Scholarships for Ph.D. Programmes

1. Self-funded Scholars: For the full-time scholars, 80% concession will be provided on their tuition fee of AED 12000 (VAT excluded)/ semester whereas 50% concession will be given on their tuition fee for the part time scholars and aspirants. This is subjected to the allotment of duties in the respective departments 6-8 hrs. per week.
2. Research Assistants: Applicants with prior research experience and excellent academic credentials will be awarded research assistantships up to AED 2000 per month for 4 years maximum. The tuition fee concession as specified in #1 is also applicable. Research Assistants have to support the institute in teaching theory and lab classes.
3. Hostel fee concession will be given for the self-funded scholars as well as Research Assistants.

Self-funded full-time scholars can apply for Research Assistantships after 1 year. The award of the research assistantships is based on their excellence in the performance after joining the program.

PART IV
DETAILS OF PROGRAMMES

Legend

AN	Aeronautics
BIO	Biological Sciences
BIOT	Biotechnology
CDP	Courses on Development Process
CE	Civil Engineering
CHE	Chemical
CHEM	Chemistry
CHI	Chinese
CS/Comp/Comp Sc	Computer Science
ECOM	Electronics and Computer Engineering
ECON	Economics
ECE	Electronics and Communication Engineering
EEE	Electrical & Electronics Engineering
EI	Electronics & Instrumentation
ES	Engineering Science
ET	Engineering Technology
Engg	Engineering: Chemical, Civil, Computer Science, Electrical & Electronics, Electronics & Instrumentation, Electronics and Communication, Manufacturing, Mechanical
ENGL	English
ExptlSc	Experimental Science: Biological Sciences, Chemistry, Physics
FIN	Finance
FRE	French
GER	German
HSS	Humanities and Social Sciences
IS	Information Systems
ITEB	Internet Technology and e-Business
JAP	Japanese
L	Lecture hours per week
MATH	Mathematics
MBA	Master of Business Administration
MECH	Mechanical
MF	Manufacturing Engineering
Min/Max	Indicates minimum/maximum number of units specified in a course or semester programme
MGTS	Management
MGSYS	Management Systems
MM	Manufacturing Management
MPH	Master in Public Health
MST	Material Science and Technology
P	Practical, Seminar & Project, etc. hours per week
PHIL	Philosophy
PHARM	Pharmacy
PHY	Physics
RUS	Russian
SAN	Sanitation Science, Technology and Management
SS	Software Systems
Sc.	Biological Sciences, Chemistry, Economics, Mathematics, Physics
T	Suffixed to a course number indicates that a non-letter grade will be awarded in such a course
TA	Technical Arts
TOC	Technique Oriented Courses
U	Number of units associated to a course

Course descriptions are available at: **https://academic.bits-pilani.ac.in/Institute_Important_Documents.aspx**

INTEGRATED FIRST DEGREE PROGRAMMES

(I) Structure of the Integrated First Degree Programmes

The structure and the requirements of the first degree programs, namely, B.E., B. Pharm., and M.Sc., are provided in the following sections.

The structure and the requirements of the first degree programs, namely, B.E., B. Pharm, M.Sc., and M.Sc.(Tech) are the same as provided in the following sections although the nomenclature of these programs is indicated without the Hons. / Tech. tag in the rest of the section**.**

The category-wise structure of each program:

Category	Number of Units Required	Number of Courses Required
(I) General Institutional Requirement		
Humanities Electives	8	3
Science Foundation	12	6
Mathematics Foundation	12	4
Engineering Foundation	6	2
Technical Arts	10	4
General Awareness / Professional Courses	3 to 6	1 to 3
Sub-Total	**51 to 54**	**20 to 22**
(II) Discipline Requirement		
Core	33 to 48	10 to 16
Elective	12 to 27	4 to 9
Sub-Total	57 to 60	15 to 20
(III) Open Electives	15 to 27	5 to 9
Course-work Sub-Total	**129 (min)**	**41 (min)**
(IV) PS-I and II **OR** **Thesis**	25 OR 9 to 16	2 OR 1
Total	**144 (min)**	**42 (min)**

A student should complete the minimum number of courses and units required in each category as well as meet the minimum requirements of courses (42) and units (144) in total.

1. The following courses are needed to meet the General Institutional Requirement:

a) General Biology, Biology Laboratory, General Chemistry, Chemistry Laboratory, Mechanics, Oscillations and Waves, and Physics Laboratory under the head of Science Foundation. For specific programs, General Physics may replace Mechanics, Oscillations and Waves.

b) Electrical Sciences, Thermodynamics and Process Engineering under the head of Engineering Foundation.

c) Computer Programming, Workshop Practice, Engineering Graphics, and Technical Report Writing under the head of Technical Arts.

d) Principles of Economics, or Principles of Management and Environmental Studies* under the head of General Awareness / Professional courses. *[Students completing this course will be awarded a non-letter grade (GOOD or POOR)]

2. The courses under the following heads are designed to meet the General Institutional Requirement under the head of Humanities Electives:

   (a) Languages and Literature

   (b) History and Philosophy

   (c) Political and Social Sciences

   (d) Fine Arts and Professional Arts

3. A thesis is for 16 units and for a full semester duration. But a student has the option of pursuing a Thesis of 9 units concurrently with coursework over a full semester, in which case the additional coursework would be at least 2 courses of total 6 units to meet the minimum unit requirements.

The nominal semester-wise chart for first degree programs are given in the Pages IV-3-21.

Dual Degree Programs:

Based on the above, the structure of a dual degree program has been derived using the following principles.

- General Institute Requirements will remain the same for both the degrees of the composite dual-degree program and therefore need not be repeated.
- While the Discipline Requirements of each of the two degrees in a dual degree program have to be met separately, any course that meets the discipline requirements of both the degree programs need not be repeated.
- In addition the Discipline Elective courses of either of the two degrees in a dual degree program may be used to fulfill the open elective requirement of the other degree.
- A PS-II or Thesis must be done to meet the requirements of each degree. Therefore to complete the dual degree program a student must complete one of the following:
  - 2 Practice School-II courses
  - 2 Thesis courses
  - 1 Practice School-II course and 1 Thesis course.

A thesis for 9 units with concurrent course work for at most 9 units over a full semester duration is also possible as an option.

Based on these principles, the semester-wise patterns for a composite dual degree program as options for the student are shown in pages IV-22-23. However the charts mentioned on pages IV-24-69 are designed to enable the students to complete the composite dual degrees in their respective programmes in 10 semesters.

Semester-wise Pattern for Students Admitted to B.E. Biotechnology Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Open/Humanities Electives	3(min)			or	or
	BIOT	F211	Biological Chemistry	3	MGTS	F211	Principles of Management	3
	BIOT	F212	Microbiology	4			Open/Humanities Electives	3(min)
	BIOT	F215	Biophysics	3	BIOT	F241	Genetic Engineering Techniques	4
	BIOT	F213	Cell Biology	3	BIOT	F243	Genetics	3
	BITS	F225	Environmental Studies	3	BIOT	F245	Introduction to Environmental Biotechnology	3
					BIOT	F244	Instrumental Methods of Analysis	4
				22				**20**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3to6			Open/Humanities Electives	3to6
	BIOT	F311	Recombinant DNA Technology	3	BIOT	F342	Immunology	3
					BIOT	F343	Experiments in Biotechnology	3
	BIOT	F314	Industrial Microbiology & Bioprocess Engineering	4	BIOT	F344	Downstream Processing	3
			Discipline Electives	8			Discipline Electives	6
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	3			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15to18
				8/14				**15/20**

Discipline Core -43 Units (13 Courses)

Discipline Electives-15 Units(5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Chemical Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	CHE	F211	Chemical Process Calculations	3	MGTS	F211	Principles of Management Humanities Electives	3 3(min)
	CHE	F214	Engineering Chemistry	3	CHE	F241	Heat Transfer	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F212	Fluid Mechanics	3	CHE	F243	Material Science & Engineering	3
	BITS	F225	Environmental Studies	3	CHE	F244	Separation Processes I	3
				21 (min)				**18(min)**
Summer	**BITS F221 Practice School – I(for PS Option Only)**							
III			Open/Humanities Electives	3to6			Open/Humanities Electives	3to6
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F313	Separation Processes II	3	CHE	F342	Process Dynamics &	3
	CHE	F311	Kinetics & Reactor Design	3			Control	
	CHE	F314	Process Design Principles I	3	CHE	F343	Process Design	
			Discipline Electives	3			Principles II	3
							Discipline Electives	6
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	6			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				11/17				**15/20**

Discipline Core -45 Units (15 Courses)

Discipline Electives-15 Units(5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Civil Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3 (min)			or	or
	CE	F211	Mechanics of Solids	3	MGTS	F211	Principles of Management	3
	CE	F231	Fluid Mechanics	3			Humanities Electives	3 (min)
	CE	F213	Surveying	4	CE	F241	Analysis of Structures	3
	CE	F230	Civil Engineering Materials	4	CE	F242	Construction Planning & Technology	3
					CE	F243	Soil Mechanics	4
					CE	F244	Highway Engineering	4
					BITS	F225	Environmental Studies	3
				20 (min)				**20(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	1 to 4			Open/Humanities	2 to 5
	CE	F320	Design of Reinforced Concrete Structures	3			Electives	
	CE	F312	Hydraulic Engineering	4	CE	F342	Water & Waste Water	4
	CE	F313	Foundation Engineering	3			Treatment	
			Discipline Electives	6	CE	F321	Engineering Hydrology	3
					CE	F343	Design of Steel Structures	3
							Discipline Electives	6
				17/20				**18/21**
IV			Open Electives	8to14	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15to18
				8/14				**15/20**

Discipline Core -48 Units (14 Courses)

Discipline Electives-12 Units(4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B. E. Computer Science Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	CS	F214	Logic in Computer Science	3	MGTS	F211	Principles of Management	3
	CS	F222	Discrete Structures for Computer Science	3			Humanities Electives	3(min)
	CS	F213	Object Oriented Programming	4	CS	F211	Data Structures & Algorithms	4
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
					CS	F212	Database Systems	4
					BITS	F225	Environmental Studies	3
				20(min)				**21(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3to6			Open/Humanities Electives	2to5
	CS	F351	Theory of Computation	3				
	CS	F372	Operating Systems	3	CS	F363	Compiler Construction	3
	CS	F301	Principles of Programming Languages	2	CS	F364	Design & Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
			Discipline Electives	3(min)			Discipline Electives	6(min)
				18/21				**18/21**
IV			Open Electives	6to12	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15to18
				9/15				**15/20**

Discipline Core -48 Units (14 Courses)

Discipline Electives-12 Units(4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Electrical & Electronics Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	EEE	F211	Electrical Machines	4	MGTS	F211	Principles of Management	3
	EEE	F212	Electromagnetic Theory	3			Humanities Electives	3(min)
	EEE	F215	Digital Design	4	EEE	F241	Microprocessors & Interfacin	4
	EEE	F214	Electronic Devices	3	EEE	F242	Control Systems	3
					EEE	F243	Signals & Systems	3
					EEE	F244	Microelectronic Circuits	3
					BITS	F225	Environmental Studies	3
				20(min)				**22(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	4to6			Open/Humanities Electives	3to6
	EEE	F311	Communication Systems	4	EEE	F341	Analog Electronics	4
	MATH	F212	Optimization	3	EEE	F342	Power Electronics	4
			or		EEE	F312	Power Systems	3
	ME	F344	Engineering Optimization	2			Discipline Electives	4(min)
	EEE	F313	Analog & Digital VLSI Design	3				
			Discipline Electives	5(min)				
				18/21				**18/21**
IV			Open Electives	5to11	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15to18
				8/14				**15/20**

Discipline Core -47 or 48 Units (14 Courses)

Discipline Electives-12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Electronics & Communication Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	ECE	F211	Electrical Machines	4	MGTS	F211	Principles of Management	3
	ECE	F212	Electromagnetic Theory	3			Humanities Electives	3(min)
	ECE	F215	Digital Design	4	ECE	F241	Microprocessors and	
	ECE	F214	Electronic Devices	3			Interfacing	4
					ECE	F242	Control Systems	3
					ECE	F243	Signals & Systems	3
					ECE	F244	Microelectronic Circuits	3
					BITS	F225	Environmental Studies	3
				20(min)				**22(min)**
Summer				**BITS F221 Practice School – I (for PS Option Only)**				
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F314	Electromagnetic Fields &		ECE	F343	Communication Networks	3
			Microwave Engineering	3	ECE	F344	Information Theory &	
	ECE	F434	Digital Signal Processing	4			Coding	3
			Discipline Electives	4(min)			Discipline Electives	5(min)
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	3			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				8/14				**15/20**

Discipline Core-48 Units (14 Courses)

Discipline Electives-12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Electronics & Computer Engineering Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	ECOM	F213	Object Oriented Programming	4	MGTS	F211	Principles of Management	3
	ECOM	F214	Electronic Devices	3	ECOM	F211	Data Structures and Algorithms	4
	ECOM	F215	Digital Design	4	ECOM	F241	Microprocessors and Interfacing	4
	ECOM	F222	Discrete Structures for Computer Science	3	ECOM	F242	Control Systems	3
					ECOM	F243	Signals & Systems	3
					ECOM	F244	Microelectronic Circuits	3
					BITS	F225	Environmental Studies	3
				20(min)				**23(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	6 to 9
	ECOM	F313	Analog & Digital VLSI Design	3	ECOM	F321	Real Time Operating Systems	4
	ECOM	F342	Computer Architecture	4	ECOM	F462	Network Programming	3
	ECOM	F343	Communication Networks	3				
			Discipline Electives	3(min)			Discipline Electives	6(min)
				16/19				**19/22**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	3			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to 18
				8/14				**15/20**

Discipline Core- 48 Units (14 Courses)

Discipline Electives-12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2023 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Electronics and Instrumentation Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	INSTR	F211	Electrical Machines	4	MGTS	F211	Principles of Management	3
	INSTR	F212	Electromagnetic Theory	3			Humanities Electives	3(min)
	INSTR	F215	Digital Design	4	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F214	Electronic Devices	3	INSTR	F242	Control Systems	3
					INSTR	F243	Signals & Systems	3
					INSTR	F244	Microelectronic Circuits	3
					BITS	F225	Environmental Studies	3
				20(min)				**22(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3to6			Open/Humanities Electives	3to6
	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
					INSTR	F342	Power Electronics	4
	INSTR	F312	Transducers & Measurement Systems	3	INSTR	F343	Industrial Instrumentation & Control	3
	INSTR	F313	Analog & Digital VLSI Design	3			Discipline Electives	4(min)
			Discipline Electives	5(min)				
				18/21				**18/21**
IV			Open Electives	5to11	BITS	F412	Practice School-II	20
			Discipline Electives	3			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15to18
				8/14				**15/20**

Discipline Core- 48 Units (14 Courses)

Discipline Electives-12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Mechanical Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BITS	F110	Engineering Graphics	2	BITS	F111	Thermodynamics	3
	BIO	F110	Biology Laboratory	1	BITS	F112	Technical Report Writing	2
	BIO	F111	General Biology	3	CS	F111	Computer Programming	4
	CHEM	F110	Chemistry Laboratory	1	EEE	F111	Electrical Sciences	3
	CHEM	F111	General Chemistry	3	MATH	F112	Mathematics II	3
	MATH	F111	Mathematics I	3	MATH	F113	Probability and Statistics	3
	PHY	F110	Physics Laboratory	1	ME	F112	Workshop Practice	2
	PHY	F111	Mechanics, Oscillations and Waves	3				
				17				**20**
II	MATH	F211	Mathematics III	3	BITS	F225	Environmental Studies	3
	ME	F211	Mechanics of Solids	3	ECON	F211	Principles of Economics	3
	ME	F212	Fluid Mechanics	3			or	or
	ME	F216	Materials Science & Engineering	3	MGTS	F211	Principles of Management	3
	ME	F217	Applied Thermodynamics	4	ME	F218	Advanced Mechanics of Solids	2
			Humanities Electives	3(min)	ME	F219	Manufacturing Processes	4
					ME	F220	Heat Transfer	4
					ME	F221	Mechanisms and Machines	3
							Humanities Electives	3(min)
				19(min)				**22(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	1 to 4			Open/Humanities Electives	3 to 6
	ME	F314	Design of Machine Elements	3	ME	F318	Computer-Aided Design	3
	ME	F315	Advanced Manufacturing Processes	3	ME	F319	Vibrations & Control	3
	ME	F316	Manufacturing Management	2	ME	F320	Engineering Optimization	3
	ME	F317	Engines, Motors, and Mobility	2	ME	F341	Prime Movers & Fluid Machines	3
			Discipline Electives	6(min)			Discipline Electives	3(min)
				17/20				**18/21**
IV			Open Electives	7to13	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				10/16				**15/20**

Discipline Core - 48 Units (16 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is an operative pattern for the students who are admitted from August 2019 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Manufacturing Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BITS	F110	Engineering Graphics	2	BITS	F111	Thermodynamics	3
	BIO	F110	Biology Laboratory	1	BITS	F112	Technical Report Writing	2
	BIO	F111	General Biology	3	CS	F111	Computer Programming	4
	CHEM	F110	Chemistry Laboratory	1	EEE	F111	Electrical Sciences	3
	CHEM	F111	General Chemistry	3	MATH	F112	Mathematics II	3
	MATH	F111	Mathematics I	3	MATH	F113	Probability and Statistics	3
	PHY	F110	Physics Laboratory	1	ME	F112	Workshop Practice	2
	PHY	F111	Mechanics, Oscillations and Waves	3				
				17				**20**
II	MATH	F211	Mathematics III	3	BITS	F225	Environmental Studies	3
	MF	F211	Mechanics of Solids	3	ECON	F211	Principles of Economics	3
	MF	F216	Materials Science & Engineering	3			or	or
	MF	F217	Machine Drawing	2	MGTS	F211	Principles of Management	3
	MF	F218	Transport Phenomena in Manufacturing	4	MF	F219	Operations Management	3
			Humanities Electives	3(min)	MF	F220	Metrology and Quality Assurance	3
					MF	F221	Mechanisms and Machines	3
					MF	F222	Casting, Forming and Welding	4
							Humanities Electives	3(min)
				18(min)				**22(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	2 to 5			Open/Humanities Electives	2 to 5
	MF	F314	Design of Machine Elements	3	MF	F317	Computer Aided Design and Manufacturing	3
	MF	F315	Automation and Control	4	MF	F318	Non Traditional Manufacturing Processes	3
	MF	F316	Machining and Machine Tools	4	MF	F319	Supply Chain Management	3
			Discipline Electives	6(min)	MF	F320	Engineering Optimization	3
							Discipline Electives	3(min)
				19/22				**17/20**
IV			Open Electives	7 to 13	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to18
				10/16				**15/20**

Discipline Core - 48 Units (15 Courses)
Discipline Electives - 12 Units (4 Courses)

Note: This is an operative pattern for the students who are admitted from August 2019 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B. Pharm. Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	PHA	F211	Pharmaceutical Analysis	3	MGTS	F211	Principles of Management	3
	PHA	F214	Anatomy, Physiology & Hygiene	3			Humanities Electives	3(min)
					PHA	F241	Pharmaceutical Chemistry	3
	PHA	F216	Pharmaceutical Formulations I	3	PHA	F242	Biological Chemistry	3
	PHA	F217	Pharmaceutical Microbiology	3	PHA	F243	Industrial Pharmacy	3
	BITS	F225	Environmental Studies	3	PHA	F244	Physical Pharmacy	3
				21(min)				**18(min)**
Summer	**BITS F221 Practice School – I**				**(for PS Option Only)**			
III			Open/Humanities Electives	2 to 5			Open/Humanities Electives	4 to 6
	PHA	F311	Pharmacology I	3	PHA	F341	Pharmacology II	3
	PHA	F312	Medicinal Chemistry I	3	PHA	F342	Medicinal Chemistry II	3
	PHA	F313	Instrumental Methods of Analysis	4	PHA	F343	Forensic Pharmacy	2
	PHA	F315	Pharmaceutical Formulations II	3	PHA	F344	Natural Drugs	3
			Discipline Electives	3(min)			Discipline Electives	3(min)
				18/21				**18/20**
IV			Open Electives	6 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	6(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				12/17				**15/20**

Discipline Core - 48 Units (16 Courses)

Discipline Electives-12 Units(4 Courses)

Note: This is operative pattern for the students who are admitted during 2011-2013 as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B. Pharm. Programme						
Year	**First Semester**		**U**	**Second Semester**		**U**
I	BIO F110	Biology Laboratory	1	BITS F114	General Mathematics II*	3
	BIO F111	General Biology	3	OR		
	CHEM F110	Chemistry Laboratory	1	MATH F112	Mathematics II	
	CHEM F111	General Chemistry	3	ME F112	Workshop Practice	2
	BITS F113	General Mathematics I*	3	CS F111	Computer Programming	4
	OR			PHA F214	Anatomy, Physiology, &	3
	MATH F111	Mathematics I			Hygiene	
	PHY F110	Physics Laboratory	1	PHA F216	Pharmaceutical Formulations I	3
	PHY F112	General Physics	3	BITS F112	Technical Report Writing	2
	OR			MGTS F211	Principles of Management	
	PHY F111	Mechanics, Oscillations and Waves		OR		3
				ECON F211	Principles of Economics	
	BITS F110	Engineering Graphics	2			
			17			**20**
II	Humanities Electives		3	Humanities Electives		3
	BITS F218	General Mathematics III*	3	BITS F111	Thermodynamics	3
	OR			PHA F241	Pharmaceutical Chemistry	3
	MATH F211	Mathematics III		MATH F113	Probability and Statistics	3
	PHA F211	Pharmaceutical Analysis	3	PHA F215	Introduction to Molecular	
	BITS F219	Process Engineering	3		Biology and Immunology	3
	PHA F242	Biological Chemistry	3	PHA F244	Physical Pharmacy	3
	PHA F217	Pharmaceutical Microbiology	3			
	BITS F225	Environmental Studies	3			
			21			**18**
Summer BITS F221 Practice School I (5 Units) Only for PS Option						
III	Open/Humanities Electives		2 to 5	Open/Humanities electives		4 to 6
	PHA F311	Pharmacology I	3	PHA F341	Pharmacology II	3
	PHA F312	Medicinal Chemistry I	3	PHA F342	Medicinal Chemistry II	3
	PHA F313	Instrumental Methods of Analysis	4	PHA F343	Forensic Pharmacy	2
				PHA F344	Natural Drugs	3
	PHA F315	Pharmaceutical Formulations II	3	Discipline Electives		3(min)
	Discipline Electives		3 (min)			
			18 /21			**18 /20**
IV	Open electives		6to11	BITS F412 Practice School II		20
	Discipline Electives		6 (min)	OR		
				BITS F421T Thesis (16) or Thesis (9) and Electives (6 to 9)		16 or 15 to 18
			12/17			**15/20**

Discipline Core -48 Units (16 Courses)

Discipline Electives- 12 Units (4 Courses)

* A student must pursue all three courses in one sequence only (i.e. either Mathematics I, Mathematics II, and Mathematics III, or General Mathematics, General Mathematics II, and General Mathematics III).

Note: This is operative pattern for the students who are admitted from August 2014 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. Biological Sciences Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	BIO	F211	Biological Chemistry	3	MGTS	F211	Principles of Management	3
	BIO	F213	Cell Biology	3			Humanities Electives	3(min)
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
	BITS	F225	Environmental Studies	3	BIO	F243	Genetics	3
					BIO	F244	Instrumental Methods of Analysis	4
				22(min)				**19(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	0 to 3
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
					BIO	F342	Immunology	3
	BIO	F312	Plant Physiology	3	BIO	F215	Biophysics	3
	BIO	F313	Animal Physiology	3			Discipline Electives	9(min)
			Discipline Electives	6(min)				
				18/21				**18/21**
IV			Open Electives	8 to14	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to18
				8/14				**15/20**

*****Discipline Core - 44 Units (14 Courses)

*Discipline Electives - 15 Units (min)-(4 Courses (min))

Note: *This is operative pattern for the students who are admitted from August 2013 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. Chemistry Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	CHEM	F211	Physical Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F212	Organic Chemistry I	3			Humanities Electives	3(min)
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	
	PHY	F212	Electromagnetic Theory I	3	CHEM	F242	Chemical Experimentation I	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F243	Organic Chemistry II	3
					CHEM	F244	Physical Chemistry III	3
					BITS	F225	Environmental Studies	3
				21(min)				**21(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	2 to 5			Open/Humanities Electives	2 to 5
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
					CHEM	F342	Organic Chemistry IV	3
	CHEM	F311	Organic Chemistry III	3	CHEM	F343	Inorganic Chemistry III	3
	CHEM	F312	Physical Chemistry IV	3			Discipline Electives	6(min)
			Discipline Electives	6(min)				
				18/21				**18/21**
IV			Open Electives	7 to13	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to18
				7/13				**15/20**

Discipline Core-47 Units (15 Courses)

Discipline Electives-12 Units(4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M. Sc. Economics Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
			Humanities Electives	3(min)			Humanities Electives	3(min)
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
	BITS	F225	Environmental Studies	3				
				21(min)				**18(min)**
Summer			**BITS F221 Practice School – I (for PS Option Only)**					
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
			Discipline Electives	6(min)			Discipline Electives	6(min)
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	6			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15to18
				11/17				**15/20**

Discipline Core -42 Units (14 Courses)

Discipline Electives -18 Units(6 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. Mathematics Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	MATH	F212	Optimization	3	MGTS	F211	Principles of Management	3
	MATH	F213	Discrete Mathematics	3			Humanities Electives	3(min)
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
	BITS	F225	Environmental Studies	3	MATH	F243	Graphs & Networks	3
					MATH	F244	Measure & Integration	3
				21(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities	
	MATH	F311	Introduction to Topology	3			Electives	0 to 3
	MATH	F312	Ordinary Differential		MATH	F341	Introduction to Functional	
			Equations	3			Analysis	3
	MATH	F313	Numerical Analysis	3	MATH	F342	Differential Geometry	3
			Discipline Electives	6	MATH	F343	Partial Differential Equations	3
							Discipline Electives	9
				18/21				**18/21**
IV			Open Electives	8 to14	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to18
				8/14				**15/20**

Discipline Core -42 Units (14 Courses)

Discipline Electives -15 Units (5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M. Sc. Physics Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	PHY	F211	Classical Mechanics	4	MGTS	F211	Principles of Management	3
	PHY	F212	Electromagnetic Theory I	3			Humanities Electives	3(min)
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
					PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
				21(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
			Discipline Electives	6(min)	PHY	F344	Advanced Physics Laboratory	3
							Discipline Electives	3(min)
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	6(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				11/17				**15/20**

*****Discipline Core - 45 Units (15 Courses)

*Discipline Electives - 15 Units (min)-4 Courses(min)

Note: *This is operative pattern for the students who are admitted from August 2014 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. General Studies – Communication and Media Studies Stream								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	GS	F221	Business Communication	3	MGTS	F211	Principles of Management	3
	GS	F222	Language Lab Practice	3			Humanities Electives	3(min)
	GS	F223	Introduction to Mass Communication	3	GS	F244	Reporting & Writing for Media	3
	GS	F224	Print & Audio Visual Advertising	3	GS	F241	Creative Writing	3
					GS	F245	Effective Public Speaking	3
	BITS	F225	Environmental Studies	3	GS	F243	Current Affairs	3
				21(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	GS	F321	Mass Media Content & Design	3	GS	F342	Computer Mediated Communication	3
	GS	F322	Critical Analysis of Literature & Cinema	3	GS	F343	Short Film & Video Production	3
			Discipline Electives	9(min)			Discipline Electives	9(min)
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to18
				8/14				**15/20**

Discipline Core - 36 Units (12 Courses)

Discipline Electives - 21 Units(7 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. General Studies – Development Studies Stream								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
			Humanities Electives	3(min)			Humanities Electives	3(min)
	GS	F211	Modern Political Concepts	3	GS	F231	Dynamics of Social Change	3
	GS	F212	Environment, Development & Climate Change	3	GS	F232	Introductory Psychology	3
	GS	F213	Development Theories	3	GS	F233	Public Policy	3
	ECON	F211	Principles of Economics	3	GS	F234	Development Economics	3
	BITS	F225	Environmental Studies	3				
				21(min)				18(min)
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	0 to 3
	GS	F311	Introduction to Conflict Management	3	GS	F331	Techniques in Social Research	3
	GS	F312	Applied Philosophy	3	GS	F332	Contemporary India	3
			Discipline Electives	9(min)	GS	F333	Public Administration	3
					GS	F334	Global Business Technology & Knowledge Sharing	3
							Discipline Electives	6(min)
				18/21				**18/21**
IV			Open Electives	8 to 14	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				8/14				**15/20**

Discipline Core - 42 Units (14 Courses)

Discipline Electives - 15 Units (5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pattern 1 Semester-wise Pattern for Composite Dual Degree Programmes (Option A: Duration 10 Sem.)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations		BITS	F111	Thermodynamics	3
	BITS	F110	and Waves	3				
			Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			First Discipline Core				or	
			Courses	13 to 17	MGTS	F211	Principles of Management	
			Electives	3 to 6			First Discipline Core	
							Courses	13 to 17
							Electives	3 to 6
				23/24				**23/24**
Summer	**BITS F221 Practice School – I(for PS Option Only)**							
III			Second Discipline Core				Second Discipline Core	
			courses	12 to 16			Courses	12 to 16
			First Discipline Courses-Core/Elective	7 to 11			First Discipline Courses – Core / Elective	7 to 11
				23/24				**23/24**
IV			First Discipline Elective Courses	3 to 10			First Discipline Elective Courses	3to10
			Second Discipline Courses – Core + Elective	14 to 18			Second Discipline Courses - Core + Elective	14 to 18
							Electives (0 to 6)	0 to 6
				23/24				**23/24**
V			Electives	5 to 9	BITS	F412	Practice School-II	20
	BITS	F423T	Thesis	9			or	or
					BITS	F421T	Thesis	16

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pattern 2	**Semester-wise Pattern for Composite Dual Degree Programmes (Option B: Duration 10 Sem. and a Summer Term)**							
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	4
	BITS	F110	Engineering Graphics(2)	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	
							or	
			First Discipline Core Courses	13 to 17	MGTS	F211	Principles of Management	3
			Electives	3 to 6			First Discipline Core Courses	13 to 17
							Electives	3 to 6
				23/24				**23/24**
Summer	**BITS F221 Practice School – I(for PS Option Only)**							
III			Second Discipline Core Courses	12 to 16			Second Discipline Core Courses	12 to 16
			First Discipline Courses - Core / Elective	7 to 11			First Discipline Courses - Core / Elective	7 to 11
				23/24				**23/24**
IV			First Discipline Elective Courses	3/10			First Discipline Elective Courses	3 to 10
			Second Discipline Courses – Core + Elective	14 to 18			Second Discipline Courses - Core + Elective	14 to 18
			Electives	0 to 6			Electives	0 to 6
				23/24				**23/24**
Summer			Electives	5/9				
V	BITS	F412	Practice School - II	20	BITS	F413	Practice School - II	20
			or	or			or	or
	BITS	F421 T	Thesis	16	BITS	F422	Thesis	16

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pattern 3 Semesterwise Pattern for Dual Degree (Duration 11 Sem.)							
Year	**First Semester**		**U**	**Second Semester**			**U**
I	BIO F110	Biology laboratory	1	MATH F112	Mathematics II		3
	BIO F111	General Biology	3	ME F112	Workshop Practice		2
	CHEMF110	Chemistry Laboratory	1	CS F111	Computer Programming		4
	CHEM F111	General Chemistry	3	EEE F111	Electrical Sciences		3
	MATH F111	Mathematics I	3	BITS F112	Technical Report Writing		2
	PHY F110	Physics Laboratory	1	MATH F113	Probability and Statistics		3
	PHY F111	Mechanics, Oscillations and Waves	3	BITS F111	Thermodynamics		3
	BITS F110	Engineering Graphics	2				
			17				**20**
II	MATH F211	Mathematics III	3	ECON F211	Principles of Economics		13
		First Discipline Core Courses	13 to 17		or		
				MGTS F211	Principles of Management		
		Electives	3 to 6		First Discipline Core Courses		13 to 17
					Electives		3 to 6
			21/22				**21/22**
Summer		**BITS F221 Practice School – I (for PS Option Only)**					
III		Second Discipline Core courses	12 to 16		Second Discipline Core		
		First Discipline Courses -			Courses		12 to 16
		Core/Elective	7 to 10		First Discipline Courses – Core / Elective		7to11
			21/22				**21/22**
IV		First Discipline Elective Courses	3 to 10		First Discipline Elective Courses		3 to10
		Second Discipline Courses – Core+Elective	14 to 18		Second Discipline Courses - Core + Elective		14 to 18
		Electives	0 to 6		Electives		0 to 6
			21/22				**21/22**
V		Electives	17 to 23	BITS F412	Practice School-II		20
					or		or
				BITS F421T	Thesis		16
VI	BITS F413	Practice School-II	20				
		or	or				
	BITS F422T	Thesis	16				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Chemical)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics/	3
	BIO	F211	Biological Chemistry	3			Principles of Management	
	BIO	F213	Cell Biology	3	BIO	F241	Ecology & Environmental	
	BIO	F212	Microbiology	4			Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to	
			Humanities Elective	3			Bioinformatics	3
	BITS	F225	Environmental Studies	3	BIO	F243	Genetics	3
					BIO	F244	Instrumental Methods of	
							Analysis	4
							Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA	3	BIO	F341	Developmental Biology	3
			Technology		BIO	F342	Immunology	3
	BIO	F312	Plant Physiology	3	BIO	F215	Biophysics	3
	BIO	F313	Animal Physiology	3	CHE	F241	Heat Transfer	3
	CHE	F211	Chemical Process Calculations	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F212	Fluid Mechanics	3	CHE	F243	Material Science &	
	CHE	F214	Engineering Chemistry	3			Engineering	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F244	Separation Processes I	3
				21				**21**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering		CHE	F342	Process Dynamics & Control	3
			Laboratory I	3	CHE	F343	Process Design Principles II	3
	CHE	F313	Separation Processes II	3			First Discipline Electives	9
	CHE	F314	Process Design Principles I	3			Second Discipline Electives	6
			First Discipline Electives	6				
			Second Discipline Electives	3				
				21				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412		Practice School - Ii	20
	BITS F423T		Thesis	9				
				15				**20**

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Civil)									
Year	**First Semester**				**U**	**Second Semester**			**U**
I	Same as First degree Programme					Same as First degree Programme			
	First Semester				**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III		3	ECON	F211	Principles of Economics	
	BIO	F211	Biological Chemistry		3			or	
	BIO	F213	Cell Biology		3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology		4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology		3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective		3	BIO	F243	Genetics	3
	BITS	F225	Environmental Studies		3	BIO	F244	Instrumental Methods of Analysis	4
								Humanities Electives	5
					22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**								
	First Semester				**U**	**Second Semester**			**U**
III	BIO	F311	Recombinant DNA Technology		3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology		3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology		3	BIO	F215	Biophysics	3
	CE	F211	Mechanics of Solids		3	CE	F241	Analysis of structures	3
	CE	F231	Fluid Mechanics		3	CE	F242	Construction Planning & Technology	3
	CE	F230	Civil Engineering Materials		4	CE	F243	Soil Mechanics	4
	CE	F213	Surveying		4	CE	F244	Highway Engineering	4
					23				**23**
	First Semester				**U**	**Second Semester**			**U**
IV	CE	F320	Design of Reinforced Concrete Structures		3	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering		4	CE	F321	Engineering Hydrology	**3**
	CE	F313	Foundation Engineering		3	CE	F343	Design of Steel Structures	3
			First Discipline Electives		6			First Discipline Electives	9
			Second Discipline Electives		6			Second Discipline Electives	3
					22				**22**
V	**First Semester**				**U**	**Second Semester**			**U**
	Second Discipline Electives				3	BITS F412 Practice School - II			20
	BITS F423T		Thesis		9				

Note: This is operative pattern for the students who are admitted from **August 2017** onwards.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Biological Sciences with B.E. Computer Science)

Year	First Semester			U	Second Semester			U
I	Same as First degree Programme				Same as First degree Programme			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
					BIO	F243	Genetics	3
			Humanities Elective	3	BIO	F244	Instrumental Methods of Analysis	4
	BITS	F225	Environmental Studies	3			Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
	First Semester			**U**	**Second Semester**			**U**
III	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
	CS	F214	Logic in Computer Science	3	CS	F212	Database Systems	4
	CS	F222	Discrete Structures for Computer Science	3	CS	F211	Data Structures & Algorithms	4
	CS	F213	Object Oriented Programming	4				
				23				**21**
	First Semester			**U**	**Second Semester**			**U**
IV	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
	CS	F301	Principles of Programming Languages	2			First Discipline Elective	9
			First Discipline Electives	6			Second Discipline Electives	3
			Second Discipline Electives	3				
				21				**22**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412		Practice School - II	20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Electrical & Electronics)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
	BITS	F225	Environmental Studies	3	BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	`5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	EEE	F212	Electromagnetic Theory	3	EEE	F243	Signals and Systems	3
	EEE	F211	Electrical Machines	4	EEE	F244	Microelectronic Circuits	3
	EEE	F214	Electronic Devices	3	EEE	F241	Microprocessors & Interfacing	4
	EE	F215	Digital Design	4	EEE	F242	Control Systems	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	EEE	F311	Communication Systems	4	EEE	F341	Analog Electronics	4
	MATH	F212	Optimization	3	EEE	F342	Power Electronics	4
			or	or	EEE	F312	Power Systems	3
	ME	F344	Engineering Optimization	2			First Discipline Electives	6
	EEE	F313	Analog & Digital VLSI Design	3			Second Discipline Elective	4
			First Discipline Electives	3				
			Second Discipline Electives	8				
				20/21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Electronics & Computer Engineering)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F212	Microbiology	4	MGTS	F211	Principles of Management	3
	BIO	F213	Cell Biology	3	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
					BIO	F243	Genetics	3
			Humanities Elective	3	BIO	F244	Instrumentation of Analysis	4
	BITS	F225	Environmental Studies	3			Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	ECOM	F213	Object Oriented Programming	4	ECOM	F211	Data Structures and Algorithms	4
	ECOM	F214	Electronic Devices	3	ECOM	F241	Microprocessor and Interfacing	4
	ECOM	F215	Digital Design	4	ECOM	F242	Control Systems	3
	ECOM	F222	Discrete Structures for Computer Science	3	ECOM	F243	Signals & Systems	3
				23				**23**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ECOM	F313	Analog & Digital VLSI Design	3	ECOM	F244	Microelectronic Circuits	3
	ECOM	F342	Computer Architecture	4	ECOM	F321	Real Time Operating Systems	4
	ECOM	F343	Communication Networks	3	ECOM	F462	Network Programming	3
			First Discipline Electives	9			First Discipline Elective	6
			Second Discipline Electives	3			Second Discipline Electives	3
				22				**19**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2023 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Electronics & Communication)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
					BIO	F243	Genetics	3
			Humanities Elective	3	BIO	F244	Instrumentation of Analysis	4
	BITS	F225	Environmental Studies	3			Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	ECE	F212	Electromagnetic Theory	3	ECE	F241	Microprocessors & Interfacing	4
	ECE	F215	Digital Design	4	ECE	F242	Control Systems	3
	ECE	F211	Electrical Machines	4	ECE	F243	Signals and Systems	3
	ECE	F214	Electronic Devices	3	ECE	F244	Microelectronic Circuits	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F434	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	3			First Discipline Elective	6
			Second Discipline Electives	7			Second Discipline Electives	5
				21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Electronics & Instrumentation)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
	BITS	F225	Environmental Studies	3	BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	INSTR	F212	Electromagnetic Theory	3	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F215	Digital Design	4	INSTR	F242	Control Systems	3
	INSTR	F211	Electrical Machines	4	INSTR	F243	Signals & Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F244	Microelectronic Circuits	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
					INSTR	F342	Power Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F343	Industrial Instrumentation & Control	3
	INSTR	F313	Analog & Digital VLSI Design	3			First Discipline Electives	6
			First Discipline Electives	9			Second Discipline Electives	4
			Second Discipline Electives	3				
				22				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			5	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Manufacturing)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
	BITS	F225	Environmental Studies	3	BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	MF	F211	Mechanics of Solids	3	MF	F219	Operations Management	3
	MF	F216	Materials Science & Engineering	3	MF	F220	Metrology and Quality Assurance	3
	MF	F217	Machine Drawing	2	MF	F221	Mechanisms and Machines	3
	MF	F218	Transport Phenomena in Manufacturing	4	MF	F222	Casting, Forming and Welding	4
				21				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	MF	F314	Design of Machine Elements	3	MF	F317	Computer Aided Design and Manufacturing	3
	MF	F315	Automation and Control	4	MF	F318	Non Traditional Manufacturing Processes	3
	MF	F316	Machining and Machine Tools	4	MF	F319	Supply Chain Management	3
			First Discipline Electives	9	MF	F320	Engineering Optimization	3
			Second Discipline Elective	3			First Discipline Electives	6
							Second Discipline Elective	3
				23				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2019 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Mechanical)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
	BITS	F225	Environmental Studies	3	BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
	First Semester			**U**	**Second Semester**			**U**
III	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	ME	F211	Mechanics of Solids	3	ME	F218	Advanced Mechanics of Solids	2
	ME	F212	Fluid Mechanics	3	ME	F219	Manufacturing Processes	4
	ME	F216	Materials Science & Engineering	3	ME	F220	Heat Transfer	4
	ME	F217	Applied Thermodynamics	4	ME	F221	Mechanisms and Machines	3
				22				**22**
	First Semester			**U**	**Second Semester**			**U**
IV	ME	F314	Design of Machine Elements	3	ME	F318	Computer-Aided Design	3
	ME	F315	Advanced Manufacturing Processes	3	ME	F319	Vibrations & Control	3
	ME	F316	Manufacturing Management	2	ME	F320	Engineering Optimization	3
	ME	F317	Engines, Motors, and Mobility	2	ME	F341	Prime Movers & Fluid Machines	3
			First Discipline Electives	9			First Discipline Electives	6
			Second Discipline Electives	3			Second Discipline Electives	3
				22				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2019 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Chemical)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
II	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
					CHEM	F342	Organic Chemistry IV	3
	CHEM	F311	Organic Chemistry III	3	CHEM	F343	Inorganic Chemistry III	3
	CHEM	F312	Physical Chemistry IV	3	CHE	F241	Heat Transfer	3
III	CHE	F211	Chemical Process Calculations	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F212	Fluid Mechanics	3	CHE	F243	Material Science & Engineering	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F244	Separation Processes I	3
				19				**22**
	First Semester			**U**	**Second Semester**			**U**
	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering	
	CHE	F312	Chemical Engineering Laboratory I	3			Laboratory II	3
IV	CHE	F313	Separation Processes II	3	CHE	F342	Process Dynamics & Control	3
	CHE	F314	Process Design Principles I	3	CHE	F343	Process Design Principles II	3
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Electives	3			Second Discipline Electives	6
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS	F423T	Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Civil)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of structures	3
	CE	**F231**	**Fluid Mechanics**	**3**	CE	F242	Construction Planning & Technology	3
	CE	**F230**	**Civil Engineering Materials**	**4**	CE	F243	Soil Mechanics	4
	CE	F213	Surveying	4	CE	F244	Highway Engineering	4
				24				**24**
	First Semester			**U**	**Second Semester**			**U**
IV	**CE**	**F320**	**Design of Reinforced Concrete Structures**	**3**	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering	4	**CE**	**F321**	**Engineering Hydrology**	**3**
	CE	F313	Foundation Engineering	3				
			First Discipline Electives	6	CE	F343	Design of Steel Structures	3
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	6
				19				**22**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from **August 2017** onwards.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Computer Science)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
	CS	F214	Logic in Computer Science	3	CS	F212	Database Systems	4
	CS	F222	Discrete Structures For Computer Science	3	CS	F211	Data Structures & Algorithms	4
	CS	F213	Object Oriented Programming	4				
				24				**22**
	First Semester			**U**	**Second Semester**			**U**
IV	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of	
	CS	F342	Computer Architecture	4			Algorithms	3
	CS	F301	Principles of		CS	F303	Computer Networks	4
			Programming Languages	2			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	3
			Second Discipline Electives	3				
				21				**19**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Electrical & Electronics)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
II	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3		F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
					CHEM		Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
III	EEE	F211	Electrical Machines	4	EEE	F243	Signals and Systems	3
	EEE	F214	Electronic Devices	3	EEE	F244	Microelectronic Circuits	3
	EEE	F215	Digital Design	4	EEE	F241	Microprocessors & Interfacing	4
					EEE	F242	Control Systems	3
				21				**23**
	First Semester			**U**	**Second Semester**			**U**
	EEE	F311	Communication	4	EEE	F341	Analog Electronics	4
			Systems		EEE	F342	Power Electronics	4
	MATH	F212	Optimization	3	EEE	F312	Power Systems	3
			or				First Discipline Elective	6
IV	ME	F344	Engineering Optimization	2			Second Discipline Elective	4
	EEE	F313	Analog & Digital VLSI Design	3				
			First Discipline Electives	6				
			Second Discipline Electives	5				
				20/21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes M.Sc. Chemistry with B.E. Electronics & Communication									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
II	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
III	ECE	F215	Digital Design	4	ECE	F241	Microprocessors &	
	ECE	F211	Electrical Machines	4			Interfacing	4
	ECE	F214	Electronic Devices	3	ECE	F242	Control Systems	3
					ECE	F243	Signals and Systems	3
					ECE	F244	Microelectronic Circuits	3
				21				**23**
	First Semester			**U**	**Second Semester**			**U**
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F434	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
IV	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Electives	4			Second Discipline Electives	5
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
M.Sc. Chemistry with B.E. Electronics & Computer Engineering

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	ECOM	F213	Object Oriented Programming	4	ECOM	F211	Data Structures and Algorithms	4
	ECOM	F214	Electronic Devices	3	ECOM	F241	Microprocessor and Interfacing	4
	ECOM	F215	Digital Design	4	ECOM	F242	Control Systems	3
	ECOM	F222	Discrete Structures for Computer Science	3	ECOM	F243	Signals & Systems	3
				24				**24**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ECOM	F313	Analog & Digital VLSI Design	3	ECOM	F244	Microelectronic Circuits	3
	ECOM	F342	Computer Architecture	4	ECOM	F321	Real Time Operating Systems	4
	ECOM	F343	Communication Networks	3	ECOM	F462	Network Programming	3
			First Discipline Electives	9			First Discipline Electives	6
			Second Discipline Electives	3			Second Discipline Electives	3
				22				**19**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2023 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Electronics & Instrumentation)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3	MGTS	F211	or	
	CHEM	F212	Organic Chemistry I	3			Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
II	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
III	INSTR	F215	Digital Design	4	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F211	Electrical Machines	4	INSTR	F242	Control Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F243	Signals & Systems	3
					INSTR	F244	Microelectronic Circuits	3
				21				**23**
	First Semester			**U**	**Second Semester**			**U**
	INSTR	F311	Electronic Instruments &		INSTR	F341	Analog Electronics	4
			Instrumentation Technology	4	INSTR	F342	Power Electronics	4
IV	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F343	Industrial Instrumentation & Control	3
	INSTR	F313	Analog & Digital VLSI Design	3			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	4
			Second Discipline Electives	5				
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Manufacturing)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	MF	F211	Mechanics of Solids	3	MF	F219	Operations Management	3
	MF	F216	Materials Science & Engineering	3	MF	F220	Metrology and Quality Assurance	3
	MF	F217	Machine Drawing	2	MF	F221	Mechanisms and Machines	3
	MF	F218	Transport Phenomena in Manufacturing	4	MF	F222	Casting, Forming and Welding	4
				22				**23**
	First Semester			**U**	**Second Semester**			**U**
IV	MF	F314	Design of Machine Elements	3	MF	F317	Computer Aided Design and Manufacturing	3
	MF	F315	Automation and Control	4	MF	F318	Non Traditional Manufacturing Processes	3
	MF	F316	Machining and Machine Tools	4	MF	F319	Supply Chain Management	3
					MF	F320	Engineering Optimization	3
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Elective	6			Second Discipline Elective	3
				23				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2019 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Chemistry with B.E. Mechanical)

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
II	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
III	ME	F211	Mechanics of Solids	3	ME	F218	Advanced Mechanics of Solids	2
	ME	F212	Fluid Mechanics	3	ME	F219	Manufacturing Processes	4
	ME	F216	Materials Science & Engineering	3	ME	F220	Heat Transfer	4
	ME	F217	Applied Thermodynamics	4	ME	F221	Mechanisms and Machines	3
				23				**23**
	First Semester			**U**	**Second Semester**			**U**
	ME	F314	Design of Machine Elements	3	ME	F318	Computer-Aided Design	3
	ME	F315	Advanced Manufacturing Processes	3	ME	F319	Vibrations & Control	3
	ME	F316	Manufacturing Management	2	ME	F320	Engineering Optimization	3
IV	ME	F317	Engines, Motors, and Mobility	2	ME	F341	Prime Movers & Fluid Machines	3
			First Discipline Electives	6				
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	3
				19				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2019 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Chemical)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
			First Discipline Elective	3			First Discipline Elective	3
	CHE	F211	Chemical Process Calculations	3	CHE	F241	Heat Transfer	3
	CHE	F212	Fluid Mechanics	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F214	Engineering Chemistry	3	CHE	F243	Material Science & Engineering	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F244	Separation Processes I	3
				24				**24**
	First Semester			**U**	**Second Semester**			**U**
IV	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F342	Process Dynamics & Control	3
	CHE	F313	Separation Processes II	3	CHE	F343	Process Design Principles II	3
	CHE	F314	Process Design Principles I	3			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	3				
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Civil)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of Structures	3
	CE	F213	Surveying	4	CE	F242	Construction Planning & Technology	3
	CE	F230	Civil Engineering Materials	4	CE	F243	Soil Mechanics	4
	CE	F231	Fluid Mechanics	3	CE	F244	Highway Engineering	4
				23				**23**
	First Semester			**U**	**Second Semester**			**U**
IV	CE	F312	Hydraulic Engineering	4	CE	F321	Engineering Hydrology	3
	CE	F313	Foundation Engineering	3	CE	F342	Water & Waste Water	4
	CE	F320	Design of Reinforced Concrete Structures	3	CE	F343	Design of Steel Structures	3
							First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	6				
				22				**22**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from **August 2017** onwards.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Computer Science)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
	CS	F214	Logic in Computer Science	3	CS	F212	Database Systems	4
	CS	F222	Discrete Structures for Computer Science	3	CS	F211	Data Structures & Algorithms	4
	CS	F213	Object Oriented Programming	4				
				23				**21**
	First Semester			**U**	**Second Semester**			**U**
IV	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
	CS	F301	Principles of Programming Languages	2			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	6				
				24				**22**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Electrical & Electronics)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Electives	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	EEE	F212	Electromagnetic Theory	3	EEE	F243	Signals and Systems	3
	EEE	F211	Electrical Machines	4	EEE	F244	Microelectronic Circuits	3
	EEE	F214	Electronic Devices	3	EEE	F241	Microprocessors & Interfacing	4
	EEE	F215	Digital Design	4	EEE	F242	Control Systems	3
				23				**22**
	First Semester			**U**	**Second Semester**			**U**
IV	EEE	F311	Communication Systems	4	EEE	F341	Analog Electronics	4
	MATH	F212	Optimization	3	EEE	F342	Power Electronics	4
			or		EEE	F312	Power Systems	3
	ME	F344	Engineering Optimization	2			First Discipline Electives	6
	EEE	F313	Analog & Digital VLSI Design	3			Second Discipline Elective	4
			First Discipline Electives	6				
			Second Discipline Electives	8				
				23/24				**21**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Electronics & Communication)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
II	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
III	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	ECE	F212	Electromagnetic Theory	3	ECE	F241	Microprocessors & Interfacing	4
	ECE	F215	Digital Design	4	ECE	F242	Control Systems	3
	ECE	F211	Electrical Machines	4	ECE	F243	Signals and Systems	3
	ECE	F214	Electronic Devices	3	ECE	F244	Microelectronic Circuits	3
				23				**22**
	First Semester			**U**	**Second Semester**			**U**
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F434	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
IV	ECE	F314	Electromagnetic Fields &		ECE	F343	Communication Networks	3
			Microwave Engineering	3			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	5
			Second Discipline Electives	7				
				24				**21**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Economics with B.E. Electronics & Computer Engineering)

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
II	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
III	ECOM	F213	Object Oriented Programming	4	ECOM	F211	Data Structures and Algorithms	4
	ECOM	F214	Electronic Devices	3	ECOM	F241	Microprocessor and Interfacing	4
	ECOM	F215	Digital Design	4	ECOM	F242	Control Systems	3
	ECOM	F222	Discrete Structures for Computer Science	3	ECOM	F243	Signals & Systems	3
				23				**22**
	First Semester			**U**	**Second Semester**			**U**
	ECOM	F313	Analog & Digital VLSI Design	3	ECOM	F244	Microelectronic Circuits	3
	ECOM	F342	Computer Architecture	4	ECOM	F321	Real Time Operating Systems	4
IV	ECOM	F343	Communication Networks	3	ECOM	F462	Network Programming	3
							First Discipline Electives	6
			First Discipline Electives	9			Second Discipline Electives	3
			Second Discipline Electives	3				
				22				**19**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2023 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Electronics & Instrumentation)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	INSTR	F212	Electromagnetic Theory	3	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F215	Digital Design	4	INSTR	F242	Control Systems	3
	INSTR	F211	Electrical Machines	4	INSTR	F243	Signals & Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F244	Microelectronic Circuits	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F342	Power Electronics	4
	INSTR	F313	Analog & Digital VLSI Design	3	INSTR	F343	Industrial Instrumentation & Control	3
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Electives	8			Second Discipline Electives	4
				24				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Manufacturing)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	MF	F211	Mechanics of Solids	3	MF	F219	Operations Management	3
	MF	F216	Materials Science & Engineering	3	MF	F220	Metrology and Quality Assurance	3
	MF	F217	Machine Drawing	2	MF	F221	Mechanisms and Machines	3
	MF	F218	Transport Phenomena in Manufacturing	4	MF	F222	Casting, Forming and Welding	4
							First Discipline Elective	3
				21				**25**
IV	**First Semester**			**U**	**Second Semester**			**U**
	MF	F314	Design of Machine Elements	3	MF	F317	Computer Aided Design and Manufacturing	3
	MF	F315	Automation and Control	4	MF	F318	Non Traditional Manufacturing Processes	3
	MF	F316	Machining and Machine Tools	4	MF	F319	Supply Chain Management	3
					MF	F320	Engineering Optimization	3
			First Discipline Electives	6			First Discipline Elective	3
			Second Discipline Electives	6			Second Discipline Electives	6
				23				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2019 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Mechanical)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance &	3	ECON	F242	Microeconomics	3
			Accounts		ECON	F243	Macroeconomics	3
II	ECON	F213	Mathematical & Statistical Methods	3	ECON	F244	Economics of Growth & Development	3
	ECON	F214	Economic Environment of Business	3			Humanities Electives	5
			Humanities Electives	3				
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
III	ME	F211	Mechanics of Solids	3	ME	F218	Advanced Mechanics of Solids	2
	ME	F212	Fluid Mechanics	3	ME	F219	Manufacturing Processes	4
	ME	F216	Materials Science & Engineering	3	ME	F220	Heat Transfer	4
	ME	F217	Applied Thermodynamics	4	ME	F221	Mechanisms and Machines	3
				22				**22**
	First Semester			**U**	**Second Semester**			**U**
	ME	F314	Design of Machine Elements	3	ME	F318	Computer-Aided Design	3
	ME	F315	Advanced Manufacturing Processes	3	ME	F319	Vibrations & Control	3
IV	ME	F316	Manufacturing Management	2	ME	F320	Engineering Optimization	3
	ME	F317	Engines, Motors, and Mobility	2	ME	F341	Prime Movers & Fluid Machines	3
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Electives	6			Second Discipline Electives	6
				22				**24**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6				
	BITS F423T		Thesis	9	BITS F412		Practice School - II	20

Note: This is operative pattern for the students who are admitted from August 2019 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Chemical)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
	BITS	F225	Environmental Studies	3	MATH	F244	Measure & Integration	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	CHE	F211	Chemical Process Calculations	3	CHE	F241	Heat Transfer	3
	CHE	F212	Fluid Mechanics	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F214	Engineering Chemistry	3	CHE	F243	Material Science & Engineering	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F244	Separation Processes I	3
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
IV	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F342	Process Dynamics & Control	3
	CHE	F313	Separation Processes II	3	CHE	F343	Process Design Principles II	3
	CHE	F314	Process Design Principles I	3			First Discipline Electives	9
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	3				
				21				**24**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Civil Engineering)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
	BITS	F225	Environmental Studies	3	MATH	F244	Measure & Integration	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of structures	3
	CE	F231	Fluid Mechanics	**3**	CE	F242	Construction Planning & Technology	3
	CE	F230	Civil Engineering Materials	**4**	CE	F243	Soil Mechanics	4
	CE	F213	Surveying	4	CE	F244	Highway Engineering	4
				23				**23**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CE	F320	Design of Reinforced Concrete Structures	**3**	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering	4	CE	F321	Engineering Hydrology	**3**
	CE	F313	Foundation Engineering	3	CE	F343	Design of Steel Structures	3
			First Discipline Electives	6			First Discipline Electives	9
			Second Discipline Electives	3			Second Discipline Electives	3
				19				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from **August 2017** onwards.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Computer Science)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
	BITS	F225	Environmental Studies	3	MATH	F244	Measure & Integration	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional	
	MATH	F312	Ordinary Differential Equations	3			Analysis	3
					MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
	CS	F214	Logic in Computer Science	3	CS	F212	Database Systems	4
	CS	F213	Object Oriented Programming	4	CS	F211	Data Structures & Algorithms	4
				20				**21**
	First Semester			**U**	**Second Semester**			**U**
IV	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
	CS	F301	Principles of Programming Languages	2			Fist Discipline Elective	6
			First Discipline Electives	3			Second Discipline Electives	6
			Second Discipline Electives	6				
				21				**22**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Electrical & Electronics)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
II	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
					MATH	F243	Graphs & Networks	3
			Humanities Elective	3	MATH	F244	Measure & Integration	3
	BITS	F225	Environmental Studies	3				
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional	
	MATH	F312	Ordinary Differential Equations	3			Analysis	3
	MATH	F313	Numerical Analysis	3	MATH	F342	Differential Geometry	3
	EEE	F212	Electromagnetic Theory	3	MATH	F343	Partial Differential Equations	3
III	EEE	F211	Electrical Machines	4	EEE	F243	Signals and Systems	3
	EEE	F214	Electronic Devices	3	EEE	F244	Microelectronic Circuits	3
	EEE	F215	Digital Design	4	EEE	F241	Microprocessors &	
							Interfacing	4
					EEE	F242	Control Systems	3
				23				**22**
	First Semester			**U**	**Second Semester**			**U**
	EEE	F311	Communication Systems	4	EEE	F341	Analog Electronics	4
	EEE	F313	Analog & Digital VLSI Design	3	EEE	F342	Power Electronics	4
					EEE	F312	Power Systems	3
IV			First Discipline Electives	6			Fist Discipline Elective	6
			Second Discipline Electives	8			Second Discipline Elective	4
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			3	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Electronics & Communication)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
II	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
					MATH	F243	Graphs & Networks	3
			Humanities Elective	3	MATH	F244	Measure & Integration	3
	BITS	F225	Environmental Studies	3			Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
III	ECE	F212	Electromagnetic Theory	3	ECE	F241	Microprocessors & Interfacing	4
	ECE	F215	Digital Design	4	ECE	F242	Control Systems	3
	ECE	F211	Electrical Machines	4	ECE	F243	Signals and Systems	3
	ECE	F214	Electronic Devices	3	ECE	F244	Microelectronic Circuits	3
				23				**22**
	First Semester			**U**	**Second Semester**			**U**
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F434	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
V	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	3			First Discipline Electives	6
			Second Discipline Electives	7			Second Discipline Electives	5
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Electronics & Computer Engineering)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
II	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
					MATH	F243	Graphs & Networks	3
			Humanities Elective	3	MATH	F244	Measure & Integration	3
	BITS	F225	Environmental Studies	3			Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
III	ECOM	F213	Object Oriented Programming	4	ECOM	F211	Data Structures and Algorithms	4
	ECOM	F214	Electronic Devices	3	ECOM	F241	Microprocessor and Interfacing	4
	ECOM	F215	Digital Design	4	ECOM	F242	Control Systems	3
	ECOM	F222	Discrete Structures for Computer Science	3	ECOM	F243	Signals & Systems	3
				23				**23**
	First Semester			**U**	**Second Semester**			**U**
	ECOM	F313	Analog & Digital VLSI Design	3	ECOM	F244	Microelectronic Circuits	3
	ECOM	F342	Computer Architecture	4	ECOM	F321	Real Time Operating Systems	4
V	ECOM	F343	Communication Networks	3	ECOM	F462	Network Programming	3
			First Discipline Electives	9			First Discipline Electives	6
			Second Discipline Electives	3			Second Discipline Electives	3
				22				**19**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2023 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Electronics & Instrumentation)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
	BITS	F225	Environmental Studies	3	MATH	F244	Measure & Integration	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	INSTR	F212	Electromagnetic Theory	3	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F215	Digital Design	4	INSTR	F242	Control Systems	3
	INSTR	F211	Electrical Machines	4	INSTR	F243	Signals & Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F244	Microelectronic Circuits	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F342	Power Electronics	4
	INSTR	F313	Analog & Digital VLSI Design	3	INSTR	F343	Industrial Instrumentation & Control	3
			First Discipline Electives	3			Fist Discipline Elective	6
			Second Discipline Electives	8			Second Discipline Electives	4
				21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Manufacturing)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
II	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
	BITS	F225	Environmental Studies	3	MATH	F244	Measure & Integration	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	MF	F211	Mechanics of Solids	3	MF	F219	Operations Management	3
III	MF	F216	Materials Science & Engineering	3	MF	F220	Metrology and Quality Assurance	3
	MF	F217	Machine Drawing	2	MF	F221	Mechanisms and Machines	3
	MF	F218	Transport Phenomena in Manufacturing	4	MF	F222	Casting, Forming and Welding	4
				21				**22**
	First Semester			**U**	**Second Semester**			**U**
	MF	F314	Design of Machine Elements	3	MF	F317	Computer Aided Design and Manufacturing	3
	MF	F315	Automation and Control	4	MF	F318	Non Traditional Manufacturing Processes	3
IV	MF	F316	Machining and Machine Tools	4	MF	F319	Supply Chain Management	3
			First Discipline Electives	6	MF	F320	Engineering Optimization	3
			Second Discipline Elective	6			First Discipline Electives	3
							Second Discipline Elective	6
				22				**21**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BITS	F423T	Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2019 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Mechanical)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
	BITS	F225	Environmental Studies	3	MATH	F244	Measure & Integration	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	ME	F211	Mechanics of Solids	3	ME	F218	Advanced Mechanics of Solids	2
	ME	F212	Fluid Mechanics	3	ME	F219	Manufacturing Processes	4
	ME	F216	Materials Science & Engineering	3	ME	F220	Heat Transfer	4
	ME	F217	Applied Thermodynamics	4	ME	F221	Mechanisms and Machines	3
				22				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ME	F314	Design of Machine Elements	3	ME	F318	Computer-Aided Design	3
	ME	F315	Advanced Manufacturing Processes	3	ME	F319	Vibrations & Control	3
	ME	F316	Manufacturing Management	2	ME	F320	Engineering Optimization	3
	ME	F317	Engines, Motors, and Mobility	2	ME	F341	Prime Movers & Fluid Machines	3
			First Discipline Electives	6			First Discipline Electives	9
			Second Discipline Electives	3			Second Discipline Electives	3
				19				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2019 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Chemical)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	CHE	F211	Chemical Process Calculations	3	PHY	F344	Advanced Physics Laboratory	3
	CHE	F212	Fluid Mechanics	3	CHE	F241	Heat Transfer	3
	CHE	F214	Engineering Chemistry	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F243	Material Science & Engineering	3
					CHE	F244	Separation Processes I	3
				21				**24**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F342	Process Dynamics & Control	3
	CHE	F313	Separation Processes II	3	CHE	F343	Process Design Principles II	3
	CHE	F314	Process Design Principles I	3			First Discipline Electives	9
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	3				
				21				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Civil)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of structures	3
	CE	F231	Fluid Mechanics	**3**	CE	F242	Construction Planning & Technology	3
	CE	F230	Civil Engineering Materials	**4**	CE	F243	Soil Mechanics	4
	CE	F213	Surveying	4	CE	F244	Highway Engineering	4
				23				**23**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CE	**F320**	**Design of Reinforced Concrete Structures**	**3**	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering	4	**CE**	**F321**	**Engineering Hydrology**	**3**
	CE	F313	Foundation Engineering	3				
			First Discipline Electives	9	CE	F343	Design of Steel Structures	3
			Second Discipline Electives	3	PHY	F344	Advanced Physics Laboratory	3
							First Discipline Electives	6
							Second Discipline Electives	3
				22				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from **August 2017** onwards.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Computer Science)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	CS	F215	Digital Design	4	PHY	F344	Advanced Physics Laboratory	3
	CS	F214	Logic in Computer Science	3	CS	F241	Microprocessors & Interfacing	4
	CS	F222	Discrete Structures For Computer Science	3	CS	F212	Database Systems	4
	CS	F213	Object Oriented Programming	4	CS	F211	Data Structures & Algorithms	4
				23				**24**
	First Semester			**U**	**Second Semester**			**U**
IV	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
	CS	F301	Principles of Programming Languages	2			First Discipline Electives	9
			First Discipline Electives	6			Second Discipline Electives	3
			Second Discipline Electives	3				
				21				**22**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Electrical & Electronics)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism &Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	EEE	F211	Electrical Machines	4	EEE	F243	Signals and Systems	3
	EEE	F214	Electronic Devices	3	EEE	F244	Microelectronic Circuits	3
	EEE	F215	Digital Design	4	EEE	F241	Microprocessors & Interfacing	4
					EEE	F242	Control Systems	3
				20				**22**
	First Semester			**U**	**Second Semester**			**U**
IV	EEE	F311	Communication Systems	4	EEE	F341	Analog Electronics	4
	MATH	F212	Optimization	3	EEE	F342	Power Electronics	4
			or		EEE	F312	Power Systems	3
	ME	F344	Engineering Optimization	2	PHY	F344	Advanced Physics Laboratory	3
	EEE	F313	Analog & Digital VLSI Design	3			First Discipline Electives	6
			First Discipline Electives	9			Second Discipline Electives	4
			Second Discipline Electives	5				
				23/24				**24**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Electronics & Communication)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	ECE	F215	Digital Design	4	ECE	F241	Microprocessors & Interfacing	4
	ECE	F211	Electrical Machines	4	ECE	F242	Control Systems	3
	ECE	F214	Electronic Devices	3	ECE	F243	Signals and Systems	3
					ECE	F244	Microelectronic Circuits	3
				20				**22**
	First Semester			**U**	**Second Semester**			**U**
IV	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F434	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	9	PHY	F344	Advanced Physics Laboratory	3
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	5
				23				**24**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			4	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Electronics & Computer Engineering)									
Year	**First Semester**			**U**	**Second Semester**				**U**
I	**Same as First degree Programme**				**Same as First degree Programme**				
	First Semester			**U**	**Second Semester**				**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics		3
	PHY	F211	Classical Mechanics	4			or		
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management		3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II		4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I		3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics		3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory		2
							Humanities Electives		5
				21					**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**								
	First Semester			**U**	**Second Semester**				**U**
III	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics		3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics		3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics		3
	ECOM	F213	Object Oriented Programming	4	ECOM	F211	Data Structures and Algorithms		4
	ECOM	F214	Electronic Devices	3	ECOM	F241	Microprocessor and Interfacing		4
	ECOM	F215	Digital Design	4	ECOM	F242	Control Systems		3
	ECOM	F222	Discrete Structures for Computer Science	3	ECOM	F243	Signals & Systems		3
				23					**23**
	First Semester			**U**	**Second Semester**				**U**
IV	ECOM	F313	Analog & Digital VLSI Design	3	ECOM	F244	Microelectronic Circuits		3
	ECOM	F342	Computer Architecture	4	ECOM	F321	Real Time Operating Systems		4
	ECOM	F343	Communication Networks	3	ECOM	F462	Network Programming		3
			First Discipline Electives	9	PHY	F344	Advanced Physics Laboratory		3
			Second Discipline Electives	3			First Discipline Electives		6
							Second Discipline Electives		3
				22					**22**
	First Semester			**U**	**Second Semester**				**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II				20
	BITS	F423T	Thesis	9					

Note: This is operative pattern for the students who are admitted from August 2023 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Electronics & Instrumentation)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism &Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	INSTR	F215	Digital Design	4	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F211	Electrical Machines	4	INSTR	F242	Control Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F243	Signals & Systems	3
					INSTR	F244	Microelectronic Circuits	3
				20				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F342	Power Electronics	4
	INSTR	F313	Analog & Digital VLSI Design	3	INSTR	F343	Industrial Instrumentation & Control	3
			First Discipline Electives	9	PHY	F344	Advanced Physics Laboratory	3
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	4
				22				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			5	BITS F412 Practice School - II			20
	BITS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Manufacturing)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism &Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	MF	F211	Mechanics of Solids	3	PHY	F344	Advanced Physics Laboratory	3
	MF	F216	Materials Science & Engineering	3	MF	F219	Operations Management	3
	MF	F217	Machine Drawing	2	MF	F220	Metrology and Quality Assurance	3
	MF	F218	Transport Phenomena in Manufacturing	4	MF	F221	Mechanisms and Machines	3
					MF	F222	Casting, Forming and Welding	4
				21				**25**
IV	**First Semester**			**U**	**Second Semester**			**U**
	MF	F314	Design of Machine Elements	3	MF	F317	Computer Aided Design and Manufacturing	3
	MF	F315	Automation and Control	4	MF	F318	Non Traditional Manufacturing Processes	3
	MF	F316	Machining and Machine Tools	4	MF	F319	Supply Chain Management	3
			First Discipline Electives	9	MF	F320	Engineering Optimization	3
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	4
				23				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			5	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2019 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Mechanical)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	ME	F211	Mechanics of Solids	3	PHY	F344	Advanced Physics Laboratory	3
	ME	F212	Fluid Mechanics	3	ME	F218	Advanced Mechanics of Solids	2
	ME	F216	Materials Science & Engineering	3	ME	F219	Manufacturing Processes	4
	ME	F217	Applied Thermodynamics	4	ME	F220	Heat Transfer	4
					ME	F221	Mechanisms and Machines	3
				22				**25**
	First Semester			**U**	**Second Semester**			**U**
IV	ME	F314	Design of Machine Elements	3	ME	F318	Computer-Aided Design	3
	ME	F315	Advanced Manufacturing Processes	3	ME	F319	Vibrations & Control	3
	ME	F316	Manufacturing Management	2	ME	F320	Engineering Optimization	3
	ME	F317	Engines, Motors, and Mobility	2	ME	F341	Prime Movers & Fluid Machines	3
			First Discipline Electives	9			First Discipline Electives	6
			Second Discipline Electives	3			Second Discipline Electives	3
				22				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2019 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

List of Courses for B.E. / M.Sc. / B.Pharm. Programmes:

The list of Discipline Core Courses and Discipline Electives for all the first degree programmes is given below. To complete the requirements of Humanities electives, a student can take courses which are normally listed under Languages and Literature, History and Philosophy, Political and social Sciences, Fine arts and Professional Arts which have also been mentioned in subsequent paragraphs.

Course No	Course Title	L	P	U
BIOTECHNOLOGY				
CORE COURSES				
BIOT F211	Biological Chemistry	3	0	3
BIOT F212	Microbiology	3	1	4
BIOT F213	Cell biology	3	0	3
BIOT F215	Biophysics	3	0	3
BIOT F241	Genetic Engineering Techniques	1	3	4
BIOT F243	Genetics	3	0	3
BIOT F244	Instrumental Methods of Analysis	1	3	4
BIOT F245	Intro to Environmental Biotechnology	3	0	3
BIOT F311	Recombinant DNA Technology	3	0	3
BIOT F314	Industrial Microbiology and Bioprocess Engineering	2	2	4
BIOT F342	Immunology	3	0	3
BIOT F343	Experiments in Biotechnology	0	3	3
BIOT F344	Downstream Processing	2	1	3
DISCIPLINE ELECTIVE COURSES				
BIOT F242	Introduction to Bioinformatics	3	0	3
BIOT F345	Proteomics	3	0	3
BIOT F346	Genomics	3	0	3
BIOT F347	Immunotechnology	3	0	3
BIOT F352	Cell and Tissue Culture Technology	3	0	3
BIOT F413	Molecular Biology of the Cell	3	0	3
BIOT F416	Introduction to Pharmaceutical Biotechnology	3	0	3
BIOT F417	Biomolecular Modeling	3	0	3
BIOT F420	Introduction to Plant Biotechnology	3	0	3
BIOT F422	Nanobiotechnology	3	0	3
BIOT F423	Drug design and delivery	3	0	3
BIOT F424	Food Biotechnology	3	0	3
BITS F467	Bioethics and Biosafety	3	0	3

CHEMICAL ENGINEERING				
CORE COURSES		**L**	**P**	**U**
CHE F211	Chemical Process Calculations	3	0	3
CHE F212	Fluid Mechanics	3	0	3
CHE F213	Chemical Engineering Thermodynamics	3	0	3
CHE F214	Engineering Chemistry	3	0	3
CHE F241	Heat Transfer	3	0	3
CHE F242	Numerical Methods for Chemical Engineers	3	0	3
CHE F243	Material Science and Engg.	3	0	3
CHE F244	Separation Processes I	3	0	3
CHE F311	Kinetics and Reactor Design	3	0	3
CHE F312	Chemical Engineering Lab I	0	3	3
CHE F313	Separation Processes II	3	0	3
CHE F314	Process Design Principles I	3	0	3
CHE F341	Chemical Engineering Lab II	0	3	3
CHE F342	Process Dynamics and Control	3	0	3
CHE F343	Process Design Principles II	3	0	3
DISCIPLINE ELECTIVE COURSES				
BIO G671	Bioconversion Technology	3	2	5
BIOT F245	Introduction to Environmental Biotechnology	3	0	3
BIOT F344	Downstream processing	2	1	3
BITS F415	Introduction to MEMS	3	1	4
BITS F416	Introduction to Nanoscience	3	0	3
BITS F417	Microfluidics and its application			4
BITS F418	Introduction to Biomedical Engineering	3	1	4
BITS F429	Nanotechnology for Renewable Energy and Environment	3	1	4
CHE F315	Machine Learning for Chemical Engineers	3	0	3
CHE F411	Environmental Pollution Control	3	0	3
CHE F412	Process Equipment Design	3	0	3
CHE F413	Process Plant Safety	3	0	3
CHE F414	Transport Phenomena	3	0	3
CHE F415	Molecular and Statistical Thermodynamics	3	0	3
CHE F416	Process Plant Design Project I	-	-	3
CHE F417	Process Plant Design Project II	-	-	3
CHE F418	Modelling and Simulation in Chemical Engineering	3	0	3
CHE F419	Chemical Process Technology	3	0	3
CHE F421	Bio-chemical Engineering	3	0	3
CHE F422	Petroleum Refining Technology	3	0	3
CHE F423	Membrane Science and Engineering	3	0	3

CHE F424	Rheology of Complex Fluids	3	0	3
ourse No	**Course Title**	**L**	**P**	**U**
CHE F433	Corrosion Engineering	3	0	3
CHE F471	Advanced Process Control	3	0	3
CHE F497	Atomic and Molecular Simulations			3
CHE F498	Colloids and Interface Engineering			3
CHE G511	Fluidization Engineering	3	1	4
CHE G512	Petroleum Refining and Petrochemicals	3	1	4
CHE G513	Environmental Management Systems	3	2	5
CHE G522	Polymer Technology	3	1	4
CHE G523	Mathematical Methods in Chemical Engineering			5
CHE G524	Introduction to Multiphase flow	3	1	4
CHE G526	Nuclear Engineering	3	1	4
CHE G527	Energy Conservation and Management	3	1	4
CHE G528	Introduction to Nanoscience & Technology	3	1	4
CHE G529	Pulp & Paper Technology	3	1	4
CHE G532	Alternate Energy Resources	3	1	4
CHE G533	Petroleum Product Characterization	3	2	5
CHE G551	Advanced Separation Technology	3	2	5
CHE G552	Advanced Transport Phenomena			5
CHE G554	Computational Fluid Dynamics			4
CHE G556	Electrochemical Engineering	3	1	4
CHE G557	Energy Systems Engineering			4
CHE G558	Chemical Process Optimization			4
CHE G568	Modeling and Simulation in Petroleum Refining			4
CHE G613	Advanced Mass Transfer	3	2	5
CHE G614	Advanced Heat Transfer	3	2	5
CHE G616	Petroleum Reservoir Engineering			5
CHE G617	Petroleum Refinery Engg.	3	2	5
CHE G618	Petroleum Downstream Processing	3	2	5
CHE G619	Process Intensification	3	2	5
CHE G620	Energy Integration Analysis	3	1	4
CHE G622	Advanced Chemical Engineering Thermodynamics			5
CHE G641	Reaction Engineering			5
CHEM F325	Polymer Chemistry	3	0	3
ME F323	Energy Storage Technologies	3	0	3
MST G521	Material Characterization Techniques	3	2	5

CIVIL ENGINEERING

CORE COURSES		**L**	**P**	**U**
CE F211	Mechanics of Solids	3	0	3
CE F213	Surveying	3	1	4
CE F230	Civil Engineering Materials			4
CE F231	Fluid Mechanics			3
CE F241	Analysis of Structures	3	0	3
CE F242	Construction Planning and Technology	3	0	3
CE F243	Soil Mechanics	3	1	4
CE F244	Highway Engineering	3	1	4
CE F312	Hydraulics Engineering	3	1	4
CE F313	Foundation Engineering	3	0	3
CE F320	Design of Reinforced Concrete Structures			3
CE F321	Engineering Hydrology			3
CE F342	Water & Waste Water Treatment	3	1	4
CE F343	Design of Steel Structures	3	0	3

DISCIPLINE ELECTIVE COURSES				
BITS F313	Multicriterion Decision Making in Engg. and Management	3	0	3
CE F323	Introduction to Environmental Engineering	3	0	3
CE F324	Numerical Analysis	3	0	3
CE F325	Fundamentals of Rock Mechanics	3	0	3
CE F345	Computational Geomechanics	3	0	3
CE F411	Operation Research for Engineers	3	0	3
CE F412	Disaster Management	3	0	3
CE F413	Advanced Structural Design	3	0	3
CE F415	Design of Prestressed Concrete Structure	3	0	3
CE F416	Computer Applications in Civil Engineering	3	1	4
CE F417	Applications of Artificial Intelligence in Civil Engg.	3	0	3
CE F419	Geotechnical Earthquake Engg. and Machine Foundation	3	0	3
CE F420	Introduction to Bridge Engineering	3	0	3
CE F421	Analysis and Design of FRP Reinforced Concrete Structures	3	0	3
CE F422	Urban Hydrology	2	1	3
CE F423	Green Buildings and Energy Conservation	3	0	3
CE F425	Airport, Railways and Waterways	3	0	3
CE F426	Geosynthetics and Reinforced Soil Structure	3	0	3

Course No	Course Title	L	P	U
CE F427	System Modeling and Analysis	3	0	3
CE F428	Earthquake Resistant Design and Construction	3	0	3
CE F429	Design of Foundation Systems	3	0	3
CE F430	Design of Advanced Concrete Structures	3	0	3
CE F431	Principles of Geographical Information Systems	3	1	4
CE F432	Structural Dynamics	3	0	3
CE F433	Remote Sensing and Image Processing	3	1	4
CE F434	Environmental Impact Assessment	3	0	3
CE F435	Introduction to Finite Element Methods	3	0	3
COMPUTER SCIENCE				
CORE COURSES		**L**	**P**	**U**
CS F211	Data Structures & Algorithms	3	1	4
CS F212	Database Systems	3	1	4
CS F213	Object Oriented Programming	3	1	4
CS F214	Logic in Computer Science	3	0	3
CS F215	Digital Design	3	1	4
CS F222	Discrete Structures for Computer Science	3	0	3
CS F241	Microprocessors & Interfacing	3	1	4
CS F301	Principles of Programming Languages	2	0	2
CS F303	Computer Networks	3	1	4
CS F342	Computer Architecture	3	1	4
CS F351	Theory of Computation	3	0	3
CS F363	Compiler Construction	2	1	3
CS F364	Design & Analysis of Algorithms	3	0	3
CS F372	Operating Systems	3	0	3
DISCIPLINE ELECTIVE COURSES				
BITS F311	Image Processing	3	0	3
BITS F312	Neural Networks and Fuzzy Logic	3	0	3
BITS F343	Fuzzy Logic and Applications	3	0	3
BITS F364	Human – Computer Interaction	3	0	3
BITS F386	Quantum Information and Computation	3	0	3
BITS F452	Blockchain Technology	3	0	3
BITS F453	Computational Learning Theory	3	0	3
BITS F454	Bio-Inspired Intelligence: Algorithms and Applications	3	0	3
BITS F463	Cryptography	3	0	3
BITS F464	Machine Learning	3	0	3
BITS F465	Enterprise Computing	3	1	4
BITS F466	Service Oriented Computing	3	1	4
CS F314	Software Development for Portable Devices	2	1	3
CS F315	Information and Communication Technologies and Development	3	0	3
CS F316	Quantum Architecture and Programming	3	0	3
CS F317	Reinforcement Learning	3	0	3
CS F320	Foundations of Data Science	3	0	3
CS F401	Multimedia Computing	3	0	3
CS F402	Computational Geometry	3	0	3
CS F407	Artificial Intelligence	3	0	3
CS F413	Internetworking Technologies	3	0	3
CS F415	Data Mining	3	0	3
CS F422	Parallel Computing	3	0	3
CS F424	Software for Embedded Systems	3	1	4
CS F425	Deep Learning	3	0	3
CS F426	Graph Mining	3	1	4
CS F427	Performance Analysis of Computer Networks	3	0	3
CS F428	Special topic in Computer Science	1	0	1
CS F429	Natural Language Processing	3	0	3
CS F430	Approximation Algorithms	3	0	3
CS F431	Combinatorial Optimization	3	0	3
CS F432	Brain-inspired Deep Learning	3	0	3
CS F433	Computational Neuroscience	3	0	3
CS F441	Selected Topics from Computer Science	-	-	3
CS F444	Real Time Systems	3	0	3
CS F446	Data Storage Technologies and Networks	3	0	3
CS F468	Information Security Project	0	3	3
CS F469	Information Retrieval	3	0	3
CS G513	Network Security	3	1	4
CS G519	Social Media Analytics	3	1	4
CS G520	Advanced Data Mining	3	1	4
CS G527	Cloud Computing			5
IS F311	Computer Graphics	3	0	3
IS F341	Software Engineering	3	1	4
IS F462	Network Programming	3	0	3
MATH F231	Number Theory	3	0	3
MATH F421	Combinatorial Mathematics	3	0	3
MATH F441	Discrete Mathematical Structures	3	0	3
ELECTRICAL AND ELECTRONICS ENGINEERING				
CORE COURSES				
EEE F211	Electrical Machines	3	1	4
EEE F212	Electromagnetic Theory	3	0	3
EEE F214	Electronic Devices	3	0	3
EEE F215	Digital Design	3	1	4
EEE F241	Microprocessors and interfacing	3	1	4

Course No	Course Title	L	P	U
EEE F242	Control Systems	3	0	3
EEE F243	Signals & Systems	3	0	3
EEE F244	Microelectronic Circuits	3	0	3
EEE F311	Communication Systems	3	1	4
EEE F312	Power Systems	3	0	3
EEE F313	Analog & Digital VLSI Design	3	0	3
EEE F341	Analog Electronics	3	1	4
EEE F342	Power Electronics	3	1	4
MATH F212	Optimization	3	0	3
OR	OR			
ME F344	Engineering Optimization	2	0	2
DISCIPLINE ELECTIVE COURSES				
BITS F312	Neural Networks and Fuzzy Logic	3	0	3
BITS F415	Introduction To MEMS	3	1	4
CS F213	Object Oriented Programming	3	1	4
CS F342	Computer Architecture	3	1	4
CS F372	Operating Systems	3	0	3
CS F451	Combinatorial Mathematics	3	0	3
CS G553	Reconfigurable Computing			5
ECE F312	EM Fields and Microwave Engineering Laboratory	0	1	1
ECE F343	Communication Networks	3	0	3
EEE F216	Electronic Devices Simulation Laboratory	0	2	2
EEE F245	Control System Laboratory	0	1	1
EEE F246	Electrical and Electronic Circuits Laboratory	0	2	2
EEE F314	EM Fields and Microwave Engineering	3	0	3
EEE F345	Power Apparatus & Networks	3	0	3
EEE F346	Data Communication Networks	2	0	2
EEE F348	FPGA Based System Design Laboratory	0	2	2
EEE F411	Internet of Things	3	1	4
EEE F414	Telecommunication Switching Systems & Networks	3	0	3
EEE F416	Digital Communication	3	0	3
EEE F417	Computer Based Control System	3	0	3
EEE F418	Modern Communication Technologies	3	0	3
EEE F419	Flexible and Stretchable Electronics	3	1	4
EEE F420	Biomedical Signal Processing	3	1	4
EEE F422	Modern Control Systems	3	0	3
EEE F424	Smart Grid for Sustainable Energy	3	0	3
EEE F425	Power System Analysis and control	3	0	3
EEE F426	Fiber Optics & Optoelectronics	3	0	3
EEE F427	Electric Power Utilization and Illumination	3	0	3
EEE F428	Energy Storage Systems	3	0	3
EEE F429	Smart Materials and Applications	3	1	4
EEE F430	Green Communications and Networks	3	0	3
EEE F431	Mobile Telecommunication Networks	3	0	3
EEE F432	Medical Instrumentation	3	0	3
EEE F433	Electromagnetic Fields & Waves	3	0	3
EEE F434	Digital Signal Processing	3	1	4
EEE F435	Digital Image Processing	3	0	3
EEE F436	Electromagnetic Compatibility	3	1	4
EEE F462	Advanced Power Systems	3	0	3
EEE F472	Satellite Communication	3	0	3
EEE F473	Wind Electrical Systems	3	0	3
EEE F474	Antenna Theory and Design	3	1	4
EEE F475	Special Electrical Machines	3	1	4
EEE F476	Switchgear and Protection	3	1	4
EEE F477	Modelling of Field-Effect NanoDevices	3	0	3
EEE F478	Power Systems Laboratory	0	2	2
EEE G512	Embedded System Design	3	1	4
EEE G513	Machine Learning for Electronics Engineers			4*
EEE G626	Hardware Software Co-Design			4

ELECTRONICS AND COMMUNICATION ENGINEERING				
CORE COURSES		**L**	**P**	**U**
ECE F211	Electrical Machines	3	1	4
ECE F212	Electromagnetic Theory	3	0	3
ECE F214	Electronic Devices	3	0	3
ECE F215	Digital Design	3	1	4
ECE F241	Microprocessors and interfacing	3	1	4
ECE F242	Control Systems	3	0	3
ECE F243	Signals & Systems	3	0	3
ECE F244	Microelectronic Circuits	3	0	3
ECE F311	Communication Systems	3	1	4
ECE F314	Electromagnetic Fields & Microwave Engineering	3	0	3
ECE F341	Analog Electronics	3	1	4
ECE F343	Communication Networks	3	0	3
ECE F344	Information Theory & Coding	3	0	3
ECE F434	Digital Signal Processing	3	1	4
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F415	Introduction to MEMS	3	1	4
BITS F463	Cryptography	3	0	3
CS F213	Object Oriented Programming	3	1	4
CS F342	Computer Architecture	3	1	4
CS F372	Operating Systems	3	0	3
CS F451	Combinatorial Mathematics	3	0	3

Course No	Course Title	L	P	U
CS G553	Reconfigurable Computing			5
ECE F216	Electronic Devices Simulation Laboratory	0	2	2
ECE F312	EM Fields and Microwave Engineering Laboratory	0	1	1
ECE F414	Telecommunication Switching Systems & Networks	3	0	3
ECE F416	Digital Communication	3	0	3
ECE F418	Modern Communication Technologies	3	0	3
ECE F424	Smart Grid for Sustainable Energy	3	0	3
ECE F428	Energy Storage Systems	3	0	3
ECE F431	Mobile Telecommunication Networks	3	0	3
ECE F472	Satellite Communication	3	0	3
EEE F245	Control System Laboratory	0	1	1
EEE F246	Electrical and Electronic Circuits Laboratory	0	2	2
EEE F313	Analog & Digital VLSI Design	3	0	3
EEE F345	Power Apparatus & Networks	3	0	3
EEE F346	Data Communication Networks	2	0	2
EEE F348	FPGA Based System Design Laboratory	0	2	2
EEE F411	Internet of Things	3	1	4
EEE F417	Computer Based Control System	3	0	3
EEE F419	Flexible and Stretchable Electronics	3	1	4
EEE F420	Biomedical Signal Processing	3	1	4
EEE F422	Modern Control Systems	3	0	3
EEE F426	Fiber Optics and Optoelectronics	3	0	3
EEE F429	Smart Materials and Applications	3	1	4
EEE F430	Green Communications and Networks	3	0	3
EEE F432	Medical Instrumentation	3	0	3
EEE F435	Digital Image Processing	3	0	3
EEE F436	Electromagnetic Compatibility	3	1	4
EEE F474	Antenna Theory and Design	3	1	4
EEE F475	Special Electrical Machines	3	1	4
EEE F476	Switchgear and Protection	3	1	4
EEE F477	Modelling of Field-Effect Nano Devices	3	0	3
EEE F478	Power Systems Laboratory	0	2	2
EEE G512	Embedded System Design	3	1	4
EEE G513	Machine Learning for Electronics Engineers			4*
EEE G626	Hardware Software Co-Design			4
INSTR F412	Analysis Instrumentation	3	0	3

ELECTRONICS AND COMPUTER ENGINEERING

CORE COURSES		L	P	U
ECOM F211	Data Structures and Algorithms	3	1	4
ECOM F213	Object Oriented Programming	3	1	4
ECOM F214	Electronic Devices	3	0	3
ECOM F215	Digital Design	3	1	4
ECOM F222	Discrete Structures for Computer Science	3	0	3
ECOM F241	Microprocessors and Interfacing	3	1	4
ECOM F242	Control Systems	3	0	3
ECOM F243	Signals & Systems	3	0	3
ECOM F244	Microelectronic Circuits	3	0	3
ECOM F313	Analog & Digital VLSI Design	3	0	3
ECOM F321	Real Time Operating Systems	3	1	4
ECOM F342	Computer Architecture	3	1	4
ECOM F343	Communication Networks	3	0	3
ECOM F462	Network Programming	3	0	3

DISCIPLINE ELECTIVE COURSES		L	P	U
BITS F312	Neural Networks and Fuzzy Logic	3	0	3
BITS F327	Artificial Intelligence for Robotics	2	1	3
BITS F343	Fuzzy Logic and Applications	3	0	3
BITS F364	Human – Computer Interaction	3	0	3
BITS F441	Robotics			3
BITS F452	Blockchain Technology	3	0	3
CS F212	Database Systems	3	1	4
CS F315	Information and Communication Technologies and Development	3	0	3
CS F316	Quantum Architecture and Programming	3	0	3
CS F407	Artificial Intelligence	3	0	3
CS F413	Internetworking Technologies	3	0	3
CS F422	Parallel Computing	3	0	3
CS F424	Software for Embedded Systems	3	1	4
CS F427	Performance Analysis of Computer Networks	3	0	3

CS F446	Data Storage Technologies and Networks	3	0	3
CS G513	Network Security	3	1	4
CS G527	Cloud Computing			5
CS G553	Reconfigurable Computing			5
EEE F245	Control System Laboratory	0	1	1
EEE F311	Communication Systems	3	1	4
EEE F341	Analog Electronics	3	1	4
EEE F348	FPGA Based System Design Laboratory	0	2	2
EEE F411	Internet of Things	3	1	4
EEE F417	Computer based control system	3	0	3
EEE F422	Modern Control Systems	3	0	3
EEE F432	Medical Instrumentation	3	0	3
EEE F434	Digital Signal Processing	3	1	4
EEE F435	Digital Image Processing	3	0	3
EEE G512	Embedded System Design	3	1	4
EEE G513	Machine Learning for Electronics Engineers			4
IS F311	Computer Graphics	3	0	3
IS F341	Software Engineering	3	1	4
MEL G621	VLSI Design	3	2	5

ELECTRONICS AND INSTRUMENTATION ENGINEERING

CORE COURSES		**L**	**P**	**U**
INSTR F211	Electrical Machines	3	1	4
INSTR F212	Electromagnetic Theory	3	0	3
INSTR F214	Electronic Devices	3	0	3
INSTR F215	Digital Design	3	1	4
INSTR F241	Microprocessors and interfacing	3	1	4
INSTR F242	Control Systems	3	0	3
INSTR F243	Signals & Systems	3	0	3
INSTR F244	Microelectronic Circuits	3	0	3
INSTR F311	Electronic Instrumentation & Instrumentation Technology	3	1	4
INSTR F312	Transducers and Measurement Systems	3	0	3
INSTR F313	Analog & Digital VLSI Design	3	0	3
INSTR F341	Analog Electronics	3	1	4
INSTR F342	Power Electronics	3	1	4
INSTR F343	Industrial Instrumentation & Control	3	0	3

DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F312	Neural Network & Fuzzy Logic	3	0	3
BITS F415	Introduction To MEMS	3	1	4
CS F213	Object Oriented Programming	3	1	4
CS F342	Computer Architecture	3	1	4
CS F372	Operating Systems	3	0	3
CS F451	Combinatorial Mathematics	3	0	3
CS G553	Reconfigurable Computing			5
ECE F312	EM Fields and Microwave Engineering Laboratory	0	1	1
ECE F314	Electromagnetic Fields & Microwave Engineering	3	0	3
EEE F245	Control System Laboratory	0	1	1
EEE F246	Electrical and Electronic Circuits Laboratory	0	2	2
EEE F311	Communication Systems	3	1	4
EEE F345	Power Apparatus & Networks	3	0	3
EEE F346	Data Communication Networks	2	0	2
EEE F348	FPGA Based System Design Laboratory	0	2	2
EEE F411	Internet of Things	3	1	4
EEE F417	Computer Based Control System	3	0	3
EEE F419	Flexible and Stretchable Electronics	3	1	4
EEE F420	Biomedical Signal Processing	3	1	4
EEE F422	Modern Control Systems	3	0	3
EEE F426	Fiber optics & Optoelectronics	3	0	3
EEE F427	Electric Power Utilization and Illumination	3	0	3
EEE F429	Smart Materials and Applications	3	1	4
EEE F430	Green Communications and Networks	3	0	3
EEE F431	Mobile Telecommunication Networks	3	0	3
EEE F433	Electromagnetic Fields & Waves	3	0	3
EEE F434	Digital Signal Processing	3	1	4
EEE F435	Digital Image Processing (check number and description with BITS Image Processing)	3	0	3
EEE F436	Electromagnetic Compatibility	3	1	4
EEE F472	Satellite Communication	3	0	3
EEE F474	Antenna Theory and Design	3	1	4
EEE F475	Special Electrical Machines	3	1	4
EEE F476	Switchgear and Protection	3	1	4
EEE F477	Modelling of Field-Effect Nano Devices	3	0	3
EEE F478	Power Systems Laboratory	0	2	2
EEE G512	Embedded System Design	3	1	4
EEE G513	Machine Learning for Electronics Engineers			4*
EEE G626	Hardware Software Co-Design			4
INSTR F216	Electronic Devices Simulation Laboratory	0	2	2
INSTR F413	Advanced Process Control	3	0	3
INSTR F414	Telecommunication Switching Systems & Networks	3	0	3

INSTR F415	Digital Control	3	0	3
INSTR F419	Virtual Instrumentation	3	1	4
INSTR F420	Design of Instrumentation Systems	3	0	3
INSTR F422	Instrumentation for Petrochemical Industry	3	0	3
INSTR F424	Smart Grid for Sustainable Energy	3	0	3
INSTR F428	Energy Storage Systems	3	0	3
INSTR F429	Smart Materials and Applications	3	1	4
INSTR F430	Green Communications and Networks	3	0	3
INSTR F432	Medical Instrumentation	3	0	3
INSTR F473	Wind Electrical Systems	3	0	3

MANUFACTURING ENGINEERING

CORE COURSES		**L**	**P**	**U**
MF F211	Mechanics of Solids	3	0	3
MF F216	Materials Science and Engineering	2	1	3
MF F217	Machine Drawing	0	2	2
MF F218	Transport Phenomena in Manufacturing	3	1	4
MF F219	Operations Management	3	0	3
MF F220	Metrology and Quality Assurance	2	1	3
MF F221	Mechanisms and Machines	3	0	3
MF F222	Casting, Forming and Welding	3	1	4
MF F314	Design of Machine Elements	3	0	3
MF F315	Automation and Control	3	1	4
MF F316	Machining and Machine Tools	3	1	4
MF F317	Computer Aided Design and Manufacturing	2	1	3
MF F318	Non Traditional Manufacturing Processes	3	0	3
MF F319	Supply Chain Management	3	0	3
MF F320	Engineering Optimization	3	0	3

DISCIPLINE ELECTIVE COURSES

BITS F415	Introduction To MEMS	3	1	4
ECON F411	Project Appraisal	3	0	3
ME F321	Data Mining in Mechanical Sciences	2	1	3
ME F323	Energy Storage Technologies	3	0	3
ME F340	Introduction to Sports Engg.	3	0	3
ME F416	Reverse Engineering and Rapid Prototyping	3	0	3
ME F417	Advanced Metal Forming	3	0	3
ME F419	Total Product Integration Engineering	3	0	3
ME F424	Energy Management	3	0	3
ME F425	Additive Manufacturing	3	0	3
ME F426	Industry 4.0 in Manufacturing	3	0	3
ME F432	Computer Aided Manufacturing	2	1	3
ME F443	Quality Control Assurance and Reliability	3	0	3
ME F484	Automotive Technology	3	0	3
MF F321	Procurement Management	3	0	3
MF F411	Fluid Power Systems	3	1	4
MF F412	Automotive Systems	3	0	3
MF F413	Mechanical Vibrations and Acoustics	3	0	3
MF F414	Manufacturing Excellence	3	0	3
MF F418	Lean Manufacturing	3	0	3
MF F422	Supply Chain Modelling and Empirical Analysis	3	1	4
MF F442	Advances in Materials Science	3	0	3
MF F453	Industrial Relations	3	0	3
MF F463	Maintenance and Safety	3	0	3
MF F471	Instrumentation and Control	3	0	3
MF F472	Precision Engineering	3	0	3
MF F473	Product Design and Development	3	0	3
MF F474	Product Design and Development Projects	0	0	3
MF F485	Sustainable Manufacturing	3	0	3

MECHANICAL ENGINEERING

CORE COURSES		**L**	**P**	**U**
ME F211	Mechanics of Solids	3	0	3
ME F212	Fluid Mechanics	3	0	3
ME F216	Materials Science and Engineering	2	1	3
ME F217	Applied Thermodynamics	3	1	4
ME F218	Advanced Mechanics of Solids	2	0	2
ME F219	Manufacturing Processes	3	1	4
ME F220	Heat Transfer	3	1	4
ME F221	Mechanisms and Machines	3	0	3
ME F314	Design of Machine Elements	3	0	3
ME F315	Advanced Manufacturing Processes	2	1	3
ME F316	Manufacturing Management	2	0	2
ME F317	Engines, Motors, and Mobility	2	0	2
ME F318	Computer-Aided Design	1	2	3
ME F319	Vibrations and Control	3	0	3
ME F320	Engineering Optimization	3	0	3
ME F341	Prime Movers & Fluid Machines	2	1	3

DISCIPLINE ELECTIVE COURSES

AN F311	Principles of Aerodynamics	3	0	3
AN F312	Aircraft Propulsion	3	0	3
AN F313	Flight Mechanics and Controls	3	0	3
AN F314	Introduction to Flight	3	0	3
AN F315	Aircraft Structures	3	0	3
BITS F327	Artificial Intelligence for Robotics	2	1	3
BITS F415	Introduction to MEMS	3	1	4
BITS F462	Renewable Energy	3	0	3

DE G513	Tribology	3	2	5
DE G514	Fracture Mechanics	3	2	5
DE G531	Product Design	3	2	5
ECE F242	Control Systems	3	0	3
ECON F411	Project Appraisal	3	0	3
EEE F242	Control Systems	3	0	3
INSTR F242	Control Systems	3	0	3
MATH F313	Numerical Analysis	3	0	3
ME F321	Data Mining in Mechanical Sciences	2	1	3
ME F323	Energy Storage Technologies	3	0	3
ME F340	Introduction to Sports Engineering	3	0	3
ME F411	Fluid Power Systems	3	1	4
ME F413	Nonlinear Vibrations	3	0	3
ME F414	Fuel Cell Science and Technology			3*
ME F415	Gas Dynamics	3	0	3
ME F416	Reverse Engineering and Rapid Prototyping	3	0	3
ME F417	Advanced Metal Forming	3	0	3
ME F418	Rocket and Spacecraft Propulsion	3	0	3
ME F419	Total Product Integration Engg.	3	0	3
ME F420	Power Plant Engineering	3	0	3
ME F423	Microfluidics and Applications			4*
ME F424	Energy Management	3	0	3
ME F425	Additive Manufacturing	3	0	3
ME F426	Industry 4.0 in Manufacturing	3	0	3
ME F427	Continuum Mechanics	3	1	4
ME F428	Smart Materials	3	1	4
ME F429	Micro-Nanoscale Heat Transport	3	1	4
ME F432	Computer Aided manufacturing	2	1	3
ME F433	Solar Thermal Process Engineering	3	1	4
ME F441	Automotive Vehicles	3	0	3
ME F443	Quality Control, Assurance and Reliability	3	0	3
ME F451	Mechanical Equipment Design	3	0	3
ME F452	Composite Materials & Design	3	0	3
ME F461	Refrigeration and Air conditioning	3	0	3
ME F472	Precision Engineering	3	0	3
ME F482	Combustion	3	0	3
ME F483	Wind Energy	3	0	3
ME F484	Automotive Technology	3	0	3
ME F485	Numerical Techniques for Fluid Flow and Heat Transfer	3	0	3
ME G511	Mechanism and Robotics	3	2	5
ME G512	Finite Element Methods	3	2	5
ME G514	Turbomachinery	3	2	5
ME G515	Computational Fluid Dynamics	3	2	5
ME G533	Conduction and Radiation Heat Transfer	3	2	5
ME G534	Convective Heat and Mass Transfer	3	2	5
MF F311	Mechatronics and Automation	2	1	3
MF F321	Procurement Management	3	0	3
MF F418	Lean Manufacturing	3	0	3
MF F421	Supply chain management			4
MF F422	Supply Chain Modelling and Empirical Analysis	3	1	4
MF F485	Sustainable Manufacturing	3	0	3
MST G522	Advanced Composites	3	2	5

PHARMACY

CORE COURSES		L	P	U
BITS F219	Process Engineering	2	1	3
PHA F211	Pharmaceutical Analysis	2	1	3
PHA F214	Anatomy, Physiology & Hygiene	2	1	3
PHA F215*	Introduction to Molecular Biology and Immunology	3	0	3
PHA F216	Pharmaceutical Formulations I	2	1	3
PHA F217	Pharmaceutical Microbiology	2	1	3
PHA F241	Pharmaceutical Chemistry	2	1	3
PHA F242	Biological Chemistry	2	1	3
PHA F243	Industrial Pharmacy	2	1	3
PHA F244	Physical Pharmacy	2	1	3
PHA F311	Pharmacology I	2	1	3
PHA F312	Medicinal Chemistry I	2	1	3
PHA F313	Instrumental Methods of Analysis	2	1	4
PHA F315	Pharmaceutical Formulations II	2	1	3
PHA F341	Pharmacology II	2	1	3
PHA F342	Medicinal Chemistry II	2	1	3
PHA F343	Forensic Pharmacy	2	-	2
PHA F344	Natural Drugs	2	1	3

*** To be offered to B.Pharm. students admitted in 2014 onwards in place of PHA F243**

DISCIPLINE ELECTIVE COURSES		L	P	U
BITS F467	Bioethics and Biosafety	3	0	3
MATH F212	Optimization	3	0	3
PHA F316	Pharmaceutical Regulatory Science	3	0	3
PHA F317	Safety Pharmacology and Toxicology	3	0	3
PHA F413	Pharmaceutical Management and Quality Control	3	0	3
PHA F414	Biopharmaceutics	3	0	3
PHA F415	Pathophysiology	3	0	3
PHA F416	Chemistry of Synthetic Drugs	3	0	3
PHA F417	Pharmacoeconomics	3	0	3
PHA F418	Biopharmaceutics and Pharmacokinetics	3	0	3

PHA F419	Herbal Drug Technology	3	0	3
PHA F422	Cosmetic Science	2	1	3
PHA F432	Hospital Pharmacy	3	0	3
PHA F441	Biochemical Engineering	3	0	3
PHA F442	Applied Pharmaceutical Chemistry	3	0	3
PHA F461	Phytochemistry	2	1	3
PHA G546	Pharmaceutical Biostatistics	3	0	3
BIOLOGICAL SCIENCES				
CORE COURSES		**L**	**P**	**U**
BIO F211	Biological Chemistry	3	0	3
BIO F212	Microbiology	3	1	4
BIO F213	Cell Biology	3	0	3
BIO F214	Integrated Biology	3	0	3
BIO F215	Biophysics	3	0	3
BIO F241	Ecology & Environmental Science	3	0	3
BIO F242	Introduction to Bioinformatics	3	0	3
BIO F243	Genetics	3	0	3
BIO F244	Instrumental Methods of Analysis	1	3	4
BIO F311	Recombinant DNA Technology	3	0	3
BIO F312	Plant Physiology	3	0	3
BIO F313	Animal Physiology	3	0	3
BIO F341	Developmental Biology	3	0	3
BIO F342	Immunology	3	0	3
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BIO F216	Water, Sanitation and Solid Waste Management	3	0	3
BIO F217	Laboratory for Water, Sanitation and Solid waste Management	1	2	3
BIO F231	Biology Project Laboratory			3
BIO F314	Conservation Biology	2	1	3
BIO F315	Applied Nutrition and Nutraceuticals	2	0	2
BIO F352	Cell and Tissue Culture Technology	3	1	4
BIO F411	Laboratory	0	3	3
BIO F413	Molecular Biology of Cell	3	0	3
BIO F417	Biomolecular Modelling	3	0	3
BIO F418	Genetic Engineering Techniques	1	3	4
BIO F419	Molecular Evolution	3	0	3
BIO F421	Enzymology	3	0	3
BIO F431	Reproductive Physiology	3	0	3
BIO F441	Biochemical Engineering	3	0	3
BIO F451	Bioprocess Technology	3	0	3
BIO G512	Molecular Mechanism of Gene Expression	3	2	5
BIO G513	Microbial and Fermentation Technology	3	2	5
BIO G515	Stem Cell and Regenerative Biology	3	1	4
BIO G522	Interferon Technology	3	1	4
BIO G523	Advanced and Applied Microbiology	3	2	5
BIO G524	Animal Cell Technology	3	2	5
BIO G525	Environmental Biotechnology & Waste Mgnt	3	2	5
BIO G526	Cancer Biology	3	2	5
BIO G544	Bioremediation and biometallurgy	5	0	5
BIO G545	Molecular Parasitology and Vector Biology			5
BIO G561	Advances in Recombinant DNA Technology	3	2	5
BIO G570	Recent Developments in Biology	1	0	1
BIO G612	Human Genetics	3	2	5
BIO G631	Membrane and Liposome Technology	3	1	4
BIO G632	Transgenic Technology	3	2	5
BIO G642	Experimental Techniques		4	4
BIO G643	Plant Biotechnology	3	2	5
BIO G651	Protein and Enzyme Bioengineering	3	2	5
BIO G661	Gene Toxicology	3	1	4
BIO G671	Bioconversion Technology	3	2	5
BIOT F345	Proteomics	3	0	3
BIOT F346	Genomics	3	0	3
BIOT F347	Immunotechnology	3	0	3
BIOT F416	Introduction to Pharmaceutical Biotechnology	3	0	3
BIOT F422	Nanobiotechnology	3	0	3
BIOT F424	Food Biotechnology	3	0	3
BITS F418	Introduction to Biomedical Engineering	3	1	4
BITS F467	Bioethics and Biosafety	3	0	3
CHEM F212	Organic Chemistry I	3	0	3
CHEM F213	Physical Chemistry II	3	0	3
MATH F212	Optimization	3	0	3
CHEMISTRY				
CORE COURSES		**L**	**P**	**U**
CHEM F211	Physical Chemistry I	3	0	3
CHEM F212	Organic Chemistry I	3	0	3
CHEM F213	Physical Chemistry II	3	0	3
CHEM F214	Inorganic Chemistry I	3	0	3
CHEM F241	Inorganic Chemistry II	3	0	3
CHEM F242	Chemical Experimentation I	0	3	3
CHEM F243	Organic Chemistry II	3	0	3
CHEM F244	Physical Chemistry III	3	0	3
CHEM F311	Organic Chemistry III	3	0	3
CHEM F312	Physical Chemistry IV	3	0	3
CHEM F313	Instrumental Methods of Analysis	3	1	4

CHEM F341	Chemical Experimentation II	0	4	4
CHEM F342	Organic Chemistry IV	3	0	3
CHEM F343	Inorganic Chemistry III	3	0	3
PHY F212	Electromagnetic Theory I	3	0	3
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
CHEM F223	Colloid and Surface Chemistry	3	0	3
CHEM F320	Introductory Computational Chemistry Laboratory	0	4	2
CHEM F323	Biophysical Chemistry	3	0	3
CHEM F324	Numerical Methods in Chemistry	3	3	4
CHEM F325	Polymer Chemistry	3	0	3
CHEM F326	Solid State Chemistry	3	0	3
CHEM F327	Electrochemistry: Fundamentals and Applications	3	0	3
CHEM F328	Supramolecular Chemistry	3	0	3
CHEM F329	Analytical Chemistry	3	1	4
CHEM F330	Photophysical Chemistry	3	1	4
CHEM F333	Chemistry of Materials	3	0	3
CHEM F334	Magnetic Resonance	3	0	3
CHEM F335	Organic Chemistry and Drug Design	3	0	3
CHEM F336	Nanochemistry	3	1	4
CHEM F337	Green Chemistry and Catalysis	3	0	3
CHEM F412	Photochemistry and Laser Spectroscopy	3	0	3
CHEM F413	Electron Correlation In Atoms And Molecules	3	1	4
CHEM F414	Bio and Chemical Sensors	3	0	3
CHEM F415	Frontiers in Organic Synthesis	3	0	3
CHEM F416	Applied Crystallography	3	0	3
CHEM F422	Statistical Thermodynamics	3	0	3
CHEM F423	Astrochemistry	3	0	3
CHEM F430	Atmospheric Chemistry	3	0	3
CHEM F431	Sustainable Chemistry using Renewables	3	0	3
CHEM G521	Environmental Chemistry			5
ECONOMICS				
CORE COURSES		**L**	**P**	**U**
ECON F211	Principles of Economics	3	0	3
ECON F212	Fundamentals of Finance and Accounts	3	0	3
ECON F213	Mathematical and Statistical Methods	3	0	3
ECON F214	Economic Environment of Business	3	0	3
ECON F241	Econometric Methods	3	0	3
ECON F242	Microeconomics	3	0	3
ECON F243	Macroeconomics	3	0	3
ECON F244	Economics of Growth and Development	3	0	3
ECON F311	International Economics	3	0	3
ECON F312	Money, Banking and Financial Markets	3	0	3
ECON F313	Issues in Economic Development	3	0	3
ECON F341	Public Finance Theory and Policy	3	0	3
ECON F342	Applied Econometrics	3	0	3
ECON F343	Economic Analysis of Public Policy	3	0	3
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
ECON F215	Computational Methods for Economics	3	0	3
BITS F314	Game Theory and It's Applications	3	0	3
ECON F315	Financial Management	3	0	3
ECON F314	Industrial Economics	3	0	3
ECON F345	Behavioral Economics	3	0	3
ECON F351	Indian Economic Development	3	0	3
ECON F352	Management of Banks and Financial Institutions	3	0	3
ECON F353	Energy Economics and Policy	3	0	3
ECON F354	Derivatives and Risk Management	3	0	3
ECON F355	Business Analysis and Valuation	3	0	3
ECON F356	Strategic Financial Management	3	0	3
ECON F357	Management Control System	3	0	3
ECON F411	Project Appraisal	3	0	3
ECON F412	Security Analysis and Portfolio Management	3	0	3
ECON F413	Financial Engineering	3	0	3
ECON F414	Creating and Leading Entrepreneurial Organizations	3	0	3
ECON F415	New Venture Creation	3	0	3
ECON F417	Risk Management and Insurance	3	0	3
ECON F418	Quantitative Analysis of International Trade	3	0	3
ECON F419	Advanced Microeconomics	3	0	3
ECON F420	Applied Macroeconometrics	3	0	3
ECON F422	Functions and Working of Stock Exchanges	3	0	3
ECON F434	International Business	3	0	3
ECON F435	Marketing Research	3	0	3
ECON F471	Resources and Environmental Economics	3	0	3
FIN F314	Investment Banking and Financial Services	3	0	3
FIN F414	Financial Risk Analytics and Management	3	0	3
MATH F212	Optimization	3	0	3
MATH F242	Operations Research	3	0	3
MATH F424	Applied Stochastic Process	3	1	4

MATHEMATICS

CORE COURSES		L	P	U
MATH F212	Optimization	3	0	3
MATH F213	Discrete Mathematics	3	0	3
MATH F214	Elementary Real Analysis	3	0	3
MATH F215	Algebra I	3	0	3
MATH F241	Mathematical Methods	3	0	3
MATH F242	Operations Research	3	0	3
MATH F243	Graphs and Networks	3	0	3
MATH F244	Measure & Integration	3	0	3
MATH F311	Introduction to Topology	3	0	3
MATH F312	Ordinary Differential Equations	3	0	3
MATH F313	Numerical Analysis	3	0	3
MATH F341	Introduction to Functional Analysis	3	0	3
MATH F342	Differential Geometry	3	0	3
MATH F343	Partial Differential Equations	3	0	3

DISCIPLINE ELECTIVE COURSES		L	P	U
BITS F314	Game Theory and Its Applications	3	0	3
BITS F343	Fuzzy Logic and Applications	3	0	3
BITS F463	Cryptography	3	0	3
CS F211	Data Structures and Algorithms	3	1	4
or	**or**			
BITS F232	Foundations of Data Structures and Algorithms	3	1	4
CS F364	Design and Analysis of Algorithms	3	0	3
MATH F231	Number Theory	3	0	3
MATH F314	Algebra II	3	0	3
MATH F315	Introduction to Statistical Inference	3	0	3
MATH F316	Matrix Theory and Linear Estimation	3	1	4
MATH F317	Sampling Theory	3	1	4
MATH F353	Statistical Inference and Applications	3	0	3
MATH F354	Complex Analysis	3	0	3
MATH F378	Advanced Probability Theory	3	0	3
MATH F420	Mathematical Modeling	3	0	4
MATH F421	Combinatorial Mathematics	3	0	3
MATH F422	Numerical Methodology for Partial Differential Equations	3	1	4
MATH F423	Introduction to Algebraic Topology	3	0	3
MATH F424	Applied Stochastic Process	3	1	4
MATH F425	Numerical Linear Algebra	3	1	4
MATH F426	Mathematical Theory of Finite Element Methods	3	1	4
MATH F427	Statistical Simulation and Data Analysis	3	1	4
MATH F428	Time Series Analysis and Forecasting	3	1	4
MATH F431	Distribution Theory	3	0	3
MATH F432	Applied Statistical Methods	3	0	3
MATH F441	Discrete Mathematical Structures	3	0	3
MATH F444	Numerical Solutions of Ordinary Differential Equations	3	0	3
MATH F445	Mathematical Fluid Dynamics	3	0	3
MATH F456	Cosmology	3	0	3
MATH F471	Nonlinear Optimization	3	0	3
MATH F481	Commutative Algebra	3	0	3
MATH F492	Wavelet analysis and applications	3	1	4

PHYSICS

CORE COURSES		L	P	U
PHY F211	Classical Mechanics	3	1	4
PHY F212	Electromagnetic Theory I	3	0	3
PHY F213	Optics	3	0	3
PHY F214	Electricity, Magnetism & Optics Laboratory	0	2	2
PHY F241	Electromagnetic Theory II	3	1	4
PHY F242	Quantum Mechanics I	3	0	3
PHY F243	Mathematical Methods of Physics	3	0	3
PHY F244	Modern Physics Laboratory	0	2	2
PHY F311	Quantum Mechanics II	3	0	3
PHY F312	Statistical Mechanics	3	0	3
PHY F313	Computational Physics	3	0	3
PHY F341	Solid State Physics	3	0	3
PHY F342	Atomic & Molecular Physics	3	0	3
PHY F343	Nuclear & Particle Physics	3	0	3
PHY F344	Advanced Physics Laboratory	0	3	3

DISCIPLINE ELECTIVE COURSES		L	P	U
BIO F215	Biophysics	3	0	3
BITS F316	Nonlinear Dynamics and Chaos	3	0	3
BITS F317	Theoretical Neuroscience	3	0	3
PHY F346	Laser Science and Technology	3	0	3
BITS F386	Quantum Information and Computation	3	0	3
BITS F416	Introduction to Nanoscience	3	0	3
BITS F417	Microfluidics & its Applications			4
BITS F446	Pattern Recognition			3
EEE F426	Fibre Optics & Optoelectronics	3	0	3
MATH F424	Applied Stochastic Processess	3	1	4
MATH F456	Cosmology	3	0	3
PHY F215	Introduction to Astronomy & Astrophysics	3	0	3
PHY F315	Theory of Relativity	3	0	3
PHY F316	Musical Acoustics	3	0	3
PHY F317	Introduction to Radio Astronomy	3	0	3
PHY F378	Plasma Physics and its Applications	3	0	3

PHY F379	Thin Film Technology	3	0	3
PHY F412	Introduction To Quantum Field Theory	3	1	4
PHY F413	Particle Physics	3	1	4
PHY F414	Physics of Advanced Materials	3	1	4
PHY F415	General Theory of Relativity and Cosmology	3	1	4
PHY F416	Soft Condensed Matter Physics	3	1	4
PHY F417	Experimental Methods of Physics	3	1	4
PHY F418	Lasers and Applications	3	1	4
PHY F419	Advanced Solid State Physics	3	1	4
PHY F420	Quantum Optics	3	1	4
PHY F421	Advanced Quantum Mechanics	3	1	4
PHY F422	Group Theory and Applications	3	1	4
PHY F423	Special Topics in Statistical Mechanics	3	1	4
PHY F424	Advanced Electrodynamics	3	1	4
PHY F425	Advanced Mathematical Methods of Physics	3	1	4
PHY F426	Physics of Semiconductor Devices	3	1	4
PHY F427	Atmospheric Physics	3	0	3
PHY F428	Quantum Information Theory	3	0	3
PHY F431	Geometrical Methods in Physics	3	0	3
PHY F432	Classical Theory of Fields: A Symmetry Perspective			4*
PHY F433	Topics in Nonlinear Optics	3	0	3
PHY F434	Foundations of Quantum Mechanics	3	0	3
PHY G512	Advanced Quantum Field Theory	3	0	3

GENERAL STUDIES – COMMUNICATION AND MEDIA STUDIES STREAM

CORE COURSES		**L**	**P**	**U**
GS F221	Business Communication	3	0	3
GS F222	Language Lab Practice	0	3	3
GS F223	Introduction to Mass Communication	3	0	3
GS F224	Print and Audio Visual Advertising	2	1	3
GS F241	Creative Writing	2	1	3
GS F243	Current Affairs	3	0	3
GS F244	Reporting and Writing for Media	3	0	3
GS F245	Effective Public Speaking	2	1	3
GS F321	Mass Media Content and Design	2	1	3
GS F322	Critical Analysis of Literature and Cinema	3	0	3
GS F342	Computer Mediated Communication	3	0	3
GS F343	Short Film and Video Production	2	1	3

DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F385	Introduction to Gender Studies	3	0	3
GS F211	Modern Political Concepts	3	0	3
GS F212	Environment, Development & Climate Change	3	0	3
GS F231	Dynamics of Social Change	3	0	3
GS F232	Introductory Psychology	3	0	3
GS F242	Cultural Studies	3	0	3
GS F311	Introduction to Conflict Management	3	0	3
GS F325	Journalism	3	0	3
GS F326	Creative Thinking	2	1	3
GS F327	Selected Reading	3	0	3
GS F333	Public Administration	3	0	3
GS F334	Global Business Technology & Knowledge Sharing	3	0	3
GS F344	Copywriting	2	0	2
HSS F227	Cross Cultural Skills	3	0	3
HSS F232	Introduction to Development Studies	3	0	3
HSS F315	Society, Business, and Politics	3	0	3
HSS F317	Introduction to Globalization	3	0	3
HSS F319	Lighting for Theatre and Films			2
HSS F323	Organizational Psychology	3	0	3
HSS F328	Human Resource Development	3	0	3
HSS F341	Performance Design	1	2	3
HSS F343	Professional Ethics	3	0	3
HSS F346	International Relations	3	0	3

GENERAL STUDIES – DEVELOPMENT STUDIES STREAM

CORE COURSES		**L**	**P**	**U**
ECON F211	Principles of Economics	3	0	3
GS F211	Modern Political Concepts	3	0	3
GS F212	Environment, Development & Climate Change	3	0	3
GS F213	Development Theories	3	0	3
GS F231	Dynamics of Social Change	3	0	3
GS F232	Introductory Psychology	3	0	3
GS F233	Public Policy	3	0	3
GS F234	Development Economics	3	0	3
GS F311	Introduction to Conflict Management	3	0	3
GS F312	Applied Philosophy	3	0	3
GS F331	Techniques in Social Research	3	0	3
GS F332	Contemporary India	3	0	3
GS F333	Public Administration	3	0	3
GS F334	Global Business Technology & Knowledge Sharing	3	0	3

DISCIPLINE ELECTIVE COURSES		L	P	U
BITS F214	Science, Technology and Modernity	3	0	3
BITS F385	Introduction to Gender Studies	3	0	3
BITS F399	Humanistic Theories of Science and Technology	3	0	3
HSS F233	Main Trends in Indian History	3	0	3
HSS F234	Main Currents of Modern History	3	0	3
HSS F235	Introductory Philosophy	3	0	3
HSS F236	Symbolic Logic	3	0	3
HSS F312	Bureaucracy	3	0	3
HSS F315	Society, Business, and Politics	3	0	3
HSS F343	Professional Ethics	3	0	3
HSS F344	Heritage of India	3	0	3
HSS F345	Gandhian Thoughts	3	0	3
HSS F346	International Relations	3	0	3

Project Type Courses

In addition to discipline electives mentioned above, the following project type courses are also being offered by the departments for each of their respective programmes. These courses may be taken by the students to meet the discipline elective requirements.

XXX F266	Study Project	3
XXX F366	Laboratory Project	3
XXX F367	Laboratory Project	3
XXX F376	Design Project	3
XXX F377	Design Project	3
XXX F491	Special Project	3

where XXX indicates the Degree programme. For example, CHE F266 Study Project is intended for a student of B.E. Chemical Engineering.

A student may avail a maximum of 3 Project courses to meet the Discipline Electives Requirement under the head of (Discipline) Electives with the following limitations:

(a) All of these Project courses should be

  (i) within the Discipline (for which the degree is being awarded) or

  (ii) from an allied Discipline if so specified by the Department offering the degree

(b) The projects may be chosen from under these sub-heads.

  (i) Study Projects (maximum of 1)

  (ii) Laboratory (maximum of 2)

  (iii) Design Projects (maximum of 2)

  (iv) Special Projects (maximum of 1)

A student may avail a maximum of 3 Project courses (under any of the heads mentioned above offered by any discipline as an Open Elective. However, in total a student may avail at most 5 Project courses against Electives slots in any category.

Pool of Humanities courses for first degree programmes:

The following is the list of courses from which Humanities Electives can be taken by the students in different first degree programs to meet the general institutional requirement of eight units under the Humanities elective category:

Course No.	Course Title	L	P	U
BITS F214	Science, Technology and Modernity	3	0	3
BITS F226	Soft Skills for Professionals	3	0	3
BITS F328	Innovation Ecosystem and the Future of Work			4*
BITS F385	Introduction to Gender Studies	3	0	3
BITS F399	Humanistic Theories of Science and Technology	3	0	3
BITS F419	Management of Cross Cultural Engineering Teams	3	0	3
GS F211	Modern Political Concepts	3	0	3
GS F212	Environment, Development & Climate Change	3	0	3
GS F213	Development Theories	3	0	3
GS F221	Business Communication	3	0	3
GS F222	Language Lab Practice	0	3	3
GS F223	Introduction to Mass Communication	3	0	3
GS F224	Print and Audio-Visual Advertisement	2	1	3
GS F231	Dynamics of Social Change	3	0	3
GS F232	Introductory Psychology	3	0	3
GS F233	Public Policy	3	0	3
GS F234	Development Economics	3	0	3
GS F241	Creative Writing			3*

Course No.	Course Title	L	P	U
GS F242	Cultural Studies	3	0	3
GS F243	Current Affairs	3	0	3
GS F244	Reporting and Writing for Media	2	1	3
GS F245	Effective Public Speaking	2	1	3
GS F311	Introduction to Conflict Management	3	0	3
GS F312	Applied Philosophy	3	0	3
GS F313	Marxian Thoughts	3	0	3
GS F321	Mass Media Content and Design	2	1	3
GS F322	Critical Analysis of Literature and Cinema	3	0	3
GS F325	Journalism	3	0	3
GS F326	Creative Thinking	2	1	3
GS F327	Selected Reading	3	0	3
GS F331	Techniques in Social Research	3	0	3
GS F332	Contemporary India	3	0	3
GS F333	Public Administration	3	0	3
GS F343	Short Film and Video Production	2	1	3
GS F344	Copywriting	2	0	2
HSS F211	Introduction to Arabic	3	0	3
HSS F221	Readings from Drama	3	0	3
HSS F222	Linguistics	3	0	3
HSS F223	Appreciation of Indian Music	3	0	3
HSS F224	English Skills for Academic	3	0	3
HSS F226	Postmodernism	3	0	3
HSS F227	Cross Cultural Skills	3	0	3
HSS F228	Phonetics & Spoken English	3	0	3
HSS F229	Introduction to Western Music	3	0	3
HSS F232	Introduction to Development Studies	3	0	3
HSS F233	Main Trends in Indian History	3	0	3
HSS F234	Main Currents of Modern History	3	0	3
HSS F235	Introductory Philosophy	3	0	3
HSS F236	Symbolic Logic	3	0	3
HSS F237	Contemporary Indian English Fiction	3	0	3
HSS F238	Sports and Society	3	0	3
HSS F244	Crime and New Media	3	0	3

Course No.	Course Title	L	P	U
HSS F245	Gender, Science and Technology	3	0	3
HSS F246	Philosophy of Nāgārjuna	3	0	3
HSS F247	Social Informatics	3	0	3
HSS F248	Introduction to Disability Studies	3	0	3
HSS F249	Politics in India	3	0	3
HSS F250	Comics and Visual Culture	3	0	3
HSS F251	Introduction to Discourse and Conversational Analysis	2	1	3
HSS F252	International Law	3	0	3
HSS F266	Study Project			3
HSS F311	Introduction to Videogame Studies	3	0	3
HSS F313	Introduction to Contemporary Arts	3	0	3
HSS F315	Society, Business, and Politics	3	0	3
HSS F316	Popular Literature and Culture of South Asia	3	0	3
HSS F317	Introduction to Globalization	3	0	3
HSS F318	Introduction to Anthropology	3	0	3
HSS F319	Lighting for Theatre and Films			2*
HSS F323	Organizational Psychology	3	0	3
HSS F325	Cinematic Adaptation	3	0	3
HSS F326	Humanities and Design	2	1	3
HSS F327	Contemporary Drama	3	0	3
HSS F328	Human Resource Development	3	0	3
HSS F329	Musicology – An – Introduction	3	0	3
HSS F330	Appreciation of Art	3	0	3
HSS F331	Sankara's Thoughts	3	0	3
HSS F332	Cinematic Art			3*
HSS F333	Comparative Religion	3	0	3
HSS F334	Srimad Bhagavad Gita	3	0	3
HSS F335	Literary Criticism	3	0	3
HSS F336	Modern Fiction	3	0	3
HSS F337	English Literary Forms and Movements	3	0	3
HSS F338	Comparative Indian Literature	3	0	3
HSS F339	Theatre Art Acting and Production	3	0	3
HSS F340	Post Colonial Literatures	3	0	3

Course No.	Course Title	L	P	U
HSS F341	Performance Design	1	2	3
HSS F342	Advanced Communicative English	3	0	3
HSS F343	Professional Ethics	3	0	3
HSS F344	Heritage of India	3	0	3
HSS F345	Gandhian Thoughts	3	0	3
HSS F346	International Relations	3	0	3
HSS F347	Introduction to Carnatic Music	3	0	3
HSS F348	Introduction to Hindustani Music	3	0	3
HSS F349	Ecocriticism	3	0	3
HSS F350	Human Rights: History, Theory & Practice	3	0	3
HSS F351	Social and Political Ecology	3	0	3
HSS F352	Technology, Work and Society	3	0	3
HSS F353	Philosophy of Aesthetics	3	0	3
HSS F354	Introduction to Islamic Economy	3	0	3
HSS F355	Dictatorship, Democracy & Development	3	0	3
HSS F356	Social Movements and Protest Politics	3	0	3
HSS F364	Political Economy of Gulf Cooperation Council States	3	0	3
HSS F365	Science of Sustainable Happiness	3	0	3
HSS F368	Asian Cinemas and Cultures	3	0	3
HSS F369	Caste and Gender in India	3	0	3
HSS F371	Cities-Life, Issues and Conflicts	3	0	3
HSS F372	Introduction to Social Psychology	3	0	3
HSS F373	Shakespeare and Popular Culture	3	0	3
HSS F374	Urban Modernity and the Renewal of Paris	3	0	3
HSS F375	Business and Politics in Colonial and Post Colonial India: a historical approach	3	0	3
HSS F378	Cinemas of India: From Past to Present	3	0	3
HSS F399	Introduction to American Literature	3	0	3
SANS F111	Sanskrit	3	0	3

It may be noted that a student cannot count a course (or its equivalent) of his/her own discipline (s) as a humanities elective even if it is listed in this pool of humanities electives.

Other Courses

BIO F231	Biology Project Laboratory	3
BITS C483	Indian Wisdom for Modern Management	3 0 3
BITS F211	Introduction to IPR	1
BITS F212	Introduction to Human Rights	1
BITS F213	Introduction to Environmental studies	1
BITS F215	Applications of Bio-Medical Instrumentation Techniques in Healthcare	2 0 2
BITS F217	Environment, Development and Climate Change	3 0 3
*BITS F225	Environmental Studies	3 0 3
BITS F311	Image Processing	3 0 3
BITS F319	Negotiation Skills and Techniques	2 0 2
BITS F320	Managerial Skills	2*
BITS F321	Legal and Economic Environment of Business	4*
BITS F333	Project on Organisational Aspects	3
BITS F334	Project on Organisational Aspects	3
BITS F372	Data Communications and Networks	3 0 3
BITS F381	TIC Projects	3
BITS F382	Reading Course	3
BITS F383	TIC Projects	3
BITS F398	Creative Multimedia	2 2 3
BITS F414	Introduction to Bioinformatics	3 0 3
BITS F416	Introduction to Nanoscience	3 0 3
BITS F417	Micro Fluidics and its Application	4*
BITS F428	Essentials of Strategic Management	3 0 3
BITS F431	Flexible Manufacturing Systems	3 2 3
BITS F441	Robotics	3
BITS F442	Remote Sensing and Image Processing	3
BITS F444	Artificial Intelligence	3
BITS F445	Neural Networks and Applications	3 0 3
BITS F446	Pattern Recognition	3
BITS F447	Multimedia Computing	3 0 3
BITS F448	Retail Management Systems	3 0 3
BITS F449	Financial Engineering	3 0 3
BITS F461	Software Engineering	3
BITS F462	Renewable Energy	3 0 3
BITS F468	New Venture Creation	3 0 3

BITS F469	Financing Infrastructure Projects	3 0 3
BITS F488	Services Management Systems	3 0 3
BITS F490	Project Management	4
BITS F493	Business Analysis and Valuation	3 0 3
BITS F494	Environmental Impact Assessment	3 1 4
BITS G516	Introduction to Business Sustainability	3 0 3
BITS G517	Cross Cultural Management	3 0 3
MGTS F351	Organisational Behaviour	3 0 3
MGTS F433	Advertising and Sales Promotion	3 0 3
PHY F221	Modern Physics	3 0 3
PHY F345	Quantum Mechanics for Engineers	3 0 3

***[Students completing this course will be awarded a non-letter grade (GOOD or POOR)]**

List of Audit Type Courses

BITS N101T	PHY FITNESS HEALTH & WEL	1*
BITS N301T	PERSONALITY INTEGRATION LEADERSHIP ORIENTATION AND TEAMWORK	
CHI N101T	BEGINNING CHINESE	3 0 3
FRE N101T	BEGINNING FRENCH	3*
FRE N102T	TECHNICAL FRENCH	3 0 3
GER N101T	BEGINNING GERMAN	3 0 3
GER N102T	TECHNICAL GERMAN	3 0 3
HSS N201T	INTRO TO PHOTOGRAPHY	3 0 3
HSS N202T	IND C DANCE BHARATNATYAM	3 0 3
HSS N203T	BASIC ARABIC	3 0 3
HSS N301T	ELEMENTS OF DANCE	1 1 2
JAP N101T	BEGINNING JAPANESE	3 0 3
MUSIC N103T	INDIAN CLASS MUSIC VOC I	3*
MUSIC N104T	INDIA CLASS MUSIC VOC II	3*
MUSIC N105T	WESTERN CLASS MUSIC I	3*
MUSIC N106T	WESTERN CLASS MUSIC II	3*
MUSIC N111T	HIND CLASS MUSIC (INST)I	3*
MUSIC N112T	HIND CLASS MUSIC(INST)II	3*
MUSIC N113T	INDIA CLASS MUSIC(INST)I	3*
MUSIC N114T	INDIA CLASS MUSIC(INST)II	3*
MUSIC N203T	INDIA CLASS MUSIC(VOC) III	3*
MUSIC N204T	IND CLASS MUSIC(VOC) IV	3*
MUSIC N205T	WESTERN CLASS MUSIC III	3*
MUSIC N206T	WESTERN CLASS MUSIC IV	3*
MUSIC N213T	IND CLASS MUSIC (INST) III	3*
MUSIC N214T	IND CLASS MUSIC(INST)IV	3*
MUSIC N303T	ADV IND MUSIC PRA(VOCAL)	-
MUSIC N313T	ADV IND MUSIC PRA (INST)	-
RUS N101T	BEGINNING RUSSIAN	3 0 3
RUS N102T	TECHNICAL RUSSIAN	3 0 3

MINOR PROGRAMMES FOR FIRST DEGREE STUDENTS

"Minor programs" are offered as options for first degree students with the intent of encouraging them to add focus to their supplemental learning (outside a major area) as well as recognizing and certifying the knowledge obtained in an area that is outside of their major area.

General Guidelines

- A minor would allow a Department (or multiple Departments) to offer a package of courses in an area/sub-area to students for whom this area/sub-area would not be part of their (major) program.
- A minor option would allow a student to pursue the study of an area or a sub-area through a set of courses but not as exhaustively as required to obtain a degree (i.e. a major) in that area.
- A minor may be inter-disciplinary (e.g. a minor in Computational Science may include courses in Numerical Analysis, Computational Physics, Computational Chemistry, and Bioinformatics among others).
- A minor will be recognized by means of a separate certificate.

Requirements for a minor

- Courses and Units Requirement:

  Each minor would be defined by coursework requirement with the following conditions:

Category	Courses	Units
Minor – Core	4 (max)	12 (max)
Minor – Electives	2 (min)	6 (min)
Minor – Total	5 (min)	15 (min)

- Elective Pool:
  - The pool of electives specific to a minor may include courses from one or more disciplines and may include project / seminar type courses.
  - A student may use at most one project / seminar type course to meet the requirements of a minor.
- Overlap in requirements:
  - At most 2 courses (and at most 6 units) out of the above requirement (of 5 courses and 15 units) may be met by mandatory courses of the student's degree i.e. major (or degrees i.e. majors) : i.e. from the general institutional requirement (excluding Humanities requirement) or the (Major) discipline Core(s).
  - No course may be used to meet the requirements of two different minors nor may a course be used to the meet the requirements of two majors and a minor.
- GPA requirement:
  - A student – on completion of the requirements for a minor – must have maintained a cumulative GPA of 4.5 or above (out of 10) in the courses applied to the minor.

Process for declaring / obtaining a minor

- A student – if he/she chooses to pursue a minor – must declare at the end of the 2nd year that he/she will pursue a specific minor. The student will charged a small fee for logistics.
- If and when he/she completes the requirements for the minor – as stipulated above and as stipulated for the specific minor, then he/she may apply for a "minor" certificate.
- If it is verified that the requirements are met then he/she will be awarded a "minor certificate" (separate from a degree – i.e. major – certificate).
- A minor certificate will be issued only on completion of a degree (i.e. a major).

At present Seventeen minor programs viz. Minor in Aeronautics, Computational Economics, Computing and Intelligence, Data Science, Data Science in Climate & Health, English Studies, Entrepreneurship, Film and Media, Finance, Management, Materials Science and Engineering, Philosophy, Economics and Politics (PEP), Physics, Public Policy, Robotics and Automation, Supply Chain Analytics and Water and Sanitation have been designed. The details of which are given below:

Minor in Aeronautics					
Description	Aeronautics is an exhilarating field encompassing the fundamentals of aerodynamics (interaction of air with objects in motion), propulsion (power systems responsible for the generation of thrust for providing motion), structures (design of airframes and material characteristics), and flight mechanics (trajectory study and optimization), as applied to air-borne vehicles within the Earth's atmosphere, and to rockets and spacecrafts outside.				
Courses & Units Req.	06 courses (min) 18 units (min)				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	AN F311	Principles of Aerodynamics	3	0	3
	AN F312	Aircraft Propulsion	3	0	3
	AN F313	Flight Mechanics and Controls	3	0	3
Electives	AN F314	Introduction to Flight	3	0	3
	AN F315	Aircraft Structures	3	0	3
	ME F415	Gas Dynamics	3	0	3
	ME F418	Rocket and Spacecraft Propulsion	3	0	3
	ME F452	Composite Materials and Design	3	0	3
	ME F482	Combustion	3	0	3
	ME F485	Numerical Techniques for Fluid Flow & Heat Transfer	3	0	3
	EEE F242	Control Systems	3	0	3
	EEE F417	Computer Based Control Systems	3	0	3
	ME F376	Design Project			3

Minor in Computational Economics					
Description	The joint field of economics, mathematics, and computer science have emerged from converging intellectual needs for interdisciplinary teaching and research. The contemporary tools and techniques used by computer scientists have become increasingly important for economists working with data to address complex business problems. Students interested in learning about computational mechanism design with applications to economics and especially those whose interest is more generally focused on data analytics will be highly benefitted from this programme. This programme is designed to cater to the needs of the cutting-edge industry thereby combining advanced computational tools with economic reasoning. It would help students to develop a deep background in advanced tools for analysis of economic data, which is essential for making sound economic decisions. The programme combines the strengths of multiple departments to educate students in these important computational skills linked to economics, and to prepare them for careers in economics, finance, and business. Reflecting on this strong interdisciplinary relationship, this programme will also be excellent preparation for graduate study in economics or decision sciences.				
Courses & Units Req.	**05 courses (min)** **15 units (min)**				
Core Courses	**Course Number**	**Course Title**	L	P	U
	ECON F215	Computational Methods for Economics	3	0	3
	ECON F241	Econometric Methods	3	0	3
	ECON F242	Microeconomics	3	0	3
Electives	BITS F314	Game Theory and its Applications	3	0	3
	BITS F464	Machine Learning	3	0	3
	CS F320	Foundations of Data Science	3	0	3
	ECON F342	Applied Econometrics	3	0	3
	ECON F419	Advanced Microeconomics	3	0	3
	ECON F420	Applied Macroeconometrics	3	0	3
	MATH F424	Applied Stochastic Process	3	1	4

Minor in Computing and Intelligence					
Description	The Minor in Computing and Intelligence aims to enable the students majoring in disciplines other than Computer Science to gain a deeper understanding of computing and artificial intelligence and apply the same in solving problems in diverse domains. While courses like Foundations of Data Structures and Algorithms would help the students with abstract thinking and problem solving, courses like Operating Systems, Artificial Intelligence etc., will give them exposure to the fundamental aspects of computing and intelligent systems. This minor programme is exclusively designed for first-degree students of non-Computer Science disciplines.				
Courses & Units Required	**06 courses (min)** **18 units (min)**				
Core Courses	**Course Number**	**Course Title**	L	P	U
	BITS F232	Foundations of Data Structures and Algorithms	3	1	4
	CS F372	Operating Systems	3	0	3
	CS F407	Artificial intelligence	3	0	3
Electives	BITS F311	Image Processing	3	0	3
	BITS F452	Blockchain Technology	3	0	3
	BITS F463	Cryptography	3	0	3
	BITS F464	Machine Learning	3	0	3
	CS F212	Database Systems	3	1	4
	CS F213	Object Oriented Programming	3	1	4
	CS F301	Principles of Programming Languages	2	0	2
	CS F303	Computer Networks	3	1	4
	CS F314	Software Development for Portable Devices	2	1	3
	CS F315	Information and Communication Technologies and Development	3	0	3
	CS F415	Data Mining	3	0	3
	IS F311	Computer Graphics	3	0	3
	IS F341	Software Engineering	3	1	4

Minor in Data Science					
Description	The minor in Data Science aims to enable students to learn the basic skills required by Data Scientist for today's world. Data Science is becoming ubiquitous to all kinds of industry and opening up new avenues of business. This minor will help students to apply knowledge from Mathematics, Statistics and Computing for analyzing data collected from different kinds of sources in their respective engineering applications and make meaningful and actionable insights.				
Courses & Units Required	5 courses (min) 15 units (min)				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	BITS F464	Machine Learning	3	0	3
	CS F320	Foundations of Data Science	3	0	3
	MATH F432	Applied statistical Methods	3	0	3
Electives	BITS F453	Computational Learning Theory	3	0	3
	BITS F454	Bio-Inspired Intelligence: Algorithms and Applications	3	0	3
	CS F317	Reinforcement Learning	3	0	3
	CS F407	Artificial Intelligence	3	0	3

Minor in Data Science					
	CS F415	Data Mining	3	0	3
	CS F425	Deep Learning	3	0	3
	CS F426	Graph Mining	3	1	4
	CS F429	Natural Language Processing	3	0	3
	CS F432	Brain-inspired Deep Learning	3	0	3
	CS F433	Computational Neuroscience	3	0	3
	CS F469	Information Retrieval	3	0	3
	CS G519	Social Media Analytics	3	1	4
	MATH F212 **OR** ME F320	Optimization **OR** Engineering Optimization	3	0	3
	MATH F353	Statistical Inference and applications	3	0	3
	MATH F424	Applied Stochastic Processes	3	1	4
	MATH F471	Nonlinear Optimization	3	0	3

Minor in Data Science in Climate and Health					
Description	The minor in Data Science aims to enable students to learn the basic skills required by Data Scientist for today's world. Data Science is becoming ubiquitous to all kinds of industry and opening up new avenues of business. This minor will equip students as emerging professionals with the interdisciplinary data skills needed to address challenges at the intersection of climate and health. This new minor programme will train data practitioners on the front lines of the climate crisis to help advance solutions to climate-related health issues.				
Courses & Units Required	**06 courses (min)** **17 units (min)**				
Core Courses	**Course Number**	**Course Title**	L	P	U
	BITS F329	Project on Social and Environmental Applications of Data Science			3*
	BITS F464	Machine Learning	3	0	3
	CS F320	Foundations of Data Science	3	0	3
	MATH F432	Applied statistical Methods	3	0	3
Electives (Any two)	CE F326	Impact of Climate Change on Water	2	1	3
	GS F212	Environmental Development and Climate Change	3	0	3
	MPH G510	Biostatistics and Computers in Public Health	3	2	5

Minor in English Studies					
Description	English has a rich linguistic, literary and cultural heritage. The classic literary masterpieces of English are still widely read and appreciated. English has also evolved over centuries and is now considered as the pre-eminent means of communication in the various sectors such as business, diplomacy, mass media, education, etc., across the globe. The Minor in English Studies introduces students to the language and literary canons, and renders them with adequate exposure not only to the cultural and linguistic aspects but also to practical applications of English language and literature. In particular, the core and elective courses included in the Minor would encourage students to acquire a critical understanding of literary and linguistic analyses, and the capacity to engage meaningfully in analysis, interpretation, and explanation. The Minor also gives an opportunity for students to choose modules and develop their own interests in language or literature. Students who follow the Minor will have an enhanced understanding of the nature of the English language and literature and also of the tools needed for further independent exploration of literary and linguistic phenomena.				
Courses & Units Required	5 courses (min) 15 units (min)				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	GS F241	Creative Writing	2	1	3
	HSS F337	English Literary Forms and Movements	3	0	3
Electives Pool – I (Language)	GS F221	Business Communication	3	0	3
	GS F244	Reporting and Writing for Media	3	0	3
	GS F245	Effective Public Speaking	3	0	3
	HSS F222	Linguistics	3	0	3
	HSS F227	Cross Cultural Skills	3	0	3
	HSS F228	Phonetics and Spoken English	3	0	3
	HSS F342	Advanced Communicative English	3	0	3
Elective Pool-II (Literature)	GS F242	Cultural Studies	3	0	3
	GS F322	Critical Analysis of Literature and Cinema	3	0	3
	HSS F221	Readings from Drama	3	0	3
	HSS F226	Postmodernism	3	0	3
	HSS F237	Contemporary Indian English Fiction	3	0	3
	HSS F316	Popular Literature and Culture of South Asia	3	0	3
	HSS F327	Contemporary Drama	3	0	3
	HSS F330	Appreciation of Art	3	0	3
	HSS F332	Cinematic Arts	3	0	3
	HSS F335	Literary Criticism	3	0	3
	HSS F336	Modern Fiction	3	0	3
	HSS F338	Comparative Indian Literature	3	0	3
	HSS F340	Postcolonial Literatures	3	0	3
	HSS F349	Ecocriticism	3	0	3
	HSS F373	Shakespeare and Popular Culture	3	0	3
	HSS F399	Introduction to American Literature	3	0	3

Minor in Entrepreneurship					
Description	Entrepreneurship has tremendous impact on development of economy as well as society addressing various market & societal problems through continuous value creation in terms of innovations and job creation. The minor in entrepreneurship aims to equip students from different disciplines with better understanding of entrepreneurial process, necessary skills and experience to translate ideas into real innovative products/services to new entrepreneurial ventures. In this programme, hands-on experiential learning is emphasized giving students an opportunity to learn in a team environment, design innovative products/services and create their own businesses. This will motivate students to pursue entrepreneurship as their career choice.				
Courses & Units Required	**5 courses (min)** **15 units (min)**				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	BITS F468	New Venture Creation	3	0	3
	BITS F482 or ECON F414	Creating and Leading Entrepreneurial Organizations	3	0	3
	ECON F212	Fundamentals of Finance and Accounting	3	0	3
Electives (minimum of 2 courses and additional units required to make the total to 15)	BITS F322	Venture Team Development and Organization	3	0	3
	BITS F323	Venture Finance	3	0	3
	BITS F324	Strategy for Entrepreneurs	3	0	3
	BITS F325	New Product and Service Design	3	0	3
	BITS F326	Design Thinking for Innovation & Entrepreneurship	3	0	3
	BITS F427	Digital Marketing	3	0	3

Minor in Film and Media					
Description	Film and its derivative forms of media such as television and advertising are dominant cultural forces in the contemporary world. The minor in Film and Media aims to provide: i. An introduction to media studies with a specific focus on film studies ii. A basic introduction to Print and Digital Media including film making and film appreciation iii. Hands-on training in writing for media and film production				
Courses & Units Required	6 courses (min) 18 units (min)				
Core Courses	**Course number**	**Course Title**	**L**	**P**	**U**
	GS F223	Introduction to Mass Communication	3	0	3
	GS F244	Reporting and Writing for Media	3	0	3
	GS F322	Critical Analysis of Literature and Cinema	3	0	3
Elective Courses	GS F224	Print and Audio Visual Advertising	3	0	3
	GS F242	Cultural Studies	3	0	3
	GS F321	Mass Media Content and Design	3	0	3
	GS F343	Short Film and Video Production	3	0	3
	HSS F332	Cinematic Arts	3	0	3

Minor in Finance					
Description	The minor in Finance aims at providing the student a grounding in the basic concepts of accounting and finance so as to complement their existing disciplinary knowledge, enrich their educational experience, enable them to make better financial decisions, and expand their career opportunities. It will also give students an opportunity to learn more about investments and quantitative applications in finance.				
Courses & Units Required	5 courses (min) 15 units (min)				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	ECON F212	Fundamentals of Finance and Accounting	3	0	3
	FIN F315	Financial Management	3	0	3
Elective Courses	ECON F241	Econometric methods	3	0	3
	ECON F312	Money banking and Financial markets	3	0	3
	ECON F355	Business Analysis & Valuation	3	0	3
	ECON F411	Project Appraisal	3	0	3
	ECON F413	Financial Engineering	3	0	3
	FIN F242	Introduction to Financial Mathematics	3	0	3
	FIN F243	Functions & Working of Stock Exchanges	3	0	3
	FIN F311	Derivatives & Risk Management	3	0	3
	FIN F312	Fundamentals of Taxation and Audit	3	0	3
	FIN F313	Security Analysis & Portfolio Management	3	0	3
	FIN F314	Investment Banking & Financial Services	3	0	3
	FIN F414	Financial Risk Analytics and Management	3	0	3

Minor in Management					
Description	"Minor in Management" is designed for the student who wants a general introduction to the functioning of a business and develops a business acumen. By gaining an understanding of the areas of management, the student will have a competitive advantage in the marketplace and throughout their career. The student shall be better equipped to handle their projects in practice school by understanding organizational and managerial issues. It would also enable him/her to combine their technical and managerial skills and explore the field of business consulting, role of management trainees, etc. Those interested in pursuing an MBA would get an opportunity to explore the management field and assess its fit with their career interest.				
Courses & Units Required	**05 courses (min)** **15 units (min)**				
Core Courses	**Course Number**	**Course Title**	L	P	U
	BITS F428	Essentials of Strategic Management	3	0	3
	MGTS F211	Principles of Management	3	0	3
	MGTS F314	Essentials of Financial Management	3	0	3
Electives	BITS F326	Design Thinking for Innovation and Entrepreneurship	3	0	3
	ECON F415	New Venture Creation	3	0	3
	ECON F434	International Business	3	0	3
	ECON F435	Marketing Research	3	0	3
	HSS F328	Human Resources Development	3	0	3
	MF F219	Operations Management	3	0	3
	MF F319	Supply Chain Management	3	0	3
	ME F443	Quality Control, Assurance and Reliability	3	0	3
	MGTS F311	Marketing	3	0	3
	MGTS F313	Product and Brand Management	3	0	3
	MGTS F315	Foundations of Business Analytics	3	0	3
	MGTS F316	Managerial and Leadership Skills	3	0	3
	MGTS F351	Organizational Behaviour	3	0	3

Minor in Materials Science and Engineering					
Description	Materials Science and Engineering is an interdisciplinary subject that makes use of knowledge from Physics, Chemistry, Engineering, Mathematics, Biology and Biotechnology, but which has its own special character. It is always evolving – new and exciting materials such as nanomaterials, high-temperature and lightweight materials, green materials and sustainable biomaterials for tissue engineering are continually emerging. The field of Material Science combines a wide knowledge base and puts it to diverse practical and commercial use.				
Courses & Units Required	5 courses (min) 15 units (min)				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	CHE F243 / ME F213	Materials Science and Engineering	3 2	0 0	3 2
	MST F331	Materials Characterization	3	1	4
	MST F332	Materials Processing	3	0	3
Elective Courses	BITS F416	Introduction to Nanoscience	3	0	3
	CHE F433	Corrosion Engineering	3	0	3
	CHEM F223	Colloid and Surface Chemistry	3	0	3
	CHEM F326	Solid State Chemistry	3	0	3
	CHEM F336	Nanochemistry	3	1	4
	ME F452	Composite Materials and Design	3	0	3
	MST F333	Introduction to Biomaterials	3	0	3
	MST F334	Materials for Catalytic Applications	3	0	3
	MST F335	Coating and thin film technology	3	0	3
	MST F336	Glass Technology	3	0	3
	MST F337	Materials for Energy Applications	3	0	3
	MST F338	Metals and Alloys	3	0	3
	MST F339	Polymer Materials	3	0	3
	PHY F379	Thin Film Technology	3	0	3
	PHY F414	Physics of Advanced Materials	3	1	4
	PHY F416	Soft condensed Matter Physics	3	1	4

Minor in Philosophy, Economics, and Politics					
Description	The minor in *Philosophy, Economics & Politics & (PEP)* aims at introducing students to a wide range of approaches to understand the social and human world we live in and to develop skills useful for a range of career opportunities in national and international organizations. It would particularly interest and enthuse those students who wish to complement their core expertise in science and engineering with a good grasp of the humanities and social sciences. As a multi-disciplinary minor, this option will provide a judicious mix of knowledge in social sciences (economics, sociology and politics) and the humanities (philosophy) that would enable students to draw connections among political, economic, and social phenomena as well as equip them with the necessary skills to think through complex challenges of our society in a creative and critical manner.				
Courses & Units Required	6 courses (min) 18 units (min)				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	ECON F211	Principles of Economics	3	0	3
	GS F211	Modern Political Concepts	3	0	3
	HSS F235	Introductory Philosophy	3	0	3
Elective Courses	BITS F 385	Introduction to Gender Studies	3	0	3
	GS F231	Dynamics of Social Change	3	0	3
	GS F234	Development Economics	3	0	3
	GS F243	Current Affairs	3	0	3
	GS F312	Applied Philosophy	3	0	3
	GS F313	Marxian Thoughts	3	0	3
	GS F332	Contemporary India	3	0	3
	GS F333	Public Administration	3	0	3
	HSS F236	Symbolic Logic	3	0	3
	HSS F315	Society, Business, and Politics	3	0	3
	HSS F322	Social and Political Ecology	3	0	3
	HSS F331	Sankara's Thoughts	3	0	3
	HSS F333	Comparative Religion	3	0	3
	HSS F343	Professional Ethics	3	0	3
	HSS F345	Gandhian Thoughts	3	0	3
	HSS F346	International Relations	3	0	3
	HSS F350	Human Rights: History, Theory and Practice	3	0	3
	HSS F353	Philosophy of Aesthetics	3	0	3
	HSS F354	Introduction to Islamic Economy	3	0	3
	HSS F355	Dictatorship, Democracy & Development	3	0	3
	HSS F356	Social Movements and Protest Politics	3	0	3

Minor in Physics					
Description	The theories in physics are all-pervading and their applications are found in varied branches of engineering and sciences. The minor in Physics aims to introduce the student to fundamental theories in physics. The core courses cover the basics and by choosing from the large pool of electives, the student will be able to pursue to a deeper level the areas of her/his interest. This minor would equip the students with the skill and knowledge which will help them in gaining insights in their own primary area of study.				
Courses & Units Required	5 courses (min) 15 units (min)				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	PHY F212 **or** ECE F212/ EEE F212/ INSTR F212	Electromagnetic Theory – 1 **or** Electromagnetic Theory	3	0	3
	PHY F242	Quantum Mechanics – 1	3	0	3
	PHY F312	Statistical Mechanics	3	0	3
Elective Courses	BITS F316	Nonlinear Dynamics and Chaos	3	0	3
	BITS F386	Quantum Information and Computing	3	0	3
	PHY F211	Classical Mechanics	3	1	4
	PHY F213	Optics	3	0	3
	PHY F214	Electricity Magnetism and Optics Lab	0	2	2
	PHY F215	Introduction to Astronomy and Astrophysics	3	0	3
	PHY F241	Electromagnetic Theory – 2	3	1	4
	PHY F243	Mathematical Method of Physics	3	0	3
	PHY F244	Modern Physics Lab	0	2	2
	PHY F311	Quantum Mechanics – 2	3	0	3
	PHY F313	Computational Physics	3	0	3
	PHY F315	Theory of Relativity	3	0	3
	PHY F341	Solid State Physics	3	0	3
	PHY F342	Atomic and Molecular Physics	3	0	3
	PHY F343	Nuclear and Particle Physics	3	0	3
	PHY F346	Laser Science and Technology	3	0	3
	PHY F418	Lasers and Applications	3	1	4
	PHY F426	Physics of Semiconductors Devices	3	1	4
	PHY F427	Atmospheric Physics	3	0	3
	PHY F428	Quantum Information Theory	3	0	3
	PHY F434	Foundations of Quantum Mechanics	3	0	3

Minor in Public Policy					
Description	The Minor in Public Policy aims at providing the students a clear and contextualised understanding of conceptual and empirical aspects of public policy, the nature of public policy interventions in India and their varying impacts. Also, it intends to provide the students an understanding of the dynamics of policymaking, central aspects of governance and core features and functions of institutions, and equip them with skills of policy analysis.				
Courses & Units Required	5 courses (min) 15 units (min)				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	GS F233	Public Policy	3	0	3
	GS F333	Public Administration	3	0	3
Elective Courses	HSS F232	Introduction to Development Studies	3	0	3
	HSS F317	Introduction to Globalisation	3	0	3
	HSS F322	Social and Political Ecology	3	0	3
	HSS F361	Urban Policy and Governance	3	0	3
	HSS F362	Local Governance and Participation	3	0	3
	HSS F363	Disaster and Development	3	0	3

Minor in Robotics and Automation					
Description	This minor aims to impart specialized knowledge and skills in robotics and automation required by engineers to the current demands of various industrial sectors. Automobile, aerospace & defense, logistics engineering and factory automation companies are currently asking for engineering graduates with add-on skills in these areas. Feedback has established that several sectors of industry need the newly recruited employees with knowledge and skills in 'automation', 'robotics', and 'mechatronics'. Currently, the need of core courses of any B.E. programme of the Institute limits sufficient coverage of these topics in the existing core and hence the only way students can complement their learning with these specialized courses is through a minor programme. This minor programme has been designed by keeping that need in focus. This minor programme consists of a fairly generic core so as to be relevant to students of any discipline and a broad set of elective courses covering application of the fundamentals of robotics and automation to various industry sectors.				
Courses & Units Required	05 courses (min) 15 units (min)				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	BITS F441	Robotics	3	0	3
	EEE/INSTR/ECE F242	Control Systems	3	0	3
	BITS F327	Artificial Intelligence for Robotics	2	1	3
Electives	BITS F312	Neural Network & Fuzzy Logic	3	0	3
	BITS F415	Introduction To MEMS	3	1	4
	BITS F442	Remote Sensing and Image Processing	3	0	3

Minor in Robotics and Automation					
	BITS F464	Machine Learning	3	0	3
	ECE F434	Digital Signal Processing	3	1	4
	EEE F411	Internet of Things (IoT)	3	1	4
	EEE F422	Modern Control Systems	3	0	3
	EEE G512	Embedded System Design	3	1	4
	INSTR F343	Industrial Instrumentation and Control	3	0	3
	INSTR G611	Advanced Control Systems	3	2	5
	ME F221 or MF F221	Mechanisms and Machines	3	0	3
	ME F432	Computer Aided Manufacturing	2	1	3
	MF F311	Mechatronics & Automation	2	1	3
	MSE G511	Mechatronics	3	2	5

Minor in Supply Chain Analytics					
Description	Supply chain analytics help organizations to take better, faster and more informed decisions about their business operations. The global market for supply chain analytics is projected to exceed $10 billion by 2025 and has a compound annual growth rate (CAGR) of 16%. Today's supply chain analytics solutions already have impressive capabilities, and with future advancements will only become more of a game-changer for businesses across all industries. Supply chain analytics minor programme will enable the students to develop foundations and to broaden their knowledge base of supply chain in general and supply chain analytics in specific. It will cover three verticals such as supply chain management, supply chain modelling and empirical analysis (qualitative data analysis) & supply chain analytics (quantitative data analysis). The minor programme is designed to create supply chain professionals for present and future business environment.					
Courses & Units Required	**05 courses (min)** **15 units (min)**				
	Course Number	**Course Title**	L	P	U
Core Courses	BITS F455	Analytics for Supply Chain	3	0	3
	MF F319	Supply Chain Management	3	0	3
	MF F422	Supply Chain Modelling and Empirical Analysis	3	1	4
Electives	ME F443	Quality Control Assurance and Reliability	3	0	3
	MF F321	Procurement Management	3	0	3
	MF F418	Lean Manufacturing	3	0	3
	MF F485	Sustainable Manufacturing	3	0	3
	MATH F212 **OR** ME F320 **OR** MF F320	Optimization **OR** Engineering Optimization **OR** Engineering Optimization	3	0	3
	MATH F242	Operations Research	3	0	3
	MATH F353	Statistical Inference and Applications	3	0	3

Minor in Water and Sanitation					
Description	Sustainable Development Goal 6 (SDG 6) focusses on Water and Sanitation and the tasks mentioned in SDG 6. Sanitation is also high on agenda of the Indian Government as evident from Swachh Bharat Mission. Trained Postgraduate and working professionals are of high demand. Bill and Melinda Gates foundation had significantly invested in Water, Sanitation and Hygiene programme and they had funded UNESCO IHE and its 8 partners in developing e learning alliance. The foundation's investment strategy in sanitation requires qualified and trained professionals. This minor would equip the students with the skill and knowledge which will help them in gaining insights in the area of water and sanitation.				
Courses & Units Required	05 courses (min) 15 units (min)				
Core Courses	**Course Number**	**Course Title**	L	P	U
	BIO F216	Water Sanitation and Solid Waste Management	3	0	3
	BIO F217	Laboratory for Water Sanitation and Solid Waste management	1	2	3
Electives	BIO F266	Study Project			3
	SAN G511	Sanitation Technology	3	2	5
	SAN G512	Sanitation and Public Health	3	2	5
	SAN G513	Sanitation Governance Behaviour change and Advocacy			5*
	SAN G514	Sanitation Finance and Project Management			5*
	SAN G515	Emergency Sanitation & Leadership			5*

BITS-RMIT HIGHER EDUCATION ACADEMY

The University Grants Commission (UGC) has approved regulations that allows Indian and foreign universities to offer twinning, joint and dual degrees in the same disciplines/subject areas and at the same qualification level (*The Gazzette of India, F.No.4-1/2022 (IC), UGC, New Delhi, Monday, May 2, 2022 as given in Annexure 3*). This is also in line with the Indian Government's commitment under the National Education Policy 2020. With the above regulations, UGC has created an arrangement where Indian universities which meet certain criteria will be able to develop and enter partnerships which would lead to the award of qualifications under the collaboration arrangements.

Accordingly, we are offering a few dual-degree programmes (as per UGC nomenclature) in collaboration with RMIT Australia in the same specialization and at the same qualification level at international level. Degrees will be awarded separately and simultaneously from both the universities. Prospective students are required to meet the admission requirements of both BITS Pilani, India and RMIT Melbourne, Australia. Finally, students shall be awarded degrees in the same discipline and at the same level.

First Degree programmes being offered under this scheme are:

- B.E. Civil at BITS Pilani and Bachelor of Engineering (Civil and Infrastructure) (Honours) at RMIT, Australia
- B.E. Mechanical at BITS Pilani and Bachelor of Engineering (Mechanical) (Honours) at RMIT, Australia
- B.E. Electrical & Electronics at BITS Pilani and Bachelor of Engineering (Electrical Engineering) (Honours) at RMIT, Australia
- B.E. Electronics & Communication at BITS Pilani and Bachelor of Engineering (Electronic and Computer Systems Engineering) (Honours) at RMIT, Australia

The partnership have included multiple programmes spanning several academic disciplines that are both desirable to students and are expected to produce graduates that are in demand by industry.

The academic model is innovative, and valuable offering to students. The Augmented Collaborative Articulation Pathway (ACAP) model presents a deeper engagement with the partner institution and students compared to a traditional articulation programme, including:

- Co-branded programmes with RMIT, including joint marketing, delivery and operational responsibilities.
- Students are recruited through the existing BITSAT admissions process.
- Students will spend two years at BITS campuses, before transferring to RMIT campuses in Australia.
- Students will have regular exposure to academics from both institutions in both locations.
- Students will receive dual degrees; one from each institution.
- Students complete their degree and obtain Post Study Work Rights in Australia.
- Student will pay a substantially lower overall cost compared to the entirely Australian programmes.

Input Qualification:

Candidates should have passed the 12th examination of 10+2 system from a recognized National/International board or its equivalent with Physics, Chemistry, and Mathematics as subjects and adequate proficiency in English.

In addition to meeting BITS academic and English requirements, the applicants need to meet the RMIT English language requirement of a minimum IELTS (Academic module) overall score of 6.5, with no band below 6.0 or equivalent. For equivalents to English entry requirements, see the English requirements web page.

Mode of Admission:

Admissions will be made purely on merit. The merit position of the candidate will be based on the score obtained by the candidate in a Computer based Online Test (BITSAT) conducted by BITS, Pilani. The candidates should also fulfil the essential requirement of a minimum of aggregate **75% marks** in Physics, Chemistry and Mathematics subjects in the 12th examination with at least 60% marks in each of the Physics, Chemistry, and Mathematics subjects.

Upon completion of the BITSAT successfully, students will make their Programme selections which will include the RMIT programmes. Details of applicants who meet BITS admission criteria will be forwarded to RMIT for assessment against RMIT eligibility criteria such as proof of year 12 marks and proof of English language proficiency to the RMIT standard.

Admission into the Academy for UAE (Dubai) based offerings will include details of applicants who meet BITS admission criteria being forwarded to RMIT for assessment against RMIT eligibility criteria such as proof of year 12 marks and proof of English language proficiency to the RMIT standard.

The RMIT admissions system, Studylink, will be used to support the entire admissions process including the generation of offer and the Genuine Temporary Entrant process.

Students that RMIT deems to have met RMIT's criteria will be confirmed with BITS. Successful applicants will be provided two offers from RMIT University (one for each of the offshore and onshore components), packaged with the BITS offer.

According to the UGC Regulations mentioned above, dual-degree programmes will be those which are offered by both the Indian and foreign university in the same subject area and at the same qualification level. Degrees will be awarded separately and simultaneously from both universities. Prospective students must meet the admission requirements of both the Indian and Foreign universities and shall apply to and be admitted separately to both universities.

Duration:

The normal duration of the programme will be 8 semesters (Four Semesters and a summer term at any of the Campuses of BITS Pilani and another four Semesters at RMIT Melbourne, Australia).

Why RMIT Melbourne, Australia?

- RMIT is a globally recognised university of science, technology, design and enterprise.
- RMIT is ranked 190th in the world by QS World University Rankings, 2022.
- BITS can derive reputational and ranking benefit from partnering with a globally-recognised Australian university.
- This collaboration will provide access to new groups of students seeking an international education.
- The partnership will create professional development opportunities for teaching, research and professional staff.
- Potential to uplift quality of curriculum and the possibility of introducing new programmes
- Collaborative research opportunities.

About BITS RMIT Academy

The vision is for high-quality partnered Academy with unique attributes: Enduring, large-scale partnership that create high-quality education and research opportunities for students and academics, and ultimately support India's sustainable development.

Objectives

The collaboration objectives of the partnerships are to develop an enduring, mutually beneficial and productive strategic partnership between the parties and to provide excellent student experiences and learning outcomes.

Motivation of any student to join such a programme

The project team landed on the partnered dual award (a*s it is defined in the UGC notification (F.No.4-1/2022 (IC)) Academic Collaboration between Indian and Foreign Higher Educational Institutions to offer Twinning, Joint Degree and Dual Degree Programmes*) with a student journey that spans India (or Dubai, UAE) and Australia.

The collaborative 'dual degree' academic model at international level provides for students to be 'separately and simultaneously' enrolled into each institution's programme. Students in the Academy will commence their degree studies with RMIT and BITS at the same time.

In the first 2 years of their study the Academy students will usually complete one RMIT course per semester in India or Dubai as well as completing the required courses in the BITS curriculum. The RMIT delivered courses have been carefully selected with student's overall study load in mind and in most instances these courses will be offered in lieu of a prescribed BITS courses.

After successfully completing the first 2 years of study in India or UAE, students will complete 2 additional years in Melbourne, Australia in the respective RMIT programme and receive the RMIT and BITS degrees as two separate awards on successful completion of the relevant courses.

The benefits to students are an overall lower cost international qualification, two degrees from well-established and internationally recognised universities, provide them with experience of RMIT learning and teaching style, various systems and processes and access to services and support that will prepare them for successful transition to their study in Australia.

In addition, an eligibility for post study work rights in Australia, a visa for international students who have recently graduated with a degree from an Australian institution, is a strong intensive for students. https://immi.homeaffairs.gov.au/visas/getting-a-visa/visa-listing/temporary-graduate-485/post-study-work. Please note that it is essential to get Visa from Australian embassy for admitted students before commencing their programme at RMIT Australia.

BITS Pilani and RMIT Melbourne, Australia have separately surveyed over 700 students in regard to the appeal of the proposal and received an overwhelmingly positive response.

Work Integrated Learning (WIL) and Professional exposure

BITS RMIT Academy shall provide enough opportunities to the students with an education that strongly links formal learning with professional or vocational practice.

Academy will adopt an approach that uses relevant work-based experiences to allow students to integrate theory with the meaningful practice of work as an intentional and assessed component of the curriculum. Students admitted through Academy will:

- Undertake and be assessed on structured activities that allow them to learn, apply and demonstrate their professional or vocational practice.
- Interact with industry and community when undertaking these activities
- Complete these activities in real work contexts or situations.
- Any or all of these aspects of a WIL experience may be in a simulated workplace environment.

- The 24 credit equivalent WIL courses in all the four engineering programs are: OENG1167 Engineering Capstone Project Part A and OENG1168 Engineering Capstone Project Part B where students will work under the guidance of a professional engineer who may be from industry or be an academic or research staff member. Students will apply their technical knowledge, research, design and professional engineering skills to either discipline specific, or cross disciplinary engineering problems, through robust research and established engineering design processes.
- In addition, students are encouraged to undertake at least 10 weeks of engineering work experience supervised by a professional engineer. This can be done by enrolling in the optional course OENG1165 Professional Engineering Experience. The course is normally undertaken in the summer vacation period between years 3 and 4 of the program, but it can be taken at other times to align with their placements. Students usually source their placement opportunities, a task that aids development of critical career skills in identifying suitable roles and performing well in the recruitment process.

Employment Scenario/ opportunities, etc.

RMIT was ranked 74th in the QS Graduate Employability Rankings 2022. The **four** dual degree programmes in collaboration with RMIT programmes are proposed to be launched in AY 2023-24 as part of partnership arrangement, which have strong connections with the industry. The formation and engagement with the Industry Advisory Committees with membership from external industry and professional institutions help RMIT inform their programme development and ensure that the RMIT-delivered programme content and student learning outcomes remain closely aligned with the needs of future employers. These programmes provide students with an opportunity to work on research projects and practical activities/capstone projects as part of their curriculum.

The engineering programmes proposed for this partnership are fully accredited by Engineers Australia (www.engineersaustralia.org.au/publications/engineers-australia-accredited-programmes) - the professional body responsible for the accreditation of higher education programmes that prepare students to practise as professional engineers. Engineers Australia is a signatory to the Washington Accord. This means that the degree is internationally recognised, and graduates are able to practise as professional engineers in many countries around the world.

Post-study work visas of up to 4 years granted to eligible students provide greater opportunities for academy graduates to participate in Australia's future skilled workforce.

RMIT provides students with access to personalised services, resources and opportunities to help plan their careers, find work and get the job-ready skills employers seek.

https://www.rmit.edu.au/students/careers-opportunities/jobs-careers-employability

The proposed semester-wise pattern of the following programmes, for students admitted to this programme in first semester are given in Annexure 1:

- B.E. Civil at BITS Pilani and Bachelor of Engineering (Civil and Infrastructure) (Honours) at RMIT, Australia
- B.E. Mechanical at BITS Pilani and Bachelor of Engineering (Mechanical) (Honours) at RMIT, Australia
- B.E. Electrical & Electronics at BITS Pilani and Bachelor of Engineering (Electrical Engineering) (Honours) at RMIT, Australia
- B.E. Electronics & Communication at BITS Pilani and Bachelor of Engineering (Electronic and Computer Systems Engineering) (Honours) at RMIT, Australia

The general curricular structure for the students admitted under Augmented Collaborative Articulation Pathway (ACAP) through BITS RMIT Academy is given below:

Category	Courses to be offered at BITS Pilani		Courses to be offered at RMIT (for BITS Requirement)		Total	
	Courses	**Unit**	**Courses**	**Eq. Unit***	**Courses**	**Unit**
Humanities Elective	2-3	6-9	0-1	0-4	3	9
Science Foundation	6	12			6	12
Mathematics Foundation	4	12			4	12
Engineering Foundation	2	6			2	6
Technical Arts	4	12			4	12
General Awareness / Professional Courses	2	7			2	7
Sub-Total	**20-21**	**55-58**	**0-1**	**0-4**	**21**	**58**
Core	8-10	26-33	4-8	14-23	14-16	47-50
Discipline Elective			4	12-14	4	12-14
Sub-Total	**8-10**	**26-33**	**8-12**	**28-37**	**18-20**	**60-63**
Open Elective	1-3	4-10	2-4	6-14	5	16-18
Capstone Project			2	8	2	8
Grand Total	**30-32**	**89-94**	**15-17**	**51-56**	**46-48**	**144 (Min)**

***Equivalent Unit:** Assuming a course of 3-4 units offered at BITS Pilani is equivalent to a 12-credit points course offered by RMIT. The Unit of each Capstone Project offered at RMIT is proposed to be considered equal to 4 units at BITS Pilani. The actual units mapping of the courses shall be decided based on the equivalent courses offered at BITS Pilani.

Note:

1. Unlike other BITS students, BITS-RMIT Academy students need not to register for Practice School or Thesis. Such students will have to complete two Capstone Projects in place of Practice School II or First Degree Thesis to meet the requirements of their degree programmes.

2. As the courses which are offered at RMIT have different credit points (12 units per course), the grades earned by the students at RMIT will be converted appropriately by making equivalency of the courses and by converting RMIT credit points into BITS units, and the CGPA shall be calculated accordingly based on their grades earned in all the respective courses.

3. Table given above describes the general curricular structure for the first degree programmes offered under BITS RMIT Academy. Accordingly, the semesterwise pattern of each specific programme is designed as given below to fulfil degree requirement of BITS Pilani for BITS-RMIT academy students.

Semester-wise Pattern for Students Admitted to B.E. Civil under BITS – RMIT Academy								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	EEE	F111	Electrical Sciences	3
	CHEM	F111	General Chemistry	3	BITS	F112	Technical Report Writing	2
	MATH	F111	Mathematics I	3	MATH	F113	Probability and Statistics	3
	PHY	F110	Physics Laboratory	1	BITS	F111	Thermodynamics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F235	Digital Fundamentals②	4
	BITS	F234	Introduction to Engineering Design①	4				
				19				**20**
Summer Term								
			Humanities Elective					3
			Humanities Elective					3
II	MATH	F211	Mathematics III	3	ECON Or MGTS	F211 Or F211	Principles of Economics Or Principles of Management	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of Structures	3
	CE	F213	Surveying	4	CE	F242	Construction Planning & Technology	3
	CE	F230	Civil Engineering Materials	4	CE	F243	Soil Mechanics	4
	CE	F231	Fluid Mechanics	3	CE	F244	Highway Engineering	4
	BITS	F236	Foundations of Artificial Intelligence for STEM③	4	BITS	F237	STEM for Sustainable Development ④	4
							Humanities Elective	3
				21 (min)				**24 (min)**
III	CIVE	1179	Steel Structures 1 ⑤	12	CIVE	1149	Engineering Practice 5 – Construction Management ⑨	12
	CIVE	1108	Geotechnical Engineering 2 ⑥	12	CIVE	1143	Analysis of Complex Structures ⑩	12
	CIVE	1177	Concrete Structures 1 ⑦	12	CIVE	1155	Engineering Practice 6 - Sustainable Infrastructure Design ⑪	12
	CIVE	1153	Storm water Management ⑧	12	CIVE	1217	Engineering Economics and Infrastructure Planning ⑫	12
				48				**48**
IV	CIVE	1145	Catchment Water Management ⑬	12	BIOL	2525	Cyber-Physical-Biological Systems: Technology for a Digital world ⑯	12
	CIVE	1200	Wastewater Systems Design and Modelling ⑭	12	OENG	1168	Engineering Capstone Project Part B ⑱	12
	CIVE	1210	Steel Structures 2 ⑮	12	OENG	1235	Innovation Ecosystem and the Future of Work ⑲	12
	OENG	1167	Engineering Capstone Project Part A ⑰	12	CIVE	1173	Infrastructure Management ⑳	12
				48				**48**

Note: Units/Credit points earned for the course(s) in BITS Pilani and RMIT shall be considered towards degrees to be awarded by both institutions in accordance with the following:

1. To complete the BITS Pilani Degree, students need to complete a minimum total of 144 units with a minimum number of 46 courses (four courses with 16 units offered jointly by BITS and RMIT + twenty-six courses with 74 units (min.) offered by BITS in first two years, including summer term + sixteen courses with 54 equivalent units offered by RMIT). The Equivalent Unit is considered by assuming that a course of 3-4 units offered at BITS Pilani is equivalent to a 12-credit points course offered by RMIT.
2. To complete the RMIT Degree, students need to complete 384 credit points in total (four courses with 48 credit points offered jointly by BITS and RMIT + twelve mapped courses with 144 equivalent credit points offered by BITS in the first two years + sixteen courses with 192 credit points offered by RMIT).
3. Upon completion of all BITS Pilani Courses during Years 1 and 2 (including summer term, if any) at the BITS Campus, students will receive 144 credit points as an RMIT credit exemption against the twelve mapped courses to complete the RMIT Degree in accordance with RMIT's policies and procedures.
4. Upon completion of all RMIT Courses, students will receive 70 units of transfer credit for the twenty mapped courses to complete the BITS Pilani Degree in accordance with BITS' policies and procedures.
5. The actual units mapping of the courses shall be decided based on the equivalent courses offered at BITS Pilani and RMIT.
6. The details of an encircled number given against the selected courses in the semester-wise pattern are given below:

Symbol	Description
①	Course BITS F234: Introduction to Engineering Design would be offered to BITS-RMIT Academy students in place of BITS F110: Engineering Graphics. This will also be equivalent to OENG1277: Introduction to Engineering Design offered at RMIT.
②	Course BITS F235: Digital Fundamentals would be offered to BITS-RMIT Academy students in place of CS F111: Computer Programming. This will also be equivalent to OENG1278: Digital Fundamentals offered at RMIT.
③	Course BITS F236: Foundations of Artificial Intelligence for STEM is one of the required courses from STEM future Technology Skill Courses' pool at RMIT and will also be the 1st Open Elective out of 5 required at BITS Pilani.
④	Course BITS F237: STEM for Sustainable Development would be offered to BITS-RMIT Academy students in place of BITS F225: Environmental Studies. This will also be equivalent to ONPS2747: STEM for Sustainable Development offered by RMIT, which is one of the required courses from STEM future Technology Skill Courses' pool at RMIT.
⑤	Course CIVE 1179: Steel Structures 1 is the core course offered in 3rd year at RMIT. Also, this will be equivalent to CE F343: Design of Steel Structures offered at BITS Pilani. Both are the core courses at the respective Institutes.
⑥	Course CIVE 1108: Geotechnical Engineering 2 will be treated as equivalent to CE F313: Foundation Engineering. Both are the core courses at the respective Institutes.
⑦	Course CIVE 1177: Concrete Structures 1 will be treated as equivalent to CE F320: Design of Reinforced Concrete Structures. Both are core courses at the respective Institutes.
⑧	BITS-RMIT Academy Students shall be advised to take the course CIVE 1153: Stormwater Management mandatorily. This will be the 1st course out 4 from list of Minor Studies "Sustainable Water Management" required at RMIT and will be treated as the core course offered at BITS, namely CE F312: Hydraulics Engineering.
⑨	Course CIVE 1149: Engineering Practice 5 is the core course offered at RMIT. Also, this

	will be the 1st Discipline course out of 4 required at BITS either as a project type course or a new elective to be introduced.
⑩	Course CIVE 1143: Analysis of Complex Structures is the core course offered at RMIT. Also, this will be the 2nd Discipline course out of 4 required at BITS either as a project type course or a new elective to be introduced.
⑪	Course CIVE 1155: Engineering Practice 6 - Sustainable Infrastructure Design is the core course offered at RMIT. Also, this will be the 3rd Discipline course out of 4 required at BITS either as a project type course or a new elective to be introduced.
⑫	Course CIVE 1217: Engineering Economics and Infrastructure Planning is the core course offered at RMIT. Also, this will be the 2nd Open Elective out of 5 required at BITS either as a project type course or a new elective shall be introduced at BITS.
⑬	Academy Students shall be advised to take the course CIVE 1145: Catchment Water Management mandatorily. This will be the 2nd course out of 4 from list of Minor Studies "Sustainable Water Management" required at RMIT and will be treated as the a core course offered at BITS, namely CE F321: Engineering Hydrology.
⑭	BITS-RMIT Academy Students shall be advised to take the course CIVE 1200: Wastewater Systems Design and Modelling mandatorily. This will be the 3rd course out of 4 from list of Minor Studies "Sustainable Water Management" required at RMIT and will be treated as the a core course offered at BITS, namely CE F342: Water & Wastewater Treatment.
⑮	Course CIVE 1210: Steel Structures 2 is the core course offered at RMIT. Also, this will be the 4th Discipline course out of 4 required at BITS.
⑯	Course BIOL2525: Cyber-Physical-Biological Systems: Technology for a Digital world is one of the required courses from STEM future Technology Skill Courses' pool at RMIT and will also considered as the 3rd Open Elective out of 5 required at BITS).
⑰	Course OENG 1167: Engineering Capstone Project Part A is one of the required courses at RMIT. Also, this will be equivalent to BITS F456: Capstone Project I to be offered at BITS Pilani. All BITS-RMIT Academy students have to do two Capstone Projects in place of Practice School II/Thesis.
⑱	Course OENG 1168: Engineering Capstone Project Part B is one of the required courses at RMIT. Also, this will be equivalent to BITS F457: Capstone Project II to be offered at BITS Pilani. All BITS-RMIT Academy students have to do two Capstone Projects in place of Practice School II/Thesis.
⑲	Course OENG 1235: Innovation Ecosystem and the Future of Work is one of the required courses from STEM future Technology Skill Courses' pool at RMIT and will be also considered as 4th Open Elective out of 5 required ones at BITS).
⑳	A course from the option list or one University Elective available at RMIT not completed earlier such as CIVE 1173 Infrastructure Management or any other course available in the pool (Also, this will be an 5th Open Elective out of 5 required at BITS).

Semester-wise Pattern for Students Admitted to B.E. Mechanical under BITS – RMIT Academy								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	EEE	F111	Electrical Sciences	3
	CHEM	F111	General Chemistry	3	BITS	F112	Technical Report Writing	2
	MATH	F111	Mathematics I	3	MATH	F113	Probability and Statistics	3
	PHY	F110	Physics Laboratory	1	BITS	F111	Thermodynamics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F235	Digital Fundamentals ②	4
	BITS	F234	Introduction to Engineering Design ①	4				
				19				**20**
Summer Term								
			Humanities Elective					3
			Humanities Elective					3
			Humanities Elective					3
II	MATH	F211	Mathematics III	3	ECON Or MGTS	F211 Or F211	Principles of Economics Or Principles of Management	3
	ME	F211	Mechanics of Solids	3	ME	F218	Advanced Mechanics of Solids	3
	ME	F213	Materials Science and Engineering	3	ME	F219	Manufacturing Processes	4
	ME	F217	Applied Thermodynamics	4	ME	F220	Heat Transfer	4
	ME	F212	Fluid Mechanics	3	ME	F316	Manufacturing Management	2
	BITS	F236	Foundations of Artificial Intelligence for STEM ③	4	BITS	F237	STEM for Sustainable Development ④	4
			Open Elective	3			Open Elective	3
				23 (min)				**23 (min)**
III	MIET	1077	Mechanics and Machines ⑤	12	MIET	1076	Mechanical Vibration ⑥	12
	MIET	2136	Mechanical Design 1 ⑨	12	MANU	1170	Advanced Manufacturing Processes ⑲	12
	MIET	1084	Finite Element Analysis ⑦	12	MIET	2518	Thermal Fluid System Design ⑪	12
	OENG	1235	Innovation Ecosystem and the Future of Work ⑳	12	BIOL	2525	Cyber-Physical-Biological Systems: Technology for a Digital world ⑫	12
				48				**48**
IV	OENG	1167	Engineering Capstone Project Part A ⑬	12	OENG	1168	Engineering Capstone Project Part B ⑭	12
	AUTO	1006	Vehicle Power System ⑮	12	MIET	2032	Renewable Energy Systems ⑯	12
	MIET	1068	Mechanical Design 2 ⑱	12	MIET Or MIET	2530 2002	Advanced Computer Aided Design ⑧ Or Advanced Engineering Computer Aided Design ⑧	12
	MIET	2006	Automatic Control ⑩	12	MIET Or MIET	2522 Or 2394	Energy Efficiency and Demand Management ⑰ Or Computational Fluid Dynamics ⑰	12
				48				**48**

Note: Units/Credit points earned for the course(s) in BITS Pilani and RMIT shall be considered towards degrees to be awarded by both institutions in accordance with the following:

1. To complete the BITS Pilani Degree, students need to complete a minimum total of 145 units with a minimum number of 46 courses (four courses with 16 units offered jointly by BITS and RMIT + twenty-eight courses with 78 units (min.) offered by BITS in first two years, including summer term + sixteen courses with 51 equivalent units offered by RMIT). The Equivalent Unit is considered by assuming that a course of 3-4 units offered at BITS Pilani is equivalent to a 12-credit points course offered by RMIT.
2. To complete the RMIT Degree, students need to complete 384 credit points in total (four courses with 48 credit points offered jointly by BITS and RMIT + twelve mapped courses with 144 equivalent credit points offered by BITS in the first two years + sixteen courses with 192 credit points offered by RMIT).
3. Upon completion of all BITS Pilani Courses during Years 1 and 2 (including summer term, if any) at the BITS Campus, students will receive 144 credit points as an RMIT credit exemption against the twelve mapped courses to complete the RMIT Degree in accordance with RMIT's policies and procedures.
4. Upon completion of all RMIT Courses, students will receive 68 units of transfer credit for the twenty mapped courses to complete the BITS Pilani Degree in accordance with BITS' policies and procedures.
5. The actual units mapping of the courses shall be decided based on the equivalent courses offered at BITS Pilani and RMIT.
6. The details of an encircled number given against the selected courses in the semester-wise pattern are given below:

Symbol	Description
①	Course BITS F234: Introduction to Engineering Design would be offered to BITS-RMIT Academy students in place of BITS F110: Engineering Graphics. This will also be equivalent to OENG1277: Introduction to Engineering Design offered at RMIT.
②	Course BITS F235: Digital Fundamentals would be offered to BITS-RMIT Academy students in place of CS F111: Computer Programming. This will also be equivalent to OENG1278: Digital Fundamentals offered at RMIT.
③	Course BITS F236: Foundations of Artificial Intelligence for STEM is one of the required courses from STEM future Technology Skill Courses' pool at RMIT and will also be the 1st Open Elective out of 5 required at BITS Pilani.
④	Course BITS F237: STEM for Sustainable Development would be offered to BITS-RMIT Academy students in place of BITS F225: Environmental Studies. This will also be equivalent to ONPS2747: STEM for Sustainable Development offered by RMIT, which is one of the required courses from STEM future Technology Skill Courses' pool at RMIT.
⑤	Course MIET 1077 Mechanics and Machines is the core course offered at RMIT. Also, this will be equivalent to ME F221 Mechanisms and Machines offered at BITS Pilani. Both are the core courses at the respective Institutes.
⑥	Course MIET1076 Mechanical Vibration is the core course offered at RMIT. Also, this will be equivalent to ME F319 Vibrations and Control offered at BITS Pilani. Both are the core courses at the respective Institutes.
⑦	Course MIET1084 Finite Element Analysis is the core course offered at RMIT. Also, this will be the 1st Discipline course out of 4 required at BITS, may be considered as equivalent to ME G512 Finite Element Methods.
⑧	Course MIET2530 Advanced Computer Aided Design or MIET2002 Advanced Engineering Computer Aided Design is to be offered at RMIT. Also, this will be equivalent to ME F318 Computer-Aided Design offered at BITS Pilani as one of the core courses. This is the discipline elective or minor at RMIT.

⑨	Course MIET2136 Mechanical Design 1 is the core course offered at RMIT. Also, this will be equivalent to ME F314 Design of Machine Elements offered at BITS Pilani. Both are the core courses at the respective Institutes.
⑩	Course MIET2006 Automatic Control is the core course offered at RMIT. Also, this will be the 2nd Discipline course out of 4 required at BITS, may be considered as equivalent to EEE F242 Control Systems.
⑪	Course MIET2518 Thermal Fluid System Design is the core course offered at RMIT. Also, this will be equivalent to ME F341 Prime Movers & Fluid Machines offered at BITS Pilani. Both are the core courses at the respective Institutes.
⑫	Course BIOL2525: Cyber-Physical-Biological Systems: Technology for a Digital world is one of the required courses from STEM future Technology Skill Courses' pool at RMIT and will also considered as the 4th Open Elective out of 5 required at BITS).
⑬	Course OENG 1167: Engineering Capstone Project Part A is one of the required courses at RMIT. Also, this will be equivalent to BITS F456: Capstone Project I to be offered at BITS Pilani. All BITS-RMIT Academy students have to do two Capstone Projects in place of Practice School II/Thesis.
⑭	Course OENG 1168: Engineering Capstone Project Part B is one of the required courses at RMIT. Also, this will be equivalent to BITS F457: Capstone Project II to be offered at BITS Pilani. All BITS-RMIT Academy students have to do two Capstone Projects in place of Practice School II/Thesis.
⑮	Course AUTO1006 Vehicle Power System is one of the courses offered at RMIT. Also, this will be equivalent to ME F317 Engines, Motors, and Mobility offered at BITS Pilani. Both are the core courses at the respective Institutes
⑯	Course MIET2032 Renewable Energy Systems is one of the courses offered at RMIT. Also, this will be the 3rd Discipline course out of 4 required at BITS, may be considered as equivalent to BITS F462 Renewable Energy.
⑰	Course MIET2394 Computational Fluid Dynamics or MIET2522 Energy Efficiency and Demand Management is to be offered at RMIT. Also, this will be the 4th Discipline course out of 4 required at BITS, may be considered as equivalent to ME F485 Numerical Techniques for Fluid Flow and Heat Transfer or ME F424 Energy Management, respectively offered at BITS. This will be considered as a discipline elective or minor at RMIT.
⑱	Course MIET1068 Mechanical Design 2 is one of the core courses offered at RMIT. Also, this will be equivalent to ME F320 Engineering Optimization offered at BITS Pilani. Both are the core courses at the respective Institutes.
⑲	Course MANU1170 Advanced Manufacturing Processes is one of the core courses offered at RMIT. Also, this will be equivalent to ME F315 Advanced Manufacturing Processes offered at BITS Pilani. Both are the core courses at the respective Institutes
⑳	Course OENG 1235: Innovation Ecosystem and the Future of Work is one of the required courses from STEM future Technology Skill Courses' pool at RMIT and will also be considered as 5th Open Elective out of 5 required ones at BITS).

Semester-wise Pattern for Students Admitted to B.E. Electrical and Communication under BITS – RMIT Academy								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	EEE	F111	Electrical Sciences	3
	CHEM	F111	General Chemistry	3	BITS	F112	Technical Report Writing	2
	MATH	F111	Mathematics I	3	MATH	F113	Probability and Statistics	3
	PHY	F110	Physics Laboratory	1	BITS	F111	Thermodynamics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F235	Digital Fundamentals②	4
	BITS	F234	Introduction to Engineering Design①	4				
				19				**20**
Summer Term								
		Humanities Elective						3
		Humanities Elective						3
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	EEE	F211	Electrical Machines	4			Or	or
	EEE	F212	Electromagnetic Theory	3	MGTS	F211	Principles of Management	3
	EEE	F215	Digital Design	4	EEE	F241	Microprocessors & Interfacing	4
	EEE	F214	Electronic Devices	3	EEE	F242	Control Systems	3
	BITS	F236	Foundations of Artificial Intelligence for STEM③	4	EEE	F243	Signals & Systems	3
					EEE	F244	Microelectronic Circuits	3
					BITS	F237	STEM for Sustainable Development ④	4
							Humanities Elective	3
				21 (min)				**23 (min)**
III	EEET	2097	Electronic Circuits⑤	12	EEET	1415	Circuit and System Simulation⑨	12
	EEET	2114	Wireless and Guided Waves ⑥	12	EEET	2368	Network Fundamentals and Applications ⑩	12
	BIOL	2525	Cyber-Physical-Biological Systems: Technology for a Digital World ⑦	12	EEET	2098	Electronic Engineering 3 ⑪	12
	EEET	2254	Communication Engineering 1 ⑧	12	EEET	1416	Digital Signal Processing for Communication Engineering ⑫	12
					EEET	2384	Professional Engineering Experience ⑯	12
				48				**48**
IV	EEET	1070	Optical Fibre Systems and Networks ⑬	12	OENG	1168	Engineering Capstone Project Part B ⑰	12
	OENG	1235	Innovation Ecosystem and the Future of Work ⑭	12	EEET	2290	Network Engineering ⑱	12
			Elective⑮	12	EEET	2370	Wireless Sensor Networks and the Internet of Things ⑲	12
	OENG	1167	Engineering Capstone Project Part A⑯	12	EEET	1083	Advanced Mobile and Wireless Systems Engineering ⑳	12
				48				**48**

Note: Units/Credit points earned for the course(s) in BITS Pilani and RMIT shall be considered towards degrees to be awarded by both institutions in accordance with the following:

1. To complete the BITS Pilani Degree, students need to complete a minimum total of 145 units with a minimum number of 46 courses (four courses with 16 units offered jointly by BITS and RMIT + twenty-six courses with 73 units (min.) offered by BITS in first two years, including summer term + sixteen courses with 56 equivalent units offered by RMIT). The Equivalent Unit is considered by assuming that a course of 3-4 units offered at BITS Pilani is equivalent to a 12-credit points course offered by RMIT.
2. To complete the RMIT Degree, students need to complete 384 credit points in total (four courses with 48 credit points offered jointly by BITS and RMIT + twelve mapped courses with 144 equivalent credit points offered by BITS in the first two years + sixteen courses with 192 credit points offered by RMIT).
3. Upon completion of all BITS Pilani Courses during Years 1 and 2 (including summer term, if any) at the BITS Campus, students will receive 144 credit points as an RMIT credit exemption against the twelve mapped courses to complete the RMIT Degree in accordance with RMIT's policies and procedures.
4. Upon completion of all RMIT Courses, students will receive 71 units of transfer credit for the twenty mapped courses to complete the BITS Pilani Degree in accordance with BITS' policies and procedures.
5. The actual units mapping of the courses shall be decided based on the equivalent courses offered at BITS Pilani and RMIT.
6. The details of an encircled number given against the selected courses in the semester-wise pattern are given below:

Symbol	Description
①	Course BITS F234: Introduction to Engineering Design would be offered to BITS-RMIT Academy students in place of BITS F110: Engineering Graphics. This will also be equivalent to OENG1277: Introduction to Engineering Design offered at RMIT.
②	Course BITS F235: Digital Fundamentals would be offered to BITS-RMIT Academy students in place of CS F111: Computer Programming. This will also be equivalent to OENG1278: Digital Fundamentals offered at RMIT.
③	Course BITS F236: Foundations of Artificial Intelligence for STEM is one of the required courses from STEM future Technology Skill Courses' pool at RMIT and will also be the 1st Open Elective out of 5 required at BITS Pilani.
④	Course BITS F237: STEM for Sustainable Development would be offered to BITS-RMIT Academy students in place of BITS F225: Environmental Studies. This will also be equivalent to ONPS2747: STEM for Sustainable Development offered by RMIT, which is one of the required courses from STEM future Technology Skill Courses' pool at RMIT.
⑤	Course EEET 2097: Electronic Circuits is the core course offered at RMIT. Also, this will be equivalent to the core course EEE F341: Analog Electronics offered at BITS Pilani. Both are the core courses at the respective Institutes.
⑥	Course EEET 2114: Wireless and Guided Waves is the core course offered at RMIT. Also, this will be equivalent to the core course ECE F314: Electromagnetic Fields & Microwave Engineering offered at BITS Pilani. Both are the core courses at the respective Institutes
⑦	Course BIOL 2525: Cyber-Physical-Biological Systems: Technology for a Digital World is to be offered as one of the University Elective Course at RMIT. This is interchangeable with OENG 1235 Innovation Ecosystem and the Future of Work ⑮. Also, this will be the 2nd Open Elective out of 5 required at BITS.
⑧	Course EEET 2254: Communication Engineering 1 is the core course offered at RMIT. Also, this will be equivalent to the core course ECE F311: Communication Systems

	offered at BITS Pilani. Both are the core courses at the respective Institutes.
⑨	Course EEET 1415: Circuit and System Simulation is the core course offered at RMIT. Also, this will be the 1st Discipline Elective out of 5 required at BITS.
⑩	Course EEET2368: Network Fundamentals and Applications is the 3rd University Elective Course offered at RMIT. Also, this will be the 2nd Discipline course out of 4 required at BITS as EEE F346: Data Communication Networks.
⑪	Course EEET 2098: Electronic Engineering 3 is the core course at RMIT. Also, this will be the 3rd Open Elective out of 5 required at BITS as EEE F422: Modern Control Systems.
⑫	Course EEET 1416: Digital Signal Processing for Communication Engineering is 1st of the 6 Technical Option Courses offered at RMIT. Also, this will be equivalent to core course ECE F434: Digital Signal Processing offered at BITS Pilani.
⑬	Course EEET 1070: Optical Fibre Systems and Networks is the core course offered at RMIT. Also, this will be the 3rd Discipline course out of 4 required at BITS as EEE F426: Fiber Optics & Optoelectronics.
⑭	Course OENG 1235: Innovation Ecosystem and the Future of Work. This is interchangeable with BIOL 2525: Cyber-Physical-Biological Systems: Technology for a Digital World ⑦. Also, this will be the 4th Open elective course out of 5 required at BITS.
⑮	Course EEET 2384: Professional Engineering Experience will be taken in case the student gets placed and will be taken after year 3(second semester) and before year 4 (first semester). Else, they will take any open elective from RMIT in 42. Also, this will be the 5th Open Elective out of 5 required at BITS.
⑯	Course OENG 1167: Engineering Capstone Project Part A is one of the required courses at RMIT. Also, this will be equivalent to BITS F456: Capstone Project I to be offered at BITS Pilani. All BITS-RMIT Academy students have to do two Capstone Projects in place of Practice School II/Thesis.
⑰	Course OENG 1168: Engineering Capstone Project Part B is one of the required courses at RMIT. Also, this will be equivalent to BITS F457: Capstone Project II to be offered at BITS Pilani. All BITS-RMIT Academy students have to do two Capstone Projects in place of Practice School II/Thesis.
⑱	Course EEET 2290: Network Engineering is 1st of the 6 Technical Option Courses offered at RMIT. Also, this will be equivalent to the core course ECE F343: Communication Networks offered at BITS Pilani.
⑲	Course EEET 2370: Wireless Sensor Networks and the Internet of Things is 3rd of the 6 Technical Option Courses offered at RMIT. Also, this will be the 4th Discipline course out of 4 required at BITS as EEE F411: Internet of Things.
⑳	Course EEET 1083: Advanced Mobile and Wireless Systems Engineering is 4^{th} of the 6 Technical Option Courses offered at RMIT. Also, this will be equivalent to core course ECE F344: Information Theory & Coding offered at BITS Pilani.

Semester-wise Pattern for Students Admitted to B.E. Electrical and Electronics under BITS – RMIT Academy								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F112	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	EEE	F111	Electrical Sciences	3
	CHEM	F111	General Chemistry	3	BITS	F112	Technical Report Writing	2
	MATH	F111	Mathematics I	3	MATH	F113	Probability and Statistics	3
	PHY	F110	Physics Laboratory	1	BITS	F111	Thermodynamics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F235	Digital Fundamentals②	4
	BITS	F234	Introduction to Engineering Design①	4				
				19				**20**
II	MATH	F211	Mathematics III	3	ECON MGTS	F211 F211	Principles of Economics Or Principles of Management	3 3
	EEE	F211	Electrical Machines	4	EEE	F241	Microprocessors & Interfacing	4
	EEE	F212	Electromagnetic Theory	3	EEE	F242	Control Systems	3
	EEE	F215	Digital Design	4	EEE	F243	Signals & Systems	3
	EEE	F214	Electronic Devices	3	EEE	F244	Microelectronic Circuits	3
	BITS	F2236	Foundations of Artificial Intelligence for STEM③	4	BITS	F237	STEM for Sustainable Development ④	4
			Humanities Elective	3			Humanities Elective	3
				24 (min)				**23 (min)**
Summer Term								
	EEE	F313	Analog & Digital VLSI Design	3				
	EEE	F341	Analog Electronics	4				
III	EEET	2106	Power System Analysis and Control ⑤	12	BIOL	2525	Cyber-Physical-Biological Systems: Technology for a Digital World ⑨	12
	EEET	2263	Electrical Plant ⑥	12	OENG	1235	Innovation Ecosystem and the Future of Work ⑩	12
	EEET	2274	Electrical Energy Conversion ⑦	12	EEET	2273	Protection and High Voltage Engineering ⑪	12
	EEET	2105	Industrial Automation ⑧	12	EEET	2384	Introduction to Electrical Building Design ⑫	12
				48				**48**
IV	EEET	2380	Advanced Power Systems ⑬	12	OENG	1168	Engineering Capstone Project Part B ⑰	12
	EEET	2334	Renewable Electrical Energy Systems ⑭	12	EEET	2171	Intelligent Systems ⑱	12
	EEET	2613	Smart Grids ⑮	12	EEET	2254	Communication Engineering 1 ⑲	12
	OENG	1167	Engineering Capstone Project Part A ⑯	12	EEET	2100	Advanced Control Systems ⑳	12
				48				**48**

Note: Units/Credit points earned for the course(s) in BITS Pilani and RMIT shall be considered towards degrees to be awarded by both institutions in accordance with the following:

1. To complete the BITS Pilani Degree, students need to complete a minimum total of 144 units with a minimum number of 46 courses (four courses with 16 units offered jointly by BITS and RMIT + twenty-seven courses with 77 units (min.) offered by BITS in first two years, including summer term + sixteen courses with 51 equivalent units offered by RMIT). The Equivalent Unit is considered by assuming that a course of 3-4 units offered at BITS Pilani is equivalent to a 12-credit points course offered by RMIT.
2. To complete the RMIT Degree, students need to complete 384 credit points in total (four courses with 48 credit points offered jointly by BITS and RMIT + twelve mapped courses with 144 equivalent credit points offered by BITS in the first two years + sixteen courses with 192 credit points offered by RMIT).
3. Upon completion of all BITS Pilani Courses during Years 1 and 2 (including summer term, if any) at the BITS Campus, students will receive 144 credit points as an RMIT credit exemption against the twelve mapped courses to complete the RMIT Degree in accordance with RMIT's policies and procedures.
4. Upon completion of all RMIT Courses, students will receive 71 units of transfer credit for the twenty mapped courses to complete the BITS Pilani Degree in accordance with BITS' policies and procedures.
5. The actual units mapping of the courses shall be decided based on the equivalent courses offered at BITS Pilani and RMIT.
6. The details of an encircled number given against the selected courses in the semester-wise pattern are given below:

Symbol	Description
①	Course BITS F234: Introduction to Engineering Design would be offered to BITS-RMIT Academy students in place of BITS F110: Engineering Graphics. This will also be equivalent to OENG1277: Introduction to Engineering Design offered at RMIT.
②	Course BITS F235: Digital Fundamentals would be offered to BITS-RMIT Academy students in place of CS F111: Computer Programming. This will also be equivalent to OENG1278: Digital Fundamentals offered at RMIT.
③	Course BITS F236: Foundations of Artificial Intelligence for STEM is one of the required courses from STEM future Technology Skill Courses' pool at RMIT and will also be the 1st Open Elective out of 5 required at BITS Pilani.
④	Course BITS F237: STEM for Sustainable Development would be offered to BITS-RMIT Academy students in place of BITS F225: Environmental Studies. This will also be equivalent to ONPS2747: STEM for Sustainable Development offered by RMIT, which is one of the required courses from STEM future Technology Skill Courses' pool at RMIT.
⑤	Course EEET 2106: Power System Analysis and Control is the core course offered at RMIT. Also, this will be equivalent to EEE F312: Power Systems offered at BITS Pilani. Both are the core courses at the respective Institutes
⑥	Course EEET 2263: Electrical Plant is the core course offered at RMIT. Also, this will be the 1st Discipline course out of 4 required at BITS as EEE F475: Special Electrical Machines.
⑦	Course EEET 2274: Electrical Energy Conversion is the core course offered at RMIT. Also, this will be equivalent to EEE F342: Power Electronics offered at BITS Pilani. Both are the core courses at the respective Institutes
⑧	Course EEET 2105: Industrial Automation is the core course offered in 3rd year at RMIT. Also, this will be the 2nd Open Elective out of 5 required at BITS.
⑨	Course BIOL 2525: Cyber-Physical-Biological Systems: Technology for a Digital World is

	the 1st University Elective Course offered at RMIT. Also, this will be the 3rd Open Elective out of 5 required at BITS.
⑩	Course OENG 1235: Innovation Ecosystem and the Future of Work. This will be also considered as 3rd humanities elective at BITS Pilani out of 3 required. This will also be one of the required courses from STEM future Technology Skill Courses' pool at RMIT.
⑪	Course EEET 2273: Protection and High Voltage Engineering is the 3rd University Elective Course offered at RMIT. Also, this will be the 2nd Discipline course out of 4 required at BITS as EEE F476: Switchgear and Protection.
⑫	Course EEET 2384: Introduction to Electrical Building Design is the 4th University Elective Course offered at RMIT. Also, this will be the 3rd Discipline course out of 4 required at BITS as EEE F427: Electric Power Utilization and Illumination.
⑬	Course EEET 2380: Advanced Power Systems is the core course offered at RMIT. Also, this will be the 4th Discipline course out of 4 required at BITS as EEE F462: Advanced Power Systems.
⑭	Course EEET 2334: Renewable Electrical Energy Systems is the core course offered at RMIT. Also, this will be the 4th Open Elective out of 5 required at BITS as EEE F473: Wind Electrical Systems
⑮	Course EEET 2613: Smart Grids is 2nd of the 6 Technical Option Courses offered at RMIT. Also, this will be the 5th Open Elective out of 5 required at BITS as EEE F424: Smart Grid for Sustainable Energy.
⑯	Course OENG 1167: Engineering Capstone Project Part A is one of the required courses at RMIT. Also, this will be equivalent to BITS F456: Capstone Project I to be offered at BITS Pilani. All BITS-RMIT Academy students have to do two Capstone Projects in place of Practice School II/Thesis.
⑰	Course OENG 1168: Engineering Capstone Project Part B is one of the required courses at RMIT. Also, this will be equivalent to BITS F457: Capstone Project II to be offered at BITS Pilani. All BITS-RMIT Academy students have to do two Capstone Projects in place of Practice School II/Thesis.
⑱	Course EEET 2171: Intelligent Systems is 3rd of the 6 Technical Option Courses offered at RMIT. Also, this will be equivalent to MATH F212: Optimization offered as a core course or BITS F312: Neural Networks and Fuzzy Logic offered as Discipline Elective at BITS Pilani.
⑲	Course EEET2254: Communication Engineering 1 is 4th of the 6 Technical Option Courses offered in 4th year at RMIT. Also, this will be equivalent to EEE F311: Communication Systems offered at BITS Pilani as one of the core courses.
⑳	Course EEET 2100: Advanced Control Systems is one of the 6 Technical Option Courses offered at RMIT. Also, this will be the additional course which shall fulfill the RMIT requirement and may be treated as equivalent to EEE F422: Modern Control Systems offered at BITS Pilani.

HIGHER DEGREE PROGRAMMES

A. Requirements

(i) M. E. and M. Pharm:

The following are structure and requirements:

1. (a) at least 12 courses and at least 48 credit units attributed to coursework; and

   (b) In addition, a Practice School (of at least 5½ months duration and 20 units) or a Dissertation (of at least 1 semester duration and 16 credit units)

B. A 4 unit course on Research Practice is mandatory for all students

   - BITS G540 Research Practice

C. Each Department may stipulate - for each program a set of 4 to 5 courses (of at least 16 units and at most 20 units) per semester.

   (a) This adds up to at least 12 courses and at least 48 units of coursework but with a maximum of 15 courses and at most 60 units of coursework stipulated by the Department.

   (b) The nominal chart for a program would be as follows:

Year	I Semester	II Semester
I year	4 to 5 courses (16 to 20 units)	4 to 5 courses (16 to 20 units)
II year	4 to 5 courses (16 to 20 units)	PS / Dissertation

D. Each Department may identify one-third (1/3) to one-half (1/2) of the coursework requirement for each program as the Core Requirement.

   (a) The Core Requirement is mandatory for all students in the program.

   (b) The Core Requirement will be common across all campuses of BITS offering the same program.

E. Rest of the coursework requirement – other than the Core Requirement and the Research Practice course – may be met by electives of each student's choice.

   (a) The student must choose such electives from a Pool of Electives listed for the specific program.

   (b) The Pool of Electives may vary from campus to campus.

F. Each course in the Core Requirement or in the List of Electives must be a graduate level (5th or 6th level) course or an advanced under-graduate course (4th level) with the restriction that a student may use at the most two 4th level courses to meet the requirements in above.

G. Each Department in each campus may decide the scheduling of Core / Elective courses as per the above chart as deemed fit.

H. A student may choose to overload his/her coursework by at most one course – carrying not more than 5 units - per semester:

   (a) Such courses may be chosen from one of the following

(i) the pool of courses listed as Electives for the program being pursued

   (ii) a general pool of courses listed as Graduate Level Electives available for all higher degree programs

   (iii) any other course under the conditions that the stipulated pre-requisites are met and that the Head of the Department of the student and Head of the Department offering the course both provide their consent

   (b) Such courses may not be counted towards the requirement stated in 1.(a) above.

I. A student who wants to pursue Dissertation may choose between doing the Dissertation on campus and doing the Dissertation in an external industrial / research organization. The Department must identify such locations/ organizations as suitable for a student pursuing Dissertation in that discipline. If a student exercises the option of doing his/her Dissertation in an organization other than BITS, then the Department must identify a co-supervisor for the student from within the Department.

J. The Dissertation will carry 16 credit units for the nominal duration of 1 semester.

(a) During this semester a student may not be permitted to do coursework.

(b) A student –with the consent of the Department - may extend the duration of the Dissertation over two semesters while concurrently doing coursework during the semester.

(c) If the student exercises option (b) then the total weight of the Dissertation will not exceed 25 credit units.

K. In addition to the above courses, the higher degree students will be required to register in the following course, unless the student clears a diagnostic test specially designed for the same.

BITS F437 Technical Communication 3 0 3

(ii) MPH:

Total number of units required – 60 (Minimum) with a breakup as follows:

(a) Dissertation: 15 (Min) – 25 (Max) Units

OR

Practice School : 20 units

(b) Course work : 35 (Min) units

(other than Dissertation/Practice School)

Courses for the course work will be chosen from the list of Core and elective courses earmarked for each degree. Total number of courses is thirteen. In addition to these thirteen courses all the students are required to do one course on Technical Communication and two courses on Research Practice.

There is also a flexibility for students of Higher Degree Programmes to register in upto a maximum of one more elective, in addition to the prescribed number of electives. The grade obtained in the additional elective will also be counted towards the CGPA but cannot be used to meet the category-wise requirements of the degree. This additional elective can be from the pool of electives of the concerned degree or courses from other disciplines' Core and electives with the permission of HoD of the program pursued by the student and the Head of the Department offering the course.

(iii) M.Phil.:

Total number of units required - 50 (Minimum) with a breakup as follows:

(a) Dissertation : 12 (Min.) - 25 (Max.) units

OR

Practice School : 20 units

(b) Course work : 25 units (min.)

(other than Dissertation/Practice School)

The courses for course work can be chosen from a list of General/Special courses earmarked for the degree. Wherever there is a need, courses can also be drawn from across the course offerings in various Higher Degree programmes as well as advanced First Degree level, provided the students are adequately prepared for the particular course.

(iv) M.B.A.: The course requirements of the MBA programme are spelt out in terms of courses belonging to different categories in the table below:

Category	No. of Units Required	No. of Courses Required
Core Courses	60	20
Elective(s)	12-24	4-6
Subtotal	72 (Min)	24 (Min)
PS OR Dissertation	20 16	1
Total	88 (Min)	25 (Min)

Courses for the course work will be chosen from the list of Core and elective courses earmarked for the MBA degree. Each campus may decide the scheduling of Core / Elective courses as per the above chart as deemed fit.

(v) MBA in Business Analytics: The course requirements of the MBA in Business Analytics programme are spelt out in terms of courses belonging to different categories in the table below:

Category	No. of Units Required	No. of Courses Required
Core Courses	45	15
Elective(s)	15-24	5-7
Subtotal	60 (Min)	20 (Min)
PS OR Dissertation	20 16	1
Total	76 (Min)	21 (Min)

Courses for the course work will be chosen from the list of Core and elective courses earmarked for the MBA in Business Analytics degree.

A. Requirements

Dissertation: Normal registration for dissertation is after completion of course work. Normally 16 units of Dissertation will be assigned at the time of this registration. In case of programmes other than MBA, units upto a maximum of 25 may be permitted depending on the total time and work put in by an individual student and the registration in more than 16 units of Dissertation will be normally available only to students who have taken higher degree courses as electives in their first degree programmes or to professionals who have shown competence in some specialized courses through their professional involvement. Concurrent registration for a nominal 8 units per semester in Dissertation with course work is also permissible for motivated, well-prepared and hardworking students. Provision exists for the Dissertation to be carried out as work-integrated dissertation at recognized off-campus centres or in an organization where the student may get employment, subject to all the stipulations of Academic Regulations.

Practice School: Registration for Practice School is possible only after the completion of all course work. Concurrent registration of other courses with Practice School is not permitted. All clauses of Academic Regulations applicable to first degree PS courses will govern the operation of this Practice School also.

B. First Degree students seeking Higher Degree admission

A first degree student can choose upto a maximum of two higher degree courses as electives for his/her first degree from the pool of general/special courses of the corresponding higher degree. When such a student seeks admission to any of the Higher Degree programme of the institute, the student may be given exemption from these courses; however, the student will have to complete the total unit requirements of the higher degree. The minimum units in Dissertation for such a candidate will be increased by the same number of units as exempted from the course work so as to earn the minimum prescribed total units.

Semester wise Pattern for Students Admitted to Higher Degree Programmes in the First Semester						
Year	**First Semester**		**U**	**Second Semester**		**U**
M.E. Biotechnology						
I	BIO G512	Molecular Mechanism of Gene Expression	5	BITS G540	Research Practice	4
				BIO G524	Animal Cell Technology	5
	BIO G542	Advanced Cell and Molecular Biology	5	BIO G643	Plant Biotechnology	5
					Elective	*
	BIO G525	Environmental Biotechnology and Waste Management	5		Elective	*
		Elective	*			
			18			20
II	BIO G523	Advanced and Applied Microbiology	5	BITS G629T	Dissertation or	16 or
		Elective	*	BITS G639	Practice School	20
		Elective	*			
		Elective	*			
			17			16/20

M.E. Chemical* [The structure of this program is given in Page IV-104]								
Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester								
Year	First Semester			U	Second Semester			U
M.E. Civil – Infrastructure Engineering and Management								
I	CE	G515	Fundamentals of Systems Engineering	4	BITS	G540	Research Practice	4
	CE	G523	Transportation Systems Planning and Management	4	CE	G520	Infrastructure Planning and Management	4
	CE	G525	Water Resources Planning and Management	4			Elective	*
	CE	G527	Construction Management	4			Elective	*
				16				14
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20
M.E. Civil – Structural Engineering								
I	CE	G551	Dynamics of Structures	4	BITS	G540	Research Practice	4
	CE	G552	Advanced Structural Mechanics and Stability	4	CE	G615	Earthquake Engineering	4
							Elective	*
	CE	G617	Advanced Structural Analysis	4			Elective	*
	CE	G619	Finite Element Analysis	5				
				17				14
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20
M.E. Civil – Transportation Engineering								
I	CE	G534	Pavement Material Characterization	4	CE	G518	Pavement Analysis and Design	4
					CE	G566	Public Transportation	4
	CE	G565	Transportation Planning	4	BITS	G540	Research Practice	4
	CE	G567	Highway Design	4			Elective	*
	CE	G568	Traffic Systems Analysis	4			Elective	*
			Elective	*				
				19				18
II	BITS	G629T	Dissertation	16	BITS	G629T	Dissertation	16
			OR	OR			or	Or
			Electives (4 courses)	16	BITS	G639	Practice School	20
				16				16/20
M.E. Civil – Water Resource Engineering								
I	CE	G526	Systems Approach to Water Resources Modeling	4	BITS	G540	Research Practice	4
					CE	G558	Advanced Groundwater Hydrology	4
	CE	G555	Remote Sensing and GIS in Water Resources	4	CE	G559	Soft Computing in Water Resources	4
	CE	G556	Advanced Computational Hydraulics	4			Elective	*
	CE	G557	Stochastic Hydrology	4				
				16				15
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				16				16/20

Semester-wise Pattern for Students Admitted to Higher Degree Programmes in the First Semester								
Year	**First Semester**			**U**	**Second Semester**			**U**
M.E. Communication Engineering								
	EEE	G613	Advanced Digital Signal Processing	5	BITS	G540	Research Practice	4
	EEE	G581	RF and Microwave Engineering	5	EEE	G592	Mobile and Personal	
	EEE	G612	Coding Theory and Practice	5			Communication	5
			Elective	*	EEE	G622	Advanced Digital Communication	5
							Elective	*
				18				17
	EEE	G591	Optical Communication	5	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				14				16/20
M.E. Computer Science								
I	CS	G525	Advanced Computer Networks	5	BITS	G540	Research Practice	4
	CS	G526	Advanced Algorithms and		CS	G513	Network Security	4
			Complexity	5	CS	G524	Advanced Computer Architecture	5
	CS	C623	Advanced Operating Systems	5			Elective	*
			Elective	*				
				18				16
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20
M.E. Electrical – Power Electronics and Drives								
I	EEE	G542	Power Electronics Converter	5	BITS	G540	Research Practice	4
	EEE	G541	Distribution Apparatus and		EEE	G545	Control and Instrumentation Systems	5
			Configuration	5	EEE	G552	Solid State Drives	5
	EEE	G543	Power Devices microelectronics				Elective	*
			and selection	3				
			Elective	*				
				18				17
II	EEE	G546	System Simulation	5	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				14				16/20
M.E. Embedded Systems								
I	BITS	G553	Real Time Systems	5	BITS	G540	Research Practice	4
	EEE	G512	Embedded System Design	4	CS	G523	Software for Embedded Systems	5
			Elective	*	MEL	G642	VLSI Architecture	5
			Elective	*			Elective	*
				17				18
II	EEE	G626	Hardware Software Co-Design	5	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				17				16/20

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester								
Year	**First Semester**			**U**	**Second Semester**			**U**
M.E. Electronics & Control								
I	EEE	G559	Advanced Power Electronics	5	BITS	G540	Research Practice	4
	EEE	G621	Advanced Electronic Circuits	5	EEE	G512	Embedded System Design	5
	INSTR	G611	Advanced Control Systems	5	EEE	G552	Solid State Drives	5
				15				14
II	EEE	G546	Systems Simulation Lab	4			Elective	*
			Elective	*			Elective	*
			Elective	*			Elective	*
				10				9
III	BITS	G629T	Dissertation	16				
			or	or				
	BITS	G639	Practice School	20				
				16/20				
M.E. Environmental Engineering								
I	CHE	G513	Environmental Management Systems	5	EE	G502	Water and Wastewater Treatment Systems	5
	CHEM	G521	Environmental Chemistry	5	BITS	G540	Research Practice	4
	EE	G501	Environmental Sampling and Analytical Methods	5			Elective 2	5
			Elective 1	5			Elective 3	5
				20				19
II	BIO	G525	Environmental Biotechnology and Waste Management	5	BITS	G562T	Dissertation	16
	CHE	G552	Advanced Transport Phenomena	5			or	Or
			Elective 4	3	BITS	G639	Practice School	20
			Elective 5	3				
				16				16/20
M.E. Microelectronics								
I	MEL	G611	IC Fabrication Technology	5	BITS	G540	Research Practice	4
	MEL	G621	VLSI Design	5	MEL	G632	Analog IC Design	5
	MEL	G631	Physics & Modeling of Microelectronic Devices	5	MEL	G641	CAD for IC Design	5
			Elective	*			Elective	*
				19				18
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				13				16/20
M.E. Manufacturing Systems Engineering								
I	MSE	G512	Manufacturing Planning and Control	5	BITS	G540	Research Practice	4
	ME	F443	Quality Control Assurance and Reliability	3	ITEB	G621	Supply Chain Management	4
	ME	G511	Mechanism and Robotics	5			Elective	*
			Elective	*			Elective	*
				15				15
II	MSE	G521	World Class Manufacturing	5	BITS	G629T	Dissertation	16
	BITS	F431	Flexible Manufacturing Systems	4			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				15				16/20

M.E. Mechanical Engineering									
I	ME	F443	Quality Control Assurance and Reliability	3	BITS	G540	Research Practice	4
	ME	G511	Mechanism and Robotics	5	ME	G611	Computer Aided Analysis and Design	5
	ME	G512	Finite Element Methods	5			Elective	*
			Elective	*			Elective	*
				16				15
II	ME	G532	Machine Tool Engineering	5	BITS	G629T	Dissertation	16
	ME	G641	Theory of Elasticity and plasticity	5			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				16				16/20

* *Minimum 3 Units*

Note: This is the suggested semesterwise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to Higher Degree Programmes in the First Semester									
Year	**First Semester**			**U**	**Second Semester**			**U**
M.E. Design Engineering									
I	DE	G631	Materials Testing and Technology	5	BITS	G540	Research Practice	4
	ME	G511	Mechanism and Robotics	5	ME	G611	Computer Aided Analysis and Design	5
	ME	G512	Finite Element Methods	5			Elective	*
			Elective	*			Elective	*
				18				15
II	DE	G531	Product Design	5	BITS	G629T	Dissertation	16
	DE	G611	Dynamics and Vibration	5			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				16				16/20
M.E. Thermal Engineering									
I	BITS	C462	Renewable Energy	3	BITS	G540	Research Practice	4
	ME	G533	Conduction and Radiation Heat Transfer	5	ME	G534	Convective Heat and Mass Transfer	5
							Elective	*
	ME	G621	Fluid Dynamics	5			Elective	*
			Elective	*				
				16				15
II	ME	G514	Turbomachinery	5	BITS	G629T	Dissertation	16
	ME	G515	Computational Fluid Dynamics	5			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				16				16/20

M. Pharma. Pharmacy							
I	PHA G532	Quality Assurance and Regulatory Affairs	5	BITS G540	Research Practice		4
	PHA G543	Clinical Research	5	PHA G611	Advanced Pharmacology		5
	PHA G612	Pharmacokinetics and Clinical Pharmacy	5	PHA G621	Advanced Medicinal Chemistry		5
		Elective	*	PHA G632	Dosage Form Design		5
			18				19
II		Elective	*	BITS G629T	Dissertation		16
		Elective	*		or		or
		Elective	*	BITS G639	Practice School		20
		Elective	*				
			12				16/20

Semester-wise Pattern for Students Admitted to M. E. Sanitation Science, Technology and Management Programme in First Semester									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	SAN	G511	Sanitation Technology	5	SAN	G514	Sanitation financing and Project Management	5
	SAN	G512	Sanitation and Public Health	5	SAN	G515	Emergency Sanitation & Leadership	5
	SAN	G513	Sanitation Governance, Behaviour change and Advocacy	5	BITS	G540	Research Practice	4
			Elective I	*			Elective II	*
				18				**17**
	BITS	G562T	Dissertation	16	BITS	G563T	Dissertation	16
				16				**16**

** Minimum 3 Units*

This is the semester-wise pattern for students admitted in the given programme in First semester under track 3 option of Higher Degree programme (Page IV-109). It may be noted that the track 3 option of Higher degree structure is available in the bulletin with 1 year course work and 1 year dissertation. The Academic Governing Committee (AGC) may also look at offering this programme under track 1 and track 2 of structure of Higher degree programmes, if there is a need in future and report back to the Senate.

M. Pharma. Pharmacy – Pharmaceutics							
I	PHA G532	Quality Assurance and Regulatory Affairs	5	BITS G540		Research Practice	4
	PHA G542	Advanced Physical Pharmaceutics	5	PHA G535		Biomaterials	5
	PHA G612	Pharmacokinetics and Clinical Pharmacy	5	PHA G632		Dosage Form Design	5
		Elective	*			Elective	*
			18				17
II	PHA G617	Advanced Drug Delivery Systems	5	BITS G629T		Dissertation	16
		Elective	*			or	or
		Elective	*	BITS G639		Practice School	20
		Elective	*				
			14				16/20

* *Minimum 3 Units*

Note: This is the suggested semesterwise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants

Semester-wise Pattern for Students Admitted to Higher Degree Programmes in the First Semester									
Year	**First Semester**			**U**	**Second Semester**			**U**
M. Pharma. Pharmacy – Pharmaceutical Chemistry								
	PHA	G544	Advanced Pharmaceutical Chemistry	5	BITS	G540	Research Practice	4
	PHA	G541	Computer Aided Drug Design	5	PHA	G522	Chemistry of Macromolecules	4
I	PHA	G543	Clinical Research	5	PHA	G621	Advanced Medicinal Chemistry	5
			Elective	*			Elective	*
				18				16
	PHA	G618	Retrosynthetic Analysis	5	BITS	G629T	Dissertation	16
			Elective	*			or	or
II			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				14				16/20
M. Pharma. Pharmacy – Pharmacology								
	PHA	G538	Immunopharmacology	4	BITS	G540	Research Practice	4
	PHA	G543	Clinical Research	5	PHA	G611	Advanced Pharmacology	5
	PHA	G619	Screening Methods and Techniques in Pharmacology	5			Elective	*
I			Elective	*			Elective	*
				17				15
	PHA	G624	Principles of Toxicology	5	BITS	G629T	Dissertation	16
	PHA	G625	Cellular and Molecular Pharmacology	5			or	or
II			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				16				16/20

M.E. Software System								
	CS	F415	Data Mining	3	BITS	G540	Research Practice	4
	SS	G514	Object Oriented Analysis and		SS	G515	Data Ware Housing	5
			Design	4	SS	G653	Software Architecture	5
I	SS	G562	Software Engineering and				Elective	*
			Management	5				
			Elective	*				
				15				17
			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	or
II			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20

Semester-wise Pattern for Students Admitted to Higher Degree Programmes in the First Semester								
Year	**First Semester**			**U**	**Second Semester**			**U**
Master of Business Administration								
I	MBA	G501	Managerial Economics	3	MBA	G510	Human Resource Management	3
	MBA	G543	Leading Modern Organizations	3	MBA	G545	Management Science	3
	MBA	G544	Organizational Theory & Behaviour	3	MBA	G557	Economic Environment of Business	3
	MBA	G546	Business Statistics	3	MBA	G558	Operations and Supply Chain Management	3
	MBA	G547	Accounting for Managers	3	MBA	G559	Corporate Finance	3
	MBA	G548	Strategic Marketing	3	MBA	G560	Marketing Research & Metrics	3
	MBA	G549	Introduction to Systems & Sustainability	3	MBA	G561	Business Analytics	3
	MBA	G550	Critical and Design Thinking	3	MBA	G564	Decision Making	3
	MBA	G565	Information & Knowledge Management Systems	3				
				27				24
II	MBA	G566	Strategic Management	3	BITS	G561	Dissertation	16
	MBA	G567	Technology Innovation & Entrepreneurship	3			or	or
	MBA	G568	International Business Strategy & Operations	3	BITS	G560	Practice School	20
			Elective	*				
			Elective	*				
			Elective	*				
			Elective	*				
				21/25				16/20

* *Minimum 3 Units*

Note: This is the suggested semester-wise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to Higher Degree Programmes in the First Semester							
First Semester			**U**	**Second Semester**			
MBA in Business Analytics							
MPBA G501	Managerial Economics		3	MPBA G508	Strategic Management		3
MPBA G502	Financial Statement Analysis & Reporting		3	MPBA G509	Corporate Finance		**3**
MPBA G503	Marketing Management		3	MPBA G510	Operations & Supply Chain Management		**3**
MPBA G504	Managing People & Organization		3	MPBA G511	Data Visualization, Ethics and Data Privacy		**3**
MPBA G505	Statistics & Basic Econometrics		3	MPBA G512	Time Series Analysis and Forecasting		**3**
MPBA G506	Data Management and Warehousing		3	MPBA G513	Predictive Analytics		3
MPBA G507	Programming for Analytics		3		Elective[GP-1]		**3**
			21				21
MPBA G514	Deep Learning for Business		3	BITS G629T		Dissertation	16
MPBA G515	Prescriptive Analytics with Mathematical Programming		3	BITS G639		or	or
	Elective[GP-1]		3			Practice School	20
	Elective [GP-2]		3				
	Elective [GP-2]		3				
	Elective [GP-2]		3				
			18				16/20

GP-1: Elective Pool Group-1
GP-2: Elective Pool Group-2
Note: This is the suggested semester-wise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants.

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester									
Year	**First Semester**			**U**	**Second Semester**			**U**
Master in Public Health									
I	MPH	G510	Biostatistics & Computers in Public Health	5	MPH	G661	Research Methodology I	5
					MPH	G521	Health Care Management	4
	MPH	G512	Environmental and Occupational Health	4	MPH	G522	Preventive Nutrition & Health Promotion	4
	MPH	G513	Public Health & Diseases	4	MPH	G523	Epidemic & Disaster Management	4
	BITS	G515	Management Principles and Practices	4	MPH	G692	Epidemology	2
					MPH	G613	Health System and Society	2
	BITS	F437	Technical Communication	3				
				20				21
II	BITS	G540	Research Practice	4	BITS	G629T	Dissertation	16
	MPH	G531	Health Economics & Financial Management	4			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
			Elective	*				
				17				16/20

* *Minimum 3 Units*

Note: This is the suggested semester-wise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M. Phil. Chemistry Programme in First Semester									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BITS	G659	Technical Communication	4	BITS	G620	Professional Practice I	3
	CHEM	G551	Advanced Organic Chemistry	5	CHEM	G552	Advanced Inorganic Chemistry	5
	CHEM	G553	Advanced Physical Chemistry	5	CHEM	G554	Physical Methods in Chemistry	5
	CHEM	G555	Chemistry of Life Processes	4			Elective	3
				18				16
II	BITS	G621	Professional Practice II	3	BITS	G629T	Dissertation	16
			Elective	*			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20

** Minimum 3 units*

Note: This is a currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M. Phil. in Liberal Studies Programme in First Semester									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	HSS	G511	Philosophical Foundations of Liberal Studies	5	BITS	G661	Research Methodology I	5
	HSS	G512	Theoretical Approaches to Liberal Studies	5	BITS	E583	Case studies I	5
	BITS	G518	Writing Seminar	5			Elective II	*
			Elective I	*			Elective III OR	5
				18	BITS	G565	Dissertation (5 Unit)	**18**
II	BITS	G561T	Dissertation	16				
				16				

** Minimum 3 Units*

While the above semester-wise pattern shows a 3-semester structure, a meritorious student may be able to complete the programme in 2 semesters and an additional summer term. In such a case, a partial dissertation of 5 units may be taken in place of Elective 3. This will be followed by a Dissertation of 10 units during the summer term.

Semester-wise Pattern for Students Admitted to M. E. Computer Science with Specialization in Information Security with B.Sc. input								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	CS	F111	Computer Programming	4	MGTS	F211	Principles of Management	3
	BITS	F437	Technical Communication	3	MATH	F212	Optimization	3
	MATH	F113	Probability and Statistics	3	BITS	F463	Cryptography	3
	CS	F215	Digital Design	4	BITS	F345	Information Law and	
	CS	F222	Discrete Structures for				Cyber Law	3
			Computer Science	3	IS	F242	Computer Organization	4
	MATH	F231	Number Theory	3	CS	F211	Data Structures & Algorithms	4
				20				20
Summer	CS	F404	Computer Crime and Forensics					2
	CS	F213	Object Oriented Programming					4
	CS	F468	Information Security Project					3
								9
II	CS	F351	Theory of Computation	3	CS	F303	Computer Networks	4
	CS	F372	Operating Systems	3	CS	F212	Database Systems	4
	IS	F341	Software Engineering	4	CS	G517	Network and System Security	4
	CS	G524	Advanced Computer Architecture	5	CS	F364	Design and Analysis of Algorithms	3
	CS	F301	Principles of Programming Languages	2	CS	F406	Ethical Hacking	2
							Elective	*
			Elective	*				
				20 (min)				20 (min)
Summer	CS	G566	Secure Software Engineering					5
	CS	F468	Information Security Project					3
			Elective					*
								11 (min)
III	CS	G623	Advanced Operating Systems	5	BITS	G639	Practice School	20
	CS	G525	Advanced Computer Networks	5				
	CS	G526	Advanced Algorithms and Complexity	5	Or			Or
	BITS	G540	Research practice	4				
					BITS	G629T	Dissertation	16
			Elective	*				
				20 (min)				16 (min)

* *Minimum 3 units*

Note: This is a currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

LIST OF COURSES FOR M.E./M.PHARM./ MBA PROGRAMMES:

Biotechnology

Core Courses

BIO G512	Molecular Mechanism of Gene Expression	5
BIO G523	Advanced and Applied Microbiology	5
BIO G524	Animal Cell Technology	5
BIO G525	Environmental Biotechnology and Waste Management	5
BIO G542	Advanced Cell and Molecular Biology	5
BIO G643	Plant Biotechnology	5
Elective Courses (any seven)		
BIO F242	Introduction to Bioinformatics	3 0 3
BIO F417	Biomolecular Modeling	3 0 3
BIO F421	Enzymology	3 0 3
BIO F441	Biochemical Engineering	3 0 3
BIO G510	Application of Computers and Statistics in Biology	5
BIO G513	Microbial and Fermentation Technology	3 2 5
BIO G514	Molecular Immunology	3 2 5
BIO G515	Stem Cell and Regenrative Biology	3 1 4
BIO G522	Interferon Technology	3 1 4
BIO G526	Cancer Biology	3 2 5
BIO G532	Biostatistics and Biomodelling	3 1 4
BIO G544	Bioremediation and bio-metallurgy	5
BIO G545	Molecular Parasitology & Vector Biology	5
BIO G561	Advances in Recombinant DNA Technology	3 2 5
BIO G570	Recent Developments in Biology	1 0 1
BIO G612	Human Genetics	3 2 5
BIO G631	Membrane and Liposome Technology	3 1 4
BIO G632	Transgenic Technology	3 2 5
BIO G642	Experimental Techniques	4*
BIO G651	Protein and Enzyme Bioengineering	3 2 5
BIO G661	Gene Toxicology	3 1 4
BIO G671	Bioconversion Technology	3 2 5
BIOT F422	Nanobiotechnology	3 0 3
BITS F418	Introduction to Biomedical Engineering	3 1 4
BITS F467	Bioethics and Biosafety	3 0 3
***BIO F418**	**Genetic Engineering Techniques**	**1 3 4**

***BIO G510 Application of Computers and Statistics in Biology (5)** *may be required to be completed as a deficiency courses for ME Biotechnology Programme.

Chemical

Core Courses

CHE G523	Mathematical Methods in Chemical Engineering	5
CHE G614	Advanced Heat Transfer	5
CHE G622	Advanced Chemical Engineering Thermodynamics	5
CHE G641	Reaction Engineering	5
Elective Courses (any six)		
BIO G544	Bioremediation and Biometallurgy	5
BITS F318	Science and Engineering of Solid Surfaces	3 0 3
BITS F418	Introduction to Biomedical Engineering	3 1 4
BITS F429	Nanotechnology for Renewable Energy and Environment	3 1 4
CHE F413	Process Plant Safety	3 0 3
CHE F421	Biochemical Engineering	3 0 3
CHE F423	Membrane Science and Engineering	3 0 3
CHE F424	Rheology of complex fluids	3 0 3
CHE F471	Advanced Process Control	3 0 3
CHE G512	Petroleum Refining and Petrochemicals	3 1 4
CHE G513	Environmental Management Systems	3 2 5
CHE G522	Polymer Technology	3 1 4
CHE G524	Introduction to Multiphase flow	3 1 4
CHE G525	Chemical Process and Equipment Design	3 1 4
CHE G526	Nuclear Engineering	3 1 4
CHE G527	Energy Conservation and Management	3 1 4
CHE G528	Introduction to Nano Science & Technology	3 1 4
CHE G529	Paper and Pulp Technology	3 1 4
CHE G532	Alternate Energy Resources	3 1 4
CHE G533	Petroleum Product Characterization	3 2 5
CHE G551	Advanced Separation Technology	3 2 5
CHE G553	Statistical Thermodynamics	4
CHE G554	Computational Fluid Dynamics	4
CHE G556	Electrochemical Engineering	4
CHE G557	Energy Systems Engineering	4
CHE G558	Chemical Process Optimization	4
CHE G568	Modeling and Simulation in Petroleum Refining	4
CHE G613	Advanced Mass Transfer	5
CHE G617	Petroleum Refinery Engineering	3 2 5
CHE G618	Petroleum Downstream Processing	3 2 5
CHE G619	Process Intensification	3 2 5
CHE G620	Energy Integration Analysis	3 2 5

Chemical with Specialization in Petroleum Engineering

Core Courses

CHE G523	Mathematical Methods in Chemical Engineering	5
CHE G616	Petroleum Reservoir Engineering	5
CHE G617	Petroleum Refinery Engineering	5
CHE G618	Petroleum Downstream Processing	5
CHE G622	Advanced Chemical Engineering Thermodynamics	5

CHE G641	Reaction Engineering	5
Elective Courses (any six)		
BIO G544	Bioremediation and Biometallurgy	5
BITS F418	Introduction to Biomedical Engineering	3 1 4
CHE F471	Advanced Process Control	3 1 4
CHE G511	Fluidization Engineering	3 1 4
CHE G513	Environmental Management Systems	3 2 5
CHE G522	Polymer Technology	3 1 4
CHE G532	Alternate Energy Resources	3 1 4
CHE G533	Petroleum Product Characterization	3 2 5
CHE G551	Advanced Separation Technology	3 2 5
CHE G567	Natural Gas Processing	4
CHE G568	Modeling and Simulation in Petroleum Refining	4
CHE G569	Petroleum Production Economics	4
CHE G613	Advanced Mass Transfer	3 2 5
CHE G614	Advanced Heat Transfer	3 2 5
CHE G619	Process Intensification	3 2 5
CHE G620	Energy Integration Analysis	3 2 5
MST G521	Material Characterization Techniques	3 2 5
Civil with Specialization in Infrastructure Engineering and Management		
Core Courses		
CE G515	Fundamentals of Systems Engineering	4
CE G520	Infrastructure Planning and Management	4
CE G523	Transportation Systems Planning and Management	4
CE G525	Water Resources Planning and Management	4
CE G527	Construction Management	4
Elective Courses (any six)		
BITS F469	Financing Infrastructure Projects	3 0 3
BITS F474	Rural Infrastructure Planning	3 0 3
BITS F494	Environmental Impact Assessment	3 1 4
CE F431	Principles of Geographical Information System	3 0 3
CE F433	Remote Sensing and Image Processing	3 0 3
CE G512	Topics in Environmental Engineering	3 1 4
CE G513	Advanced Computational Techniques	3 1 4
CE G516	Multicriteria Analysis in Engineering	3 1 4
CE G517	Waste Management Systems	3 1 4
CE G518	Pavement Design & Analysis	3 1 4
CE G522	Pavement Design, Maintenance and Management	3 2 5
CE G524	Urban Mass Transit Planning, Operations and Management	3 1 4
CE G526	Systems Approach to Water Resources Modelling	3 1 4
CE G528	Selection of Construction Equipment and Modelling	3 1 4
CE G529	Construction Project Control Systems	3 1 4
CE G530	Design of Construction Operation	3 1 4
CE G531	Environmental Conservation	3 1 4
CE G533	Advanced Composite Materials for Structures	3 1 4
CE G537	Transportation Economics and Finance	3 1 4
CE G538	Project Planning & Management	3 1 4
CE G542	Water Resources and Management	3 1 4
CE G545	Airport Planning & Design	3 1 4
CE G562	Advanced Concrete Technology	3 1 4
CE G563	Stochastic Methods in Civil Engineering	3 1 4
CE G564	Structural Health Assessment and Rehabilitation	3 1 4
CE G576	Advanced Computational Modelling	3 1 4
CE G610	Computer Aided Analysis and Design in Civil Engineering	3 2 5
CE G614	Prestressed Concrete	3 1 4
CE G616	Bridge Engineering	3 1 4
CE G618	Design of Multi-storey Structures	3 1 4
CE G619	Finite Element Analysis	5
CE G632	Design of Foundation for Dynamic Loads	3 1 4
Civil with Specialization in Structural Engineering		
Core Courses		
CE G551	Dynamics of Structures	4
CE G552	Advanced Structural Mechanics and Stability	4
CE G615	Earthquake Engineering	4
CE G617	Advanced Structural Analysis	4
CE G619	Finite Element Analysis	5
Elective Courses (any six)		
CE G511	Matrix Method in Civil Engineering	3 2 5
CE G513	Advanced Computational Techniques	3 1 4
CE G514	Structural Optimization	3 1 4
CE G521	Topics in Structural Engineering	3 2 5
CE G532	Advanced Soil Mechanics	3 1 4
CE G533	Advanced Composite Materials for Structures	3 1 4
CE G544	Fracture Mechanics of Concrete Structures	3 1 4
CE G553	Theory of Plates and Shells	3 1 4
CE G554	Advanced Structural Design	3 1 4
CE G562	Advanced Concrete Technology	4
CE G563	Stochastic Methods in Civil Engineering	3 1 4
CE G564	Structural Health Assessment and Rehabilitation	3 1 4
CE G576	Advanced Computational Modelling	3 1 4
CE G610	Computer Aided Analysis and Design in Civil Engineering	3 2 5

CE G611	Computer Aided Analysis and Design	3 2 5
CE G612	Advanced Steel Structures	3 1 4
CE G613	Advanced Concrete Structures	3 1 4
CE G614	Prestressed Concrete Structures	3 1 4
CE G616	Bridge Engineering	3 1 4
CE G618	Design of Multi-storey Structures	3 1 4
CE G620	Advanced Foundation Engineering	3 1 4
CE G621	Fluid Dynamics	3 2 5
CE G622	Soil-Structure Interaction	3 1 4
CE G623	Ground Improvement Techniques	3 1 4
CE G631	Selected Topics in Soil Mechanics and Geotechnical Engineering	3 1 4
CE G632	Design of Foundation for Dynamic Loads	3 1 4
CE G641	Theory of Elasticity and Plasticity	3 2 5

Civil with Specialization in Transportation Engineering

Core Courses

CE G518	Pavement Analysis and Design	4
CE G534	Pavement Material Characterization	4
CE G565	Transportation Planning	3 1 4
CE G566	Public Transportation	3 1 4
CE G567	Highway Design	3 1 4
CE G568	Traffic Systems Analysis	3 1 4

Elective Courses (any six)

BITS F494	Environmental Impact Assessment	3 1 4
BITS G529	Research Project I	6
CE G516	Multicriteria Analysis in Engineering	3 1 4
CE G520	Infrastructure Planning and Management	3 1 4
CE G528	Selection of Construction Equipment and Modeling	3 1 4
CE G538	Project Planning & Management	3 1 4
CE G539	Introduction to Discrete Choice Theory	4*
CE G543	Traffic Flow Theory	3 1 4
CE G545	Airport Planning and Design	3 1 4
CE G547	Pavement Failures, Evaluation and Rehabilitation	3 1 4
CE G549	Rural Road Technology	3 1 4
CE G563	Stochastic Methods in Civil Engineering	3 1 4
CE G569	Transportation Economics	3 1 4
CE G570	Highway Construction Technology	3 1 4
CE G571	Road Asset Management	3 1 4
CE G572	Transportation Data Analytics	3 1 4
CE G573	Road Safety and Accident Analysis	3 1 4
CE G574	Pavement Maintenance	3 1 4
CE G575	Freight Transportation	3 1 4
CE G616	Bridge Engineering	3 1 4
CE G619	Finite Element Analysis	3 2 5
CE G632	Design of Foundation for Dynamic Loads	3 1 4

Civil with Specialization in Water Resource Engineering

Core Courses

CE G526	Systems Approach to Water Resources Modeling	4
CE G555	Remote Sensing and GIS in Water Resources	4
CE G556	Advanced Computational Hydraulics	4
CE G557	Stochastic Hydrology	4
CE G558	Advanced Groundwater Hydrology	4
CE G559	Soft Computing in Water Resources	4

Elective Courses (any five)

BITS F494	Environmental Impact Assessment	3 1 4
CE G516	Multicriteria Analysis in Engineering	3 1 4
CE G517	Waste Management Systems	3 1 4
CE G525	Water Resources Planning and Management	3 1 4
CE G560	Hydrologic Simulation Laboratory	4
CE G561	Impact of Climate Change on Water Resources and Environment	4
CE G621	Fluid Dynamics	3 2 5

Communication Engineering

Core Courses

EEE G581	RF and Microwave Engineering	5
EEE G591	Optical Communication	5
EEE G592	Mobile and Personal Communication	5
EEE G612	Coding Theory and Practice	5
EEE G613	Advanced Digital Signal Processing	5
EEE G622	Advanced Digital Communication	5

Elective Courses (any five)

BITS F415	Introduction to MEMS	4
BITS G553	Real Time Systems	3 1 5
BITS G554	Data Compression	3 1 4
CS F303	Computer Networks	3 0 3
CS F401	Multimedia Computing	3 0 3
CS F413	Internetworking Technologies	3 0 3
CS G541	Pervasive Computing	4
CS G553	Reconfigurable Computing	5
CS G555	System Specification and Modeling	3 3 4
EEE F414	Telecommunication Switching Systems and Networks	3 0 3
EEE F430	Green Communications and Networks	3 0 3
EEE F472	Satellite Communication	3 0 3
EEE F474	Antenna Theory and Design	3 1 4
EEE G510	RF Microelectronics	5
EEE G512	Embedded System Design	3 1 4
EEE G513	Machine Learning for Electronics Engineers	4
EEE G521	Optoelectronic Devices, Circuits and Systems	3 2 5
EEE G522	Advanced Satellite Communication	5*
EEE G582	Telecom Network Management	3 2 5

EEE G613	Advanced Digital Signal Processing	5
EEE G614	Advanced Wireless Communications	3 2 5
EEE G626	Hardware Software Co-Design	4
EEE G627	Network Embedded Application	4
EEE G641	Applied Estimation Theory	3 2 5
IS F462	Network Programming	3 0 3
MEL G621	VLSI Design	3 2 5
MEL G622	Introduction to Artificial Neural networks	2 2 4

Computer Science

Core Courses

CS G513	Network Security	4
CS G524	Advanced Computer Architecture	5
CS G525	Advanced Computer Networks	5
CS G526	Advanced Algorithms and Complexity	5
CS G623	Advanced Operating Systems	5

Elective Courses (any six)

BITS F452	Blockchain Technology	3 0 3
BITS F453	Computational Learning Theory	3 0 3
BITS F454	Bio-Inspired Intelligence: Algorithms and Applications	3 0 3
BITS F464	Machine Learning	3 0 3
BITS G553	Real-Time Systems	5
CS F402	Computational Geometry	3 0 3
CS F407	Artificial Intelligence	3 0 3
CS F413	Internetworking Technologies	3 0 3
CS F415	Data Mining	3 0 3
CS F422	Parallel Computing	3 0 3
CS F425	Deep Learning	3 0 3
CS F426	Graph Mining	3 1 4
CS F427	Performance Analysis of Computer Networks	3 0 3
CS F428	Special Topic in Computer Science	3 0 3
CS F429	Natural Language Processing	3 0 3
CS F430	Approximation Algorithms	3 0 3
CS F431	Combinatorial Optimization	3 0 3
CS F432	Brain-inspired Deep Learning	3 0 3
CS F433	Computational Neuroscience	3 0 3
CS F441	NetSelected topics from Computer Science	1 0 1
CS F446	Data Storage Technologies & Networks	3 0 3
CS F469	Information Retrieval	3 0 3
CS G516	Advanced Database Systems	3 1 4
CS G518	Internet of Things: Design and Development	3 1 4
CS G519	Social Media Analytics	3 1 4
CS G520	Advanced Data Mining	3 1 4
CS G523	Software for Embedded Systems	3 2 5
CS G527	Cloud Computing	5
CS G541	Pervasive Computing	4
CS G551	Advance Compilation Techniques	5
CS G553	Reconfigurable Computing	5
CS G554	Distributed Data Systems	3 2 5
CS G568	Network Security Project	0 3 3
CS G612	Fault Tolerant System Design	2 3 5
EEE G512	Embedded System Design	3 1 4
EEE G582	Telecom Network management	5
EEE G627	Networked Embedded Applications	3 1 4
IS F462	Network Programming	3 0 3
SS G514	Object Oriented Analysis and Design	4
SS G515	Data Ware Housing	5
SS G552	Software Testing Methodologies	4
SS G562	Software Engineering and Management	5
SS G653	Software Architecture	5

Design Engineering

Core Courses

DE G531	Product Design	5
DE G611	Dynamics and Vibration	5
DE G631	Materials Testing and Technology	5
ME G511	Mechanism and Robotics	5
ME G512	Finite Element Methods	5
ME G611	Computer Aided Analysis and Design	5

Elective Courses (any five)

BITS F415	Introduction to MEMS	3 1 4
DE G513	Tribology	3 2 5
DE G514	Fracture Mechanics	3 2 5
DE G522	Design Projects	3 2 5
ME F423	Micro Fluidics and its Application	4*
ME F428	Smart Materials	3 1 4
ME F429	Micro-Nanoscale Heat Transport	3 1 4
ME G515	Computational Fluid Dynamics	3 2 5
ME G521	Mechanical System Design	3 2 5
ME G532	Machine Tool Engineering	3 2 5
ME G535	Advanced Engineering Mathematics	3 2 5
ME G536	Thermal Equipment Design	5
ME G542	Advanced Welding Techniques	3 2 5
ME G612	Plastics Engineering	3 2 5
ME G613	Advanced Finite Element Modelling & Analysis	3 2 5
ME G641	Theory of Elasticity and Plasticity	3 2 5
MSE G511	Mechatronics	3 2 5
MSE G531	Concurrent Engineering	3 2 5
MST G511	Nondestructive Testing Techniques	3 2 5
MST G522	Advanced Composites	3 2 5
MST G531	Experimental Stress Analysis Techniques	3 2 5

Electrical with specialization in Power Electronics & Drives

Core Courses

EEE G541	Distribution Apparatus and Configuration	5
EEE G542	Power Electronics Converter	5
EEE G543	Power Devices Microelectronics and Selection	3
EEE G545	Control and Instrumentation Systems	5
EEE G546	System Simulation Lab.	5
EEE G552	Solid State Drives	5

Elective Courses (any five)

BITS F462	Renewable Energy	3 0 3
CHE G526	Nuclear Engineering	3 1 4
EEE F422	Modern Control Systems	3 0 3

EEE F462	Advanced Power Systems	3 0 3
EEE G544	Steady State and Dynamics of Electrical Motors	3 2 5
EEE G553	Utility Applications of Power Electronics	3 0 3
EEE G554	Soft Switching ConverterTechnologies	3 0 3
EEE G555	Transformer and Motor Design	3 0 3
EEE G557	Drives for Electric Traction	3 0 3
EEE G558	DSP based Implementation Drivers	3 0 3
EEE G593	Power Quality	5
MEL G622	Introduction to Artificial Neural networks	2 2 4

Embedded Systems

Core Courses

BITS G553	Real Time Systems	5
CS G523	Software for Embedded Systems	5
EEE G512	Embedded System Design	3 1 4
EEE G626	Hardware Software Co-Design	5
MEL G642	VLSI Architecture	5

Elective Courses (any six)

BITS F415	Introduction to MEMS	4
CS G518	Internet of Things: Design and Development	3 1 4
CS G541	Pervasive Computing	4
CS G553	Reconfigurable Computing	5
CS G611	Distributed Processing Systems	2 2 4
CS G612	Fault Tolerant System Design	2 3 5
ECE F423	Electronic Material Design and Simulations Laboratory	1 2 3
EEE F423	Electronic Material Design and Simulations Laboratory	1 2 3
EEE F434	Digital Signal Processing	3 1 4
EEE G513	Machine Learning for Electronics Engineers	4
EEE G547	Device Drivers	3 2 5
EEE G594	Advanced VLSI Devices	5
EEE G595	Nanoelectronics and Nanophotonics	5
EEE G613	Advanced Digital Signal Processing	5
EEE G625	Safety Critical Embedded System Design	4
EEE G627	Network Embedded Application #	4
INSTR F423	Electronic Material Design and Simulations Laboratory	1 2 3
MEL G531	Testable Design and Fault Tolerant Computing	3 2 5
MEL G621	VLSI Design	3 2 5
MEL G622	Introduction to Artificial Neural networks	2 2 4
MEL G623	Advanced VLSI Design	5
MEL G624	Advanced VLSI Architectures	5
MEL G626	VLSI Test and Testability	5
MSE G511	Mechatronics	3 2 5

M.E. Electronics and Control

Core Courses

EEE G512	Embedded System Design	4
EEE G546	Systems Simulation Lab	4
EEE G552	Solid State Drives	5
EEE G559	Advanced Power Electronics	5
EEE G621	Advanced Electronic Circuits	5
INSTR G611	Advanced Control Systems	5

Elective Courses (any five)

BITS F415	Introduction to MEMS	3 1 4
BITS G654	Advanced Instrumentation Techniques	5
EEE F422	Modern Control Systems	3 0 3
EEE G521	Optoelectronic Devices, Circuits & Systems	5
EEE G544	Steady State and Dynamics of Electric Motors	5
EEE G545	Control and Instrumentation Systems	5
EEE G553	Utility Applications of Power Electronics	3
EEE G554	Soft Switching Converter Technologies	3
EEE G556	DSP Based Control of Electric Drives	3
EEE G593	Power Quality	5
EEE G613	Advanced Digital Signal Processing	5
ME G516	Energy Systems Engineering	5
MSE G511	Mechatronics	3 2 5

Environmental Engineering

Core Courses

BIO G525	Environmental Biotechnology and Waste Management	3 2 5
CHE G513	Environmental Management Systems	3 2 5
CHE G552	Advanced Transport Phenomena	5*
CHEM G521	Environmental Chemistry	5*
EE G501	Environmental Sampling and Analytical Methods	3 2 5
EE G502	Water and Wastewater Treatment Systems	3 2 5
BITS G540	Research Practice	4*

Elective Courses (Group -1)

BITS G513	Study in Advanced Topics	5
EE G503	Environmental Systems Modelling	3 2 5
EE G504	Physico Chemical Treatment Principles and Design of Wastewater Treatment Systems	3 2 5
EE G505	Biological Treatment Principles and Design of Wastewater Treatment Systems	3 2 5
EE G506	Environmental Statistics	3 2 5
EE G507	Industrial Pollution Abatement	5*
EE G508	Urban Water Management	5*
EE G601	Energy Generation and Management in Waste Treatment Plants	3 2 5
EE G602	Environmental Remote Sensing and GIS	3 2 5
EE G603	Air Pollution Control Technologies	3 2 5
EE G604	Solid Waste Management	3 2 5
EE G605	Environmental Process Engineering	3 2 5
EE G606	Environmental Impact and Risk Assessment	3 2 5

Elective Courses (Group -2)

SAN G511	Sanitation Technology	3 2 5
SAN G512	Sanitation and Public Health	3 2 5
SAN G513	Sanitation Governance, Behaviour change and advocacy	5*
SAN G514	Sanitation financing, and Project Management	5*
SAN G515	Emergency Sanitation & Leadership	5*

Manufacturing Systems Engineering		
Core Courses		
BITS F431	Flexible Manufacturing Systems	4
ITEB G621	Supply Chain Management	4
ME F443	Quality Control Assurance and Reliability	3
ME G511	Mechanism and Robotics	5
MSE G512	Manufacturing Planning and Control	5
MSE G521	World Class Manufacturing	5
Elective Courses (any five)		
DE G522	Design Projects	3 2 5
DE G531	Product Design	3 2 5
ME G535	Advanced Engineering Mathematics	3 2 5
ME G538	Toyota Production System	3 2 5
ME G539	Computer Integrated Manufacturing	3 2 5
MF F422	Supply Chain Modelling and Empirical Analysis	3 1 4
MSE G511	Mechatronics	3 2 5
MSE G513	Maintenance Engineering	3 1 4
MSE G514	Leadership and Managing Change	3 1 4
MSE G531	Concurrent Engineering	3 2 5
Mechanical Engineering		
Core Courses		
ME F443	Quality Control Assurance and Reliability	3
ME G511	Mechanism and Robotics	5
ME G512	Finite Element Methods	5
ME G532	Machine Tool Engineering	5
ME G611	Computer Aided Analysis and Design	5
ME G641	Theory of Elasticity and Plasticity	5
Elective Courses (any five)		
BITS F415	Introduction to MEMS	3 1 4
DE G513	Tribology	3 2 5
DE G522	Design Projects	3 2 5
DE G531	Product Design	3 2 5
DE G611	Dynamics and Vibrations	3 2 5
ME F423	Micro Fluidics and its Application	4*
ME F428	Smart Materials	3 1 4
ME F429	Micro-Nanoscale Heat Transport	3 1 4
ME F472	Precision Engineering	3 0 3
ME F483	Wind Energy	3 0 3
ME G513	Heating and Cooling of Buildings	3 2 5
ME G514	Turbomachinery	3 2 5
ME G515	Computational Fluid Dynamics	3 2 5
ME G535	Advanced Engineering Mathematics	3 2 5
ME G542	Advanced Welding Techniques	3 2 5
ME G613	Advanced Finite Element Modelling & Analysis	3 2 5
ME G631	Advanced Heat Transfer	3 2 5
Mechanical with specialization in Thermal Engineering		
Core Courses		
BITS F462	Renewable Energy	3
ME G514	Turbomachinery	5
ME G515	Computational Fluid Dynamics	5
ME G533	Conduction and Radiation Heat Transer	5
ME G534	Convective Heat and Mass Transfer	5
ME G621	Fluid Dynamics	5
Electives Courses (any five)		
BITS F415	Introduction to MEMS	4*
BITS F417	Micro-fluidics and its Applications	4*
ME F433	Solar Thermal Process Engineering	3 1 4
ME F461	Refrigeration & Air-conditioning	3 0 3
ME F482	Combustion	3 0 3
ME F483	Wind Energy	3 0 3
ME G513	Heating and Cooling of Buildings	5
ME G516	Energy Systems Engineering	5
ME G535	Advanced Engineering Mathematics	5
ME G536	Thermal Equipment Design	5
ME G537	Cryogenic Engineering	5
Microelectronics		
Core Courses		
MEL G611	IC Fabrication Technology	5
MEL G621	VLSI Design	5
MEL G631	Physics & Modeling of Microelectronic Devices	5
MEL G632	Analog IC Design	5
MEL G641	CAD for IC Design	5
Elective Courses (any six)		
BITS F415	Introduction to MEMS	3 1 4
CS G518	Internet of Things: Design and Development	3 1 4
CS G553	Reconfigurable Computing	5
CS G562	Advanced Architecture and Performance Evaluation	3 2 5
CS G612	Fault Tolerant System Design	2 3 5
ECE F423	Electronic Material Design and Simulations Laboratory	1 2 3
EEE F419	Flexible and Stretchable Electronics	3 1 4
EEE F423	Electronic Material Design and Simulations Laboratory	1 2 3
EEE F434	Digital Signal Processing	3 1 4
EEE G510	RF Microelectronics	5
EEE G512	Embedded System Design	3 1 4
EEE G513	Machine Learning for Electronics Engineers	4
EEE G514	Nanoelectronic Memories and Technology	3 2 5
EEE G522	Advanced Satellite Communication	5
EEE G594	Advanced VLSI Devices	5
EEE G595	Nanoelectronics and Nanophotonics	5
EEE G613	Advanced Digital Signal Processing	5
EEE G626	Hardware Software Co-Design	4
INSTR F423	Electronic Material Design and Simulations Laboratory	1 2 3
MEL G512	Optoelectronic Devices Circuits and Systems	3 2 5
MEL G514	Nanoelectronic Memories and Technology	3 2 5
MEL G531	Testable Design and Fault Tolerant Computing	3 2 5
MEL G612	Integrated Electronics Design	2 2 4
MEL G622	Introduction to Artificial Neural networks	2 2 4
MEL G623	Advanced VLSI Design	5
MEL G624	Advanced VLSI Architectures	5
MEL G625	Advanced Analog and Mixed Signal Design	5
MEL G626	VLSI Test and Testability	5
MEL G642	VLSI Architectures	2 2 4
Pharmacy		
Core Courses		
PHA G532	Quality Assurance and Regulatory Affairs	5

PHA G543	Clinical Research	5
PHA G611	Advanced Pharmacology	5
PHA G612	Pharmacokinetics and Clinical Pharmacy	5
PHA G621	Advanced Medicinal Chemistry	5
PHA G632	Dosage Form Design	5

Elective Courses (any five)

BIO F417	Biomolecular Modelling	3 0 3
BITS F467	Bioethics and Biosafety	3 0 3
PHA G521	Molecular Biology and Immunology	3 1 4
PHA G541	Computer Aided Drug Design	3 2 5
PHA G542	Advanced Physical Pharmaceutics	3 2 5
PHA G544	Advanced Pharmaceutical Chemistry	3 2 5
PHA G545	Intellectual property rights and Pharmaceuticals	3 0 3
PHA G547	Quality-by-Design in Pharmaceutical Product Development	3 2 5
PHA G548	Chemistry of Natural Drugs	3 2 5
PHA G613	Pharmaceutical Biotechnology	3 2 5
PHA G614	Clinical Pharmacy and Therapeutics	3 2 5
PHA G615	Pharmacy Practice	3 2 5
PHA G616	Pharmaceutical Administration and Management	3 2 5
PHA G619	Screening Methods & Techniques in Pharmacology	5*
PHA G622	Chemistry of Natural Drugs and Macromolecules	3 2 5
PHA G625	Cellular and Molecular Pharmacology	5
PHA G642	Laboratory Projects	6

PHA G540 Modern Pharmaceutical Analytical Techniques

PHA G546 Pharmaceutical Biostatistics (3 0 3)

may be required to be completed as a deficiency courses for M. Pharm. Programme.

M. Pharm. With specialization in Pharmaceutics

Core Courses

PHA G532	Quality Assurance and Regulatory Affairs	5
PHA G535	Biomaterials	5
PHA G542	Advanced Physical Pharmaceutics	5
PHA G612	Pharmacokinetics and Clinical Pharmacy	5
PHA G617	Advanced Drug Delivery Systems	5
PHA G632	Dosage Form Design	5

Elective Courses (any five)

BITS F467	Bioethics and Biosafety	3 0 3
PHA G536	Cosmetics and Cosmeceuticals	3 2 5
PHA G537	Parenteral Product Development	5
PHA G543	Clinical Research	5
PHA G545	Intellectual property rights and Pharmaceuticals	3 0 3
PHA G547	Quality-by-Design in Pharmaceutical Product Development	3 2 5
PHA G613	Pharmaceutical Biotechnology	3 2 5
PHA G616	Pharmaceutical Administration and Management	3 2 5
PHA G619	Screening Methods & Techniques in Pharmacology	5*
PHA G623	Pharmaceutical Applications of Polymers and Biopolymers	5
PHA G642	Laboratory Projects	6

PHA G540 Modern Pharmaceutical Analytical Techniques

PHA G546 Pharmaceutical Biostatistics (3 0 3)

may be required to be completed as a deficiency courses for M. Pharm. With specialization in Pharmaceutics Programme.

M. Pharm. With specialization in Pharmaceutical Chemistry

Core Courses

PHA G522	Chemistry of Macromolecules	4
PHA G541	Computer Aided Drug Design	5
PHA G543	Clinical Research	5
PHA G544	Advanced Pharmaceutical Chemistry	3 2 5
PHA G618	Retrosynthetic Analysis	5
PHA G621	Advanced Medicinal Chemistry	5

Elective Courses (any five)

BITS F467	Bioethics and Biosafety	3 0 3
PHA G532	Quality Assurance and Regulatory Affairs	3 2 5
PHA G533	Pharmaceutical Process Chemistry	4
PHA G534	Separation and Structure Elucidation Techniques	4
PHA G545	Intellectual property rights and Pharmaceuticals	3 0 3
PHA G548	Chemistry of Natural Drugs	3 2 5
PHA G613	Pharmaceutical Biotechnology	3 2 5
PHA G619	Screening Methods & Techniques in Pharmacology	5*
PHA G642	Laboratory Projects	6

PHA G540 Modern Pharmaceutical Analytical Techniques

PHA G546 Pharmaceutical Biostatistics (3 0 3)

may be required to be completed as a deficiency courses for M. Pharm. With specialization in Pharmaceutical Chemistry Programme.

M. Pharm. With specialization in Pharmacology

Core Courses

PHA G538	Immunopharmacology	4
PHA G543	Clinical Research	5
PHA G619	Screening Methods and Techniques in Pharmacology	3 2 5
PHA G611	Advanced Pharmacology	3 2 5
PHA G624	Principles of Toxicology	5
PHA G625	Cellular and Molecular Pharmacology	5

Elective Courses (any five)

BITS F467	Bioethics and Biosafety	3 0 3
PHA G532	Quality Assurance and Regulatory Affairs	3 2 5
PHA G539	Principles of Drug Discovery	4
PHA G545	Intellectual Property Rights and Pharmaceuticals	3 0 3
PHA G612	Pharmacokinetics and Clinical Pharmacy	3 2 5
PHA G614	Clinical Pharmacy and Therapeutics	3 2 5
PHA G623	Pharmaceutical Applications of Polymers	5
PHA G626	Pharmacovigilance	4
PHA G627	Medical Devices and Testing	4
PHA G642	Laboratory Projects	6

PHA G540 Modern Pharmaceutical Analytical Techniques

PHA G546 Pharmaceutical Biostatistics (3 0 3)

may be required to be completed as a deficiency courses for M. Pharm. With specialization in Pharmacology Programme.

Software Systems

Core Courses

CS F 415	Data Mining	3
SS G514	Object Oriented Analysis and Design	4
SS G515	Data Ware Housing	5
SS G562	Software Engineering and Management	5
SS G653	Software Architecture	5

Elective Courses (any six)

BITS F452	Blockchain Technology	3 0 3
BITS F464	Machine Learning	3 0 3
	Real-Time Systems	5
CS F401	Multimedia Computing	3 0 3
CS F402	Computational Geometry	3 0 3
CS F407	Artificial Intelligence	3 0 3
CS F413	Internetworking Technologies	3 0 3
CS F422	Parallel Computing	3 0 3
CS F425	Deep Learning	3 0 3
CS F426	Graph Mining	3 1 4
CS F427	Performance Analysis of Computer Networks	3 0 3
CS F428	Special Topic in Computer Science	1 0 1
CS F441	Selected topics from Computer Science	3
	Data Storage & Networks	3 0 3
CS F469	Information Retrieval	3 0 3
CS G523	Software for Embedded Systems	3 2 5
CS G524	Advanced Computer Architecture	5
CS G525	Advanced Computer Networks	5
CS G526	Advanced Algorithms and Complexity	5
CS G541	Pervasive Computing	4
CS G553	Reconfigurable Computing	5
CS G568	Network Security Project	0 3 3
CS G612	Fault Tolerant System Design	2 3 5
CS G623	Advanced Operating Systems	5
IS F462	Network Programming	3 0 3
SS G513	Network Security	3 1 4
SS G519	Social Media Analytics	3 1 4
SS G520	Advanced Data Mining	3 1 4
SS G527	Cloud Computing	5
SS G551	Advance Compilation Techniques	5
SS G552	Software Testing Methodologies	4
SS G554	Distributed Data Systems	3 2 5

Master of Business Administration

Core Courses

MBA G501	Managerial Economics	3
MBA G510	Human Resource Management	4
MBA G543	Leading Modern Organizations	3 0 3
MBA G544	Organizational Theory & Behaviour	3 0 3
MBA G545	Management Science	3 0 3
MBA G546	Business Statistics	3 0 3
MBA G547	Accounting for Managers	3 0 3
MBA G548	Strategic Marketing	3 0 3
MBA G549	Introduction to Systems & Sustainability	3 0 3
MBA G550	Critical and Design Thinking	3 0 3
MBA G557	Economic Environment of Business	3 0 3
MBA G558	Operations and Supply Chain Management	3 0 3
MBA G559	Corporate Finance	3 0 3
MBA G560	Marketing Research & Metrics	3 0 3
MBA G561	Business Analytics	3 0 3
MBA G564	Decision Making	3 0 3
MBA G565	Information & Knowledge Management Systems	3 0 3
MBA G566	Strategic Management	3 0 3
MBA G567	Technology Innovation & Entrepreneurship	3 0 3
MBA G568	International Business Strategy & Operations	3 0 3

Elective Courses

For Operations and Decision Sciences

MBA G512	Manufacturing Strategy	4
MBA G514	Technology Management	3 0 3
MBA G522	Total Quality Management	4
MBA G523	Project Management	4
MBA G525	R & D Management	3 0 3
MBA G539	Six Sigma	3 1 4
MBA G541	Operations Strategy	3 0 3
MBA G577	Supply Chain Analytics	3 1 4
MBA G579	Management Practice	3*
MBA G588	Services Management System	3 0 3

For Information Systems Management

MBA G527	e-Business and Internet Marketing	4
MBA G528	Internet Security and Cyber-laws	4
MBA G579	Management Practice	3*
MBA G581	Expert Systems	4
MBA G589	Enterprise Resource Planning	3 0 3
MBA G622	Software Project Management	4

For Finance

FIN F414	Financial Risk Analytics & Management	3 0 3
MBA G507	International Financial Markets & Services	3 0 3
MBA G508	Functions and Working of Stock Exchanges	3 0 3
MBA G509	Investment Banking and Financial Services	3 0 3
MBA G530	Project Appraisal	3 0 3
MBA G532	Risk Management and Insurance	3 0 3
MBA G536	Strategic Financial Management	3 0 3
MBA G537	Security Analysis and Portfolio Management	3 0 3
MBA G575	Financial Engineering	3 0 3
MBA G579	Management Practice	3*
MBA G593	Business Analysis and Valuation	3 0 3

For Marketing

MBA G533	Advertising and Sales Promotion	3 0 3
MBA G538	Marketing Models	3 0 3
MBA G540	Sports Marketing	3 0 3
MBA G542	Consumer Behaviour	3 0 3
MBA G562	Services Marketing	3 0 3
MBA G563	Industrial Marketing	3 0 3
MBA G574	Retail Management Systems	3 0 3
MBA G576	Digital Marketing	3 0 3
MBA G579	Management Practice	3*
MBA G583	Marketing Research	3 0 3
MBA G586	Product and Brand Management	3 0 3

For Organization Behavior and Human Resource Management		
MBA G535	Cross Cultural Management	3 0 3
MBA G553	Organizational Change and Development	3 0 3
MBA G554	Innovative Leadership	3 0 3
MBA G555	International Human Resource Management	3 0 3
MBA G556	Performance Management	3 0 3
MBA G579	Management Practice	3*
For Strategy & Entrepreneurship		
BITS F468	New Venture Creation	3 0 3
MBA G578	Game Theory and Business Strategy	3 0 3
MBA G579	Management Practice	3*
MBA G582	Creating and Leading Entrepreneurial Organization	3 0 3

MBA in Business Analytics

Core Courses

MPBA G501	Managerial Economics	3 0 3
MPBA G502	Financial Statement Analysis & Reporting	3*
MPBA G503	Marketing Management	3 0 3
MPBA G504	Managing People & Organization	3 0 3
MPBA G505	Statistics & Basic Econometrics	3*
MPBA G506	Data Management And Warehousing	3*
MPBA G507	Programming For Analytics	3*
MPBA G508	Strategic Management	3 0 3
MPBA G509	Corporate Finance	3*
MPBA G510	Operations & Supply Chain Management	3*
MPBA G511	Data Visualization, Ethics And Data Privacy	3*
MPBA G512	Time Series Analysis And Forecasting	3*
MPBA G513	Predictive Analytics	3*
MPBA G514	Deep Learning For Business	3*
MPBA G515	Prescriptive Analytics With Mathematical Programming	3*

Elective Courses - Pool Group-1

List of courses - in the **pool of Elective - Group-1**: This **Elective Pool (Group-1)** will be from Mathematics & Statistics, Technology Track -any two electives from the following list are required to be taken to satisfy requirement of this pool of elective

MPBA G516	Advanced Spreadsheet & Macro Programming For Business	3*
MPBA G517	Big Data Analytics	3*
MPBA G518	Bayesian Analysis	3*
MPBA G519	Natural Language Processing For Business	3*
MPBA G537	Data Structures and Algorithmic Thinking	3*

Elective Courses - Pool Group-2

This Elective Pool (Group-2) will be from Functional-Analytics Track - any three electives from the following list are required to be taken to satisfy requirement of this pool of electives:

MPBA G520	Analytics For Supply Chain	3*
MPBA G521	Supply Chain Finance	3*
MPBA G522	Discrete Event Simulation	3*
MPBA G523	IT Project Management	3*
MPBA G524	Marketing Analytics	3*
MPBA G525	Digital Analytics	3*
MPBA G526	Pricing Analytics	3*
MPBA G527	Retail Analytics	3*
MPBA G528	Customer Engagement And Analytics	3*
MPBA G529	Marketing Research & Metrics	3*
MPBA G530	Financial Analytics	3*
MPBA G531	Financial Derivatives And Analysis	3*
MPBA G532	Financial Modelling And Valuation	3*
MPBA G533	Financial Technology	3*
MPBA G534	People Analytics	3*
MPBA G535	Strategy Analytics	3*
MPBA G536	Knowledge Management And Digital Strategy	3*
MPBA G538	Critical Product Management	3*

Master in Public Health Core Courses		
BITS G515	Management Principles and Practices	4*
MPH G510	Biostatistics & Computers in Public Health	5
MPH G512	Environmental & Occupational Health	4
MPH G513	Public Health & Diseases	4
MPH G515	Communication in Health Care	4
MPH G521	Health Care Management	4
MPH G522	Preventive Nutrition & Health Promotion	4
MPH G523	Epidemic & Disaster Management	4
MPH G531	Health Economics & Financial Management	4
MPH G613	Health Systems and Society	2
MPH G661	Research Methodology I	5
MPH G692	Epidemiology	2
Elective Courses (any three)		
BITS F467	Bioethics and Biosafety	3 0 3
MPH C431	Accounting & Finance	4
MPH G535	Family & Community Health Measures	3
MPH G537	Law & Ethics in Public Health	3
MPH G538	Telemedicine	3
MPH G539	Inter-sectoral co-ordination in Health Services	3
MPH G540	Role of Voluntary Bodies/NGO's in Public Health	3
MPH G665	Hospital Operations Management	3
MPH G681	Strategic Management	3

M. Phil. Chemistry Core Courses		
CHEM G551	Advanced Organic Chemistry	5*
CHEM G552	Advanced Inorganic Chemistry	5*
CHEM G553	Advanced Physical Chemistry	5*

CHEM G554	Physical Methods in Chemistry	5*
CHEM G555	Chemistry of Life Processes	5*

Elective Courses (any four)

BIO G513	Microbial and Fermentation Technology	5*
BITS G654	Advanced Instrumentation Techniques	5*
CHEM F412	Photochemistry and Laser Spectroscopy	3 0 3
CHEM F422	Statistical Thermodynamics	3 0 3
CHEM C431	Stereochemistry and Reaction Mechanism	3 0 3
CHEM G513	Advanced Nuclear and Radio Chemistry	5*
CHEM G521	Environmental Chemistry	5*
CHEM G531	Recent Advances in Chemistry	5*
CHEM G541	Chemical Applications of Group Theory	5*
CHEM G556	Catalysis	4*
CHEM G557	Solid Phase Synthesis and Combinatorial Chemistry	4*
CHEM G558	Electronic Structure Theory	5*
CHEM G559	Bioinorganic Chemistry	4*
CHEM G561	Heterocyclic Chemistry	5*
CHEM G562	Solid State Chemistry	4*
CHEM G563	Advanced Statistical Mechanics	5*
EEE F432	Medical Instrumentation	3 0 3
PHA G621	Advanced Medicinal Chemistry	2 3 5

DCA is empowered to add the following course as a deficiency course on case by case basis if the student is found to be deficient in Mathematics.

CHEM C453	Mathematics for Chemists	4*

* This is the total units and its break-up in terms of lectures and practical/seminars/project may be announced from time to time through the timetable.

M. Phil. in Liberal Studies
Core Courses

BITS E583	Case Study I	5
BITS G518	Writing Seminar	5
BITS G561T	Dissertation	16
BITS G661	Research Methodology I	5
HSS G511	Philosophical Foundations of Liberal Studies	5
HSS G512	Theoretical Approaches to Liberal Studies	5

Elective Courses

The 3 Electives will be fulfilled by taking one or more of the following courses or any other discipline course subject to approval by the department.

BITS E573	Study in Advanced Topics I	5
BITS E574	Study in Advanced Topics II	5
BITS E584	Case Studies II	4
BITS G565T	Dissertation	5

M.E. COMPUTER SCIENCE WITH SPECIALIZATION IN INFORMATION SECURITY WITH B.SC. INPUT
Core Courses

BITS F345	Information Law and Cyber Law	3 0 3
BITS F437	Technical Communication	3 0 3
BITS F463	Cryptography	3 0 3
BITS G540	Research Practice	4
CS F111	Computer Programming	3 1 4
CS F211	Data Structures & Algorithms	3 1 4
CS F212	Database Systems	3 1 4
CS F213	Object Oriented Programming	3 1 4
CS F215	Digital Design	3 1 4
CS F222	Discrete Structures for Computer Science	3 0 3
CS F301	Principles of Programming Languages	2 0 2
CS F303	Computer Networks	3 1 4
CS F342	Computer Architecture	3 1 4
CS F351	Theory of Computation	3 0 3
CS F364	Design and Analysis of Algorithms	3 0 3
CS F372	Operating Systems	3 0 3
CS F404	Computer Crime and Forensics	2 0 2
CS F406	Ethical Hacking	2 2 3
CS F468	Information Security Project	0 3 3
CS G517	Network & Systems Security	4
CS G524	Advanced Computer Architecture	3 0 5
CS G525	Advanced Computer Networks	3 2 5
CS G526	Advanced Algorithms and Complexity	3 2 5
CS G566	Secure Software Engineering	5
CS G568	Network Security Project	0 3 3
CS G623	Advanced Operating Systems	3 2 5
IS F242	Computer Organization	3 1 4
IS F341	Software Engineering	3 1 4
MATH F113	Probability and Statistics	3 0 3
MATH F212	Optimization	3 0 3
MATH F231	Number Theory	3 0 3
MGTS F211	Principles of Management	3 0 3

Elective Courses

CS F401	Multimedia Computing	3 0 3
CS F402	Computational Geometry	3 0 3
CS F407	Artificial Intelligence	3 0 3
CS F415	Data Mining	3 0 3
CS F441	Selected topics from Computer Science	3
CS F446	Data Storage Technologies & Networks	3 0 3
CS F451	Combinatorial Mathematics	3 0 3
CS G501	Mobile Computing	5
CS G514	Object Oriented analysis and Design	2 2 4
CS G527	Cloud computing	5
CS G557	Distributed Computing	5
CS G559	Database Security	5
CS G564	Advanced Cryptography	5
IS F322	Software Testing	2 1 3

M.E. Sanitation Science, Technology and Management
Core Courses

BITS G540	Research Practice	4*
SAN G511	Sanitation Technology	3 2 5
SAN G512	Sanitation and Public Health	3 2 5

SAN G513	Sanitation Governance, Behaviour change and Advocacy	5*
SAN G514	Sanitation financing and Project Management	5*
SAN G515	Emergency Sanitation & Leadership	5*

Elective Courses

BIO G525	Environmental Biotechnology & Waste Management	3 2 5
BITS G513	Study in Advanced Topics	5
CHE G513	Environmental Management System	3 2 5
MPH G510	Biostatistics & Computers in Public Health	5

In addition to above courses, the students will be required to register in the following courses as deficiency courses if they have not done it during their First Degree programme:

- BIO F216 Water, Sanitation and Solid Waste Management
- BIO F217 Laboratory for Water, Sanitation and Solid Waste Management
- CE F342 Water & Waste Water Treatment

LIST OF GENERAL/SPECIAL COURSES FOR M.PHIL. PROGRAMMES

BIO G511	Population and Quantitative Genetics	5
BIO G522	Interferon Technology	2 2 4
BIO G541	Neural Network Analysis	5
BIO G551	Membrane Biology	5
BITS G511	Advanced Project	5
BITS G513	Study in Advanced Topics	5
BITS G514	Environmental Health	3 0 3
BITS G644	Development and use of Computer Software	5
BITS G654	Advanced Instrumentation Techniques	5
CHEM G511	Nuclear and Radio Chemistry	5
CHEM G513	Advanced Nuclear and Radiochemistry	5
CHEM G521	Environmental Chemistry	5
CHEM G531	Recent Advances in Chemistry	5
CHEM G541	Chemical Applications of Group Theory	5
CHEM G551	Advanced Organic Chemistry	5
CHEM G552	Advanced Inorganic Chemistry	5
ECON G511	Dynamic Modelling and Control of National Economies	5
ECON G521	Modern Cost Engineering	5
ECON G531	Theory of Macroeconomic Policy	5
ECON G541	Economic Systems Analysis	5
ENGL G511	Growth of the English Language	5
ENGL G512	Language and S & T	5
ENGL G513	Social Impact of S & T	5
ENGL G521	Principles of Language Teaching	5
ENGL G522	Aesthetics and Technology	5
ENGL G531	Applied Linguistics	5
ENGL G541	Interpretation of Literature	5
ENGL G551	Information Technology Lab. I	5
ENGL G561	Information Technology Lab. II	5
ENGL G571	Applied Communication I	5
ENGL G581	Applied Communication II	5
ENGL G591	Project Formulation and Preparation	5
ENGL G611	Twentieth Century English Literature	5
ET G511	Science and Technology Dynamics	5
ET G521	Hi-Tech Management	5
ET G531	Systems Engineering	5
ET G541	Overview of Technology	5
HUM G511	Introduction to Health System	3 0 3
MATH G511	Design and Analysis of Algorithms	5
MATH G512	Selected Topics in Advanced Mathematics for Engineering Situations	5
MATH G521	Applied Functional Analysis	5
MATH G531	Number Theory	5
MATH G541	Advanced Methods in Discrete Mathematics	5
MATH G611	Algebraic Number Theory	5
MATH G612	Riemann Surfaces	5
MATH G621	Fibre Bundles	5
MATH G622	Algebraic Geometry	5
MATH G632	Lie Groups & Lie Algebras	5
MATH G642	Complex Manifolds	5
MGTS G511	Advanced Marketing Theories and Advertising	5
MGTS G521	Business Policy - Structure and Organization	5
MGTS G531	Recent Advances in Organization Behaviour Theory	5
MGTS G541	Management Information and Decision Support Systems	5
MGTS G551	Frontiers in Financial Management	5
MGTS G561	Institutional Finance & Project Appraisal	5
PHY G511	Theoretical Physics	5
PHY G521	Nuclear and Particle Physics	5
PHY G531	Selected Topics in Solid State Physics	5
PHY G541	Physics of Semiconductor Devices	5
SKILL G611	Computer Operation and Software Development I	5
SKILL G612	Computer Operation and Software Development II	5
SKILL G621	Computer Maintenance I	5
SKILL G622	Computer Maintenance II	5
SKILL G631	Professional Communication I	5
SKILL G632	Professional Communication II	5
SKILL G641	Modern Experimental Methods I	5
SKILL G642	Modern Experimental Methods II	5
SKILL G651	Techniques in Development Management I	5
SKILL G652	Techniques in Development Management II	5
SKILL G661	Research Methodology I	5
SKILL G662	Research Methodology II	5

All courses given above are unstructured. Actual structuring will be done from time to time.

COMMON COURSES FOR HIGHER DEGREES

BITS F437	Technical Communication	3 0 3
BITS G529	Research Project I	6
BITS G539	Research Project II	6
BITS G540	Research Practice	4
BITS G619	Professional Practice	4
BITS G620	Professional Practice I	3
BITS G621	Professional Practice II	3

BITS G629T	Dissertation	25(Max.)
BITS G639	Practice School	20
BITS G649	Reading Course	5

NOTE: Courses with 4 level numbers given above are advanced level electives from the offering of the Integrated First Degree programmes.

COMMON POOL OF ELECTIVES FOR HIGHER DEGREES

BITS G513	Study in Advanced Topics	5
BITS G649	Reading Course	5

NOTE: The courses from this pool will be available as electives to all higher degree students subject to approval from higher degree counseling committee.

REVISED CURRICULUM STRUCTURE FOR M.E. / M.PHARM. PROGRAMS

[This structure is applicable for students admitted in 2014 or after into the M.E. Chemical Engineering program including any specializations thereof.]

(a) General Structure of M.E. / M.Pharm. programs

Keeping in mind the increasing interest on behalf of the Departments to involve Higher Degree students in research and to provide options for students' interested in pursuing research, there is provision of certain flexibilities of pursuing Dissertation of duration between one semester and two semesters for these Higher Degree programs as illustrated below.

(i) Duration and Requirements to define a program

- Duration of the program: 4 semesters (2 years)
- Number of Credit Units: 64 (min).
- Coursework: 8 courses and 32 units (min)
- PS/Dissertation: 16 units (min) to 32 units: (max)

(ii) Structure

Prescribed coursework to meet the requirements of the program may not exceed 20 units per semester.

The program is structured primarily as a coursework track wherein the student pursues three semesters of coursework and pursues either a Practice School or a Dissertation for the entire last semester:

or alternatively, to enable a research track wherein the student pursues two semesters of coursework and starts his/her Dissertation in the third semester (possibly concurrent with coursework) and spends the entire fourth semester pursuing Dissertation.

The options are depicted below:

Track 1

Year	Semester I	Semester II
I	Coursework (4 or 5 courses -16 to 20 units)	Coursework (4 or 5 courses -16 to 20 units)
II	Coursework (4 or 5 courses -16 to 20 units)	BITS G639 Practice School (20 units) OR BITS G562T Dissertation (16 units)

Track 2

Year	Semester I	Semester II
I	Coursework (4 or 5 courses -16 to 20 units)	Coursework (4 or 5 courses - 16 to 20 units)
II	Coursework (2 courses - 7 to 9 units) AND BITS G564T Dissertation (9 units)	BITS G563T Dissertation (16 units)

Track 3

Year	Semester I	Semester II
I	Coursework (4 or 5 courses -16 to 20 units)	Coursework (4 or 5 courses - 16 to 20 units)
II	BITS G562T Dissertation (16 units)	BITS G563T Dissertation (16 units)

(Course Description for BITS G562/BITS G563/BITS G564 is the same as BITS G629T; BITS G562T or BITS G564T is a pre-requisite for BITS G563T).

(iii) Flexibilities and Constraints

In addition to the above requirements:

a) a student may be prescribed one or more deficiency courses;

b) a student may overload at most one course per semester when he/she is pursuing only coursework (i.e. no overload during dissertation semesters irrespective of whether he/she is pursuing concurrent coursework);

while this overloaded course need not be within the student's discipline but it will be subject to pre-requisites and operational conditions such as approval of the Heads of Department concerned.

In all, the workload per semester for a student may not exceed

i. 25 units when the student is pursuing only coursework but the limit may be relaxed for students who are prescribed deficiency courses.

ii. 19 units when the student is pursuing concurrent coursework and dissertation (so that the student may pursue 9 units of dissertation and 2 courses of at most 5 units each)

iii. 16 units when the student is pursuing full semester of dissertation

iv. 20 units when the student is pursuing full semester of Practice School.

Operational Aspects and Implementation

It is to be noted that the revised curriculum structure has been designed without prejudice to the existing programs i.e. given the existing structure and flexibilities of M.E./M.Pharm. programs all three tracks are operable.

The above structure will be made applicable for all students admitted to an M.E./M.Pharm program in 2014 or after under the proviso:

- for any new M.E. / M.Pharm. program starting from Academic Year 2014-15 all three tracks mentioned above will be enabled.

(b) Specializations within an M.E./M.Pharm. program

These programs are structured in such a way that a specialization can be obtained by a student:

- The coursework requirement proposed in the structure above can be categorized as follows:
  - Core: 6 courses / 30 units (max.)
  - Specialization **(if applicable)** : 3 courses / 12 units (min.) to 6 courses / 30 units (max.)
  - Some Specialization courses may be mandatory and some may be electives.
  - Total of Core and Specialization courses may not exceed 7 courses / 32 units.
  - A Research Practice or a Research Methodology course will be prescribed for all programs as part of the coursework requirement.
  - Rest of the coursework requirement may be obtained via other electives within the discipline but not necessarily within the specialization.

The name of the degree will be common (e.g. M.E. in Chemical Engineering) and only this will appear in the degree certificate whereas the name of the specialization will be mentioned only in the transcript.

(c) Structure of M.E. (Chemical Engineering) and specializations within

(i) Structure of M.E. (Chemical Engineering)

Year	Semester I	U	Semester II	U
I	CHE G622 Advanced Chemical Engineering Thermodynamics	5	CHE G641 Reaction Engineering	5
	CHE G523 Mathematical Methods in Chemical Engineering	5	CHE G552 Advanced Transport Phenomena	5
	Elective I	*	BITS G661 Research Methodology I	5
	Elective II	*	Elective III	*
	Total	16 (min)	**Total**	16 (min)
	Semester III		**Semester IV**	
II	Elective IV to Elective VII	16 (min)	PS / Dissertation	16/20
	OR Elective IV AND Elective V AND Dissertation (9 units)	16 (min)		
	OR Dissertation (16 units)	16		
	Total	**16(min)**	**Total**	**16/20**

Structure of M.E. (Chemical Engineering) – Specialization in Nuclear Engineering

The structure of M.E. (Chemical Engineering) with specialization in Nuclear Engineering will be the same as the chart given above for M.E. (Chemical Engineering) with the added constraint that at least 3 electives should be from the pool of Specialization electives for Nuclear Engineering (given below).

Pool of Specialization Electives for Nuclear Engineering

Course No.	Course Title	Units		
		L	P	U
CHE G559	Reactor Physics and Engineering			5
CHE G560	Nuclear Fuel Cycle and Waste Management			5
CHE G561	Nuclear Reactor Control and Instrumentation			4
CHE G562	Thermal Hydraulics and Heat Transfer			4
CHE G563	Nuclear Chemical Engineering			4
CHE G564	Nuclear Materials and Radiation Damage			4
CHE G565	Radiation and Radio Isotopes Applications			4
CHE G566	Nuclear Safety, Security and Safeguards			4

Structure of M.E. (Chemical Engineering) – Specialization in Petroleum Engineering

The structure of M.E. (Chemical Engineering) with specialization in Petroleum Engineering will be the same as the chart given above for M.E. (Chemical Engineering) with the added constraint that at least 3 electives should be from the pool of Specialization electives for Petroleum Engineering (given below).

Pool of Specialization Electives for Petroleum Engineering

Course No.	Course Title	Units		
		L	P	U
CHE G533	Petroleum Product Characterization	3	2	5
CHE G567	Natural Gas Processing			4
CHE G568	Modeling and Simulation in Petroleum Refining			4
CHE G569	Petroleum Production Economics			4
CHE G616	Petroleum Reservoir Engg.			5
CHE G617	Petroleum Refinery Engineering			5
CHE G618	Petroleum Downstream Engg.			5

Ph.D. PROGRAMME

Structure

1. Course Work

The various categories of courses, for the whole possible range of input of Ph.D. students, are described in the Academic Regulations. In most cases, this course work would consist of courses which are required to be completed for a higher degree programme of the Institute. Departures from these normal situations are described in the Academic Regulations.

2. Ph.D. Qualifying Examination

Every student admitted to Ph.D. must pass the qualifying examination which is based on two areas chosen by the candidate depending on his intended area of research and courses done. The qualifying examination tests the student's knowledge, grasp of fundamentals and his ability to use them in unknown situations.

3. Foreign Language when required

The foreign language will be prescribed as an eligibility requirement for the Ph.D. only when the supervisor and/or the Academic-Graduate Studies and Research Division (AGSRD) have made recommendations for the same justifying its need for the particular topic of research and the literature available and this recommendation has been accepted by the Research Board. Otherwise English or an Indian language, as the case may be, would suffice the requirement of the foreign language.

4. Teaching Practice/Practice Lecture Series/ Research Methodology

BITS C791T	Teaching Practice I	1
BITS G661	Research Methodology I	1

The above two separate and independent courses, to be taken one at a time, are designed and operated to provide cumulative experience for a Ph.D. student in the practice of teaching.

BITS E793T	Practice Lecture Series I	1

This course is in lieu of the Teaching Practice I and designed and operated to provide cumulative experience for a Ph.D. student in the practice of teaching in his own professional setting where it is not feasible to operate the teaching practice courses. The student will deliver a predetermined series of technical talks before a professional audience as approved by Dean (AGSRD)

5. Seminar/Independent Study

1. BITS C797T Ph.D. Seminar (Min) 2

   While the total minimum number of units is 2, registration is done for one unit in each semester/term until the submission of the thesis.

2. BITS C790T Independent Study (Min) 2

   A student may be asked to register in this course in lieu of BITS C797T by Dean, AGSRD if situation so warrants. While the total number of units is 2, registration is done for one unit in each semester/term until the submission of the thesis.

6. Thesis

BITS C799T Ph.D. Thesis (Min) 40

While the total minimum units assigned to this course are 40, the distribution of the units between different semesters/terms would be determined by the AGSRD

7. General

The `Doctoral Counselling Committee (DCC)' monitors the academic progress of Ph.D. students similar to the monitoring of academic progress of students of integrated First Degree and Higher Degree programmes by the ACB. The decisions of the DCC are reported to the Research Board and the Senate.

A Doctoral Advisory Committee (DAC) is appointed by the DRC for each candidate admitted to the Ph.D. programme. This committee consists of at least two faculty members from the broad area in which the candidate opts to pursue the Ph.D

Collaborative PhD Programme

Under BITS-RMIT Higher Education Academy

BITS and RMIT will jointly select applicants for admission into the Doctoral Degree Studies program on the basis of the following Eligibility

Criteria

(a) be enrolled at RMIT and BITS as required.

(b) meet the Eligibility and Completion Requirements at both Institutes to qualify for the award of the PhD degree; and

(c) upon successful completion shall be entitled to receive Testamurs sealed each by RMIT and BITS.

This programme of research involves coursework and research work to be undertaken by a Participating Candidate towards a Doctor of Philosophy award or degree at RMIT and/or BITS.

Interdisciplinary PhD Programmes

Data Sciences for Global Health

This interdisciplinary PhD programme intends to train students on current global health issues with cutting-edge research methodology, rigorous fieldwork and data analysis. This is a unique full-time interdisciplinary degree that provides advanced education in global health along with expertise in statistical/quantitative and qualitative skills, operated in collaboration with One Health Trust, Bengaluru.

Ph.D. Aspirants Scheme for Professionals

This programme enables experienced personnel and professionals working in industries and R&D organizations that collaborate with BITS to work for a Ph.D. degree of the Institute in their respective work environment. This makes it possible for practicing professionals to be offered the same challenges that are traditionally offered to teachers in universities. Candidates, sponsored by their organizations, work for the Ph.D. degree without any dislocation from their work environment on research problems relevant to their organizations.

Admission to this programme is done through what is known as Ph.D. Aspirants Scheme. Ph.D. Aspirants will be first asked to write the qualifying examination. The Ph.D. qualifying examination is based on two areas chosen by the candidate depending on his intended area of research and courses done. The institute recognizes that there may be professionals who might not possess a degree equivalent to a higher degree of the institute, but has gained knowledge and skills through experience (substantiated by documentary evidence), which could be treated as equivalent to one of the higher degrees of the institute. For convenience of operation, for these cases, the institute has devised a higher degree programme called M.Phil (Applied). A list of courses for M.Phil.(Applied) is given below, from which a minimum number of 8 courses are to be chosen.

M.Phil. (Applied)

BITS E511	Computer Applications I	4
BITS E512	Computer Applications II	4
BITS E521	Technical Communication I	4
BITS E522	Technical Communication II	4
BITS E531	Social, Behavioral & Economic Sciences I	4
BITS E532	Social Behavioral & Economic Sciences II	4
BITS E533	Modern Experimental Techniques-I	4
BITS E534	Modern Experimental Techniques-II	4
BITS E535	Management Methods & Techniques I	4
BITS E536	Management Methods & Techniques II	4
BITS E537	Systems Sciences and Engineering I	4
BITS E538	Systems Science and Engineering II	4
BITS E541	Chemical and Life Science I	4
BITS E542	Chemical and Life Science II	4
BITS E543	Instrumentation Engineering I	4
BITS E544	Instrumentation Engineering II	4
BITS E545	Project and Consultancy I	4
BITS E546	Project and Consultancy II	4
BITS E547	Public Administration I	4
BITS E548	Public Administration II	4
BITS E551	Physical and Mathematical Sciences I	4
BITS E552	Physical and Mathematical Sciences II	4
BITS E561	Use of English for Professional Purposes I	4
BITS E562	Use of Eng. for Professional Purposes II	4
BITS E571	Methods of Planning and Development I	4
BITS E572	Methods of Planning and Development II	4
BITS E573	Study in Advanced Topics I	5
BITS E574	Study in Advanced Topics II	5
BITS E583	Case Studies I	4
BITS E584	Case Studies II	4

BITS E591	Science and Technology Development I	4
BITS E592	Science and Technology Development II	4
BITS E593	Reading Course I	5
BITS E594	Reading Course II	5
BITS E611	Internship I	20
BITS E612	Internship II	20
BITS G661	Research Methodology I	5
BITS G662	Research Methodology II	5

Note: *No direct admission to M.Phil.(Applied) will be done. Courses described above will be used for students admitted to the Ph.D. programmes under the Ph.D. Aspirant Scheme.*

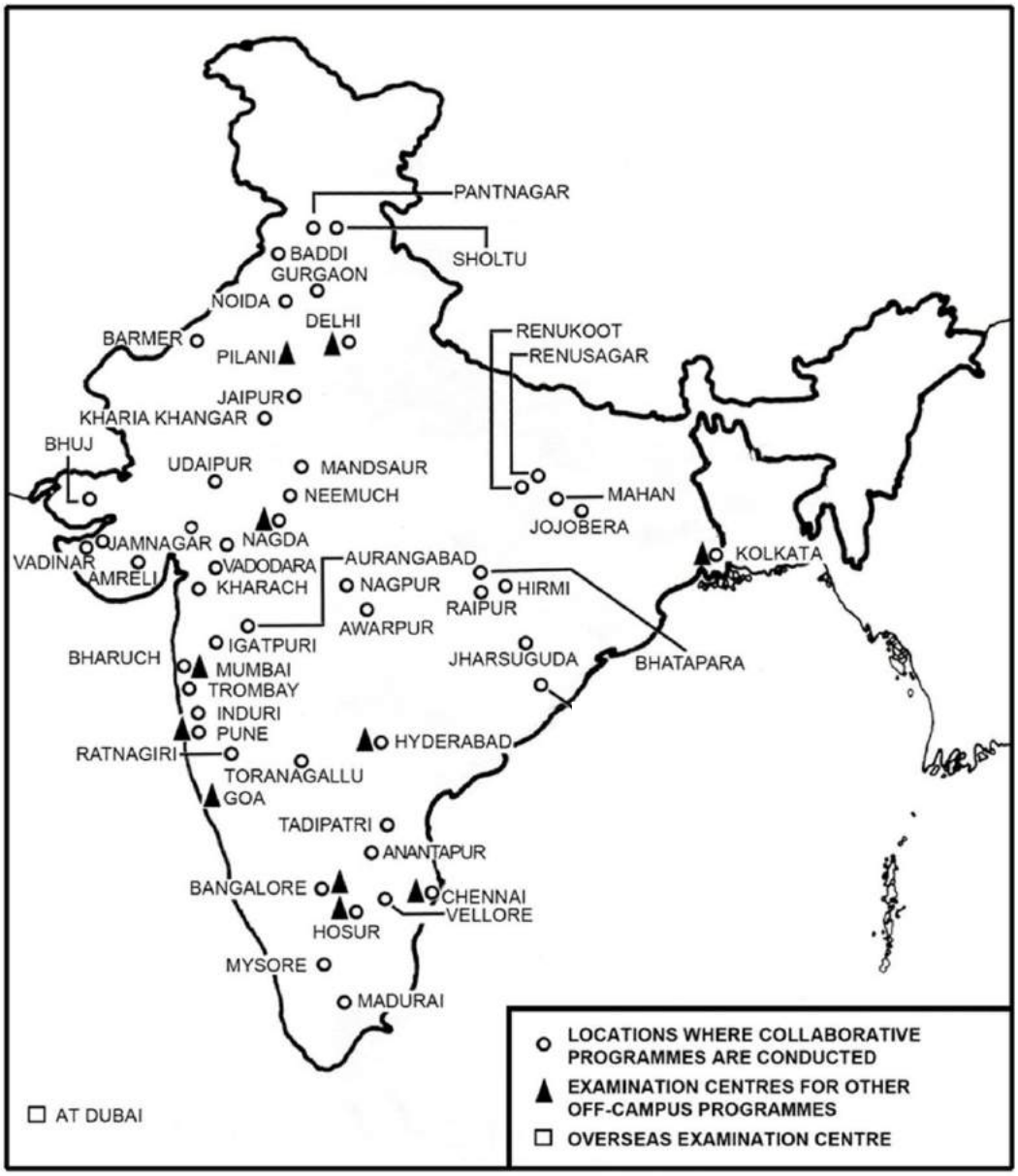
LIST OF COURSES FOR PhD PROGRAMMES		
CHEM G511	Nuclear and Radio Chemistry	5
CHEM G513	Advanced Nuclear and Radiochemistry	5
CHEM G521	Environmental Chemistry	5
CHEM G531	Recent Advances in Chemistry	5
CHEM G541	Chemical Applications of Group Theory	5
CHEM G551	Advanced Organic Chemistry	5
CHEM G552	Advanced Inorganic Chemistry	5
ECON G511	Dynamic Modelling and Control of National Economies	5
ECON G521	Modern Cost Engineering	5
ECON G531	Theory of Macroeconomic Policy	5
ECON G541	Economic Systems Analysis	5
ECON G542	Accounting Theory and Empirical Research	4
ECON G543	Advanced Corporate Finance	4
ECON G544	Empirical Asset Pricing	4
ECON G545	Financial Economics	4
ECON G546	Topics in Econometrics	4
ECON G547	Topics in Macroeconomics	4
ECON G548	Topics in Mathematical Economics	4
ECON G549	Topics in Microeconomics	
MATH G511	Design and Analysis of Algorithms	5
MATH G512	Selected Topics in Advanced Mathematics for Engineering Situations	5
MATH G521	Applied Functional Analysis	5
MATH G531	Number Theory	5
MATH G541	Advanced Methods in Discrete Mathematics	5
MATH G611	Algebraic Number Theory	5
MATH G612	Riemann Surfaces	5
MATH G621	Fibre Bundles	5
MATH G622	Algebraic Geometry	5
MATH G632	Lie Groups & Lie Algebras	5
MATH G642	Complex Manifolds	5
PHY G511	Theoretical Physics	5
PHY G521	Nuclear and Particle Physics	5
PHY G531	Selected Topics in Solid State Physics	5
PHY G541	Physics of Semiconductor Devices	5
PHY G518	Computational Methods in Physics	3 2 5

PART V

WORK INTEGRATED LEARNING PROGRAMMES

MAP OF BITS WORK-INTEGRATED LEARNING & COLLABORATIVE PROGRAMMES

2023-2024



Introduction

Since 1979, the Institute has been participating in the human resources development activities of the industries by evolving several degree programmes that integrate the working environment of the employees with the learning environment required by the Institute. These programmes are offered in several domains like Information Technology, Engineering Technology and Management.

The Institute conducts **Work Integrated Learning Programmes (WILP)** as a means of continuing education for employed professionals to meet the Learning & Development needs of a diverse spectrum of industries. These programmes are a conducted through a collaborative arrangement between BITS Pilani and the collaborating organization / industry, whose ultimate aim is to build competencies and to attain advancement of technical workplace skills.

Salient Features of WILP

For the conduct of Work Integrated Learning programmes, the basic requirement is the participation of the collaborative organizations. Such a collaboration includes extending physical and other facilities and by agreeing to integrate their work requirements with the academic requirements of the Institute for the pursuit of the programme. The WILP Division of the Institute operates these programmes.

The Work Integrated Learning Programmes are offered in two modes: Programmes that are designed to meet exclusive requirements of specific collaborating organizations are offered as Enterprise Education Solutions for sponsored employees, with classes organized in the premises of the collaborating organizations. Programmes designed to meet the generic industry requirements are offered as Programmes for Individual students from various organizations. Instruction in such programmes is typically delivered through technology.

The Work Integrated Learning Programmes are characterized by the following salient features:

1. Enrollment is permitted only to suitably qualified, employed professionals having specified educational qualifications, with adequate and relevant work experience, to programmes that are closely aligned with their work profiles.

2. Enrollment also requires endorsement of the employer, and a commitment from the employer to provide necessary support (including that of a qualified mentor) and facilities to enable effective work integrated learning. The rationale for permitting only qualified employed professionals to enroll under WILP alongwith the consent from the employer is with the objective that the skill and knowledge enhancement attained by the employee through these WILP would ultimately benefit, add value to the organization and increase productivity.

3. A judicious combination of synchronous and asynchronous modes of instruction is used, for regular and effective interaction between the students and faculty members, to maintain the necessary academic rigor and standards of instruction.

4. WILP are characterized by person-centered approach with the same rigor and standards at par with the on-campus system of education. There is no replacement of inter-personal communication of conventional classroom based education, since all courses are conducted in a manner akin to actual classroom teaching ensuring two-way communication between experienced faculty of BITS and the students.

5. The pedagogy of WILP is based on the successful and established methodologies followed by BITS for on-campus education system without compromising on the duration of the programme, methodology of study, assessment and programme completion requirements which are

comparable to programmes offered on-campus. All the programmes under WILP follow a credit-based system at par with the on-campus education system.

6. For each WILP course there is an instructor who is a BITS faculty responsible for the conduct of the course, as well as a qualified mentor (being a senior professional from the student's own organization who agrees to act as a mentor and a resource person) at the work place to provide structured guidance to the employee throughout the duration of the programme, which helps in strengthening the work-study integration.

7. All programmes are designed to meet the industry needs, and hence require application of concepts learnt in the classroom. Therefore, the Institute provides several technology enabled tools like simulators, virtual labs and remote labs to enable experiential learning. Such labs are equipped with contemporary computational simulators and remote operating equipment. Students spend sufficient time in learning, practicing and experimenting industry oriented problems designed and developed by BITS faculty in collaboration with industry experts.

The currently operative programmes are given in Table on pages V-4to V-6. The curriculum structure and semesterwise pattern of courses for the currently operative programmes are given on Pages V-13& V-105.

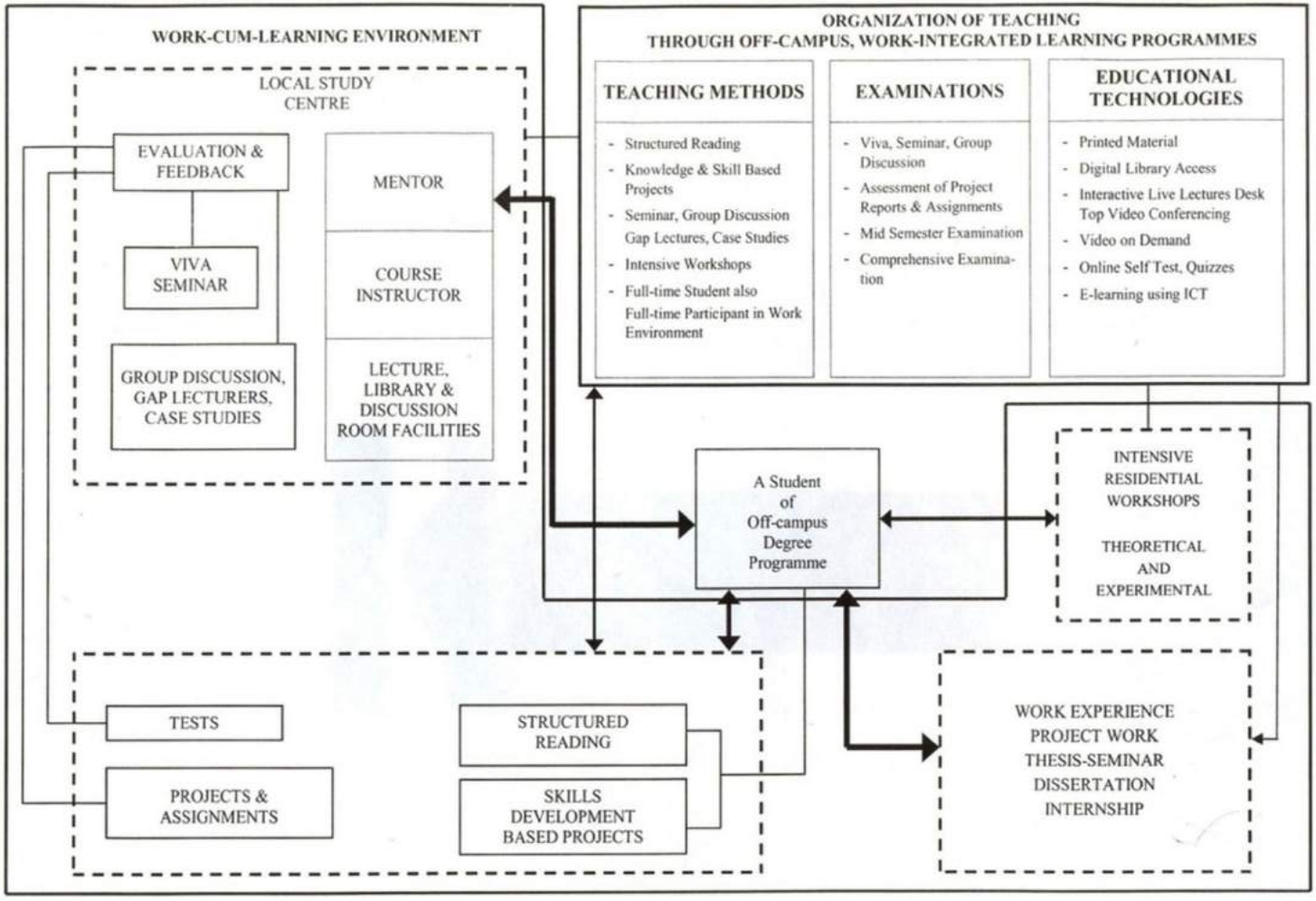


Figure 1: Person-centred Approach in the Off-campus Work-Integrated Learning Programme

Table: Currently Operative Work-Integrated-Learning Programmes at a Glance

Programmes		Collaborating / Sponsoring Organization
B.Tech. Programmes		
1. Electronics Engineering	-	Designed for the HRD needs of a diverse spectrum of Electronics Industries
2. Engineering Design	-	Designed for the HRD needs of a diverse spectrum of Engineering Industries
3. Engineering Technology	-	Designed for the HRD needs of a diverse spectrum of Engineering Industries and John Deere, Pune
4. Information Systems	-	Designed for the HRD needs of a diverse spectrum of IT Industries and Wipro Bangalore
5. Manufacturing Technology	-	Kirloskar Oil Engines, Kolhapur, Bharat Forge, Pune, Tata Motors, Jamshedpur; TACO, Pune; Maruti Suzuki, Gurgaon; Mahindra Motor Vehicles; Cummins, Pune; GE Locomotives
6. Power Engineering	-	Aditya Birla Group, Tata Power, JSW Energy – Mumbai
7. Process Engineering	-	Aditya Birla Group, Mumbai; JSW Steel, Toranagallu; Vedanta, Jharsuguda; BPCL, Mumbai; Arcelor Mittal Nippon Steel India
8. Software Systems and Engineering	-	Designed for the HRD needs of a diverse spectrum of IT Industries
M.Sc. Programmes		
1. Business Analytics	-	Designed for the HRD needs of a diverse spectrum of IT Industries; KPMG Global Services
2. Information Systems	-	Designed for the HRD needs of a diverse spectrum of IT Industries
B.Sc. Programme		
1. Computer Science		Designed for the HRD needs of a diverse spectrum of IT Industries
2. Design & Computing	-	Designed for the HRD needs of a diverse spectrum of IT Industries, and HCL Technologies, Noida
3. Engineering Science	-	Designed for the HRD needs of a diverse spectrum of Manufacturing, Mechanical, Chemical, and circuits Industries
4. Pharmaceutical Sciences	-	Designed for the HRD needs of a diverse spectrum of Pharmaceutical Industries, and Dr. Reddy's Laboratories, Hyderabad; CIPLA
B.Sc. (Hons) Programme		
1. Computer Science	-	Designed for the HRD needs of a diverse spectrum of IT Industries

M.Tech. Programmes

1.	Artificial Intelligence and Machine Learning	- Designed for the HRD needs of a diverse spectrum of IT industries
2.	Automotive Electronics	- Designed for the HRD needs of a diverse spectrum of Automotive Industries and Aptive
3.	Automotive Engineering	- Designed for the HRD needs of a diverse spectrum of Automotive Industries, Tata Technologies, Tata Motors, Pune; Mercedes Benz; Cummins
4.	Cloud Computing	- Designed for the HRD needs of a diverse spectrum of IT Industries
5.	Computing Systems & Infrastructure	- Designed for the HRD needs of a diverse spectrum of IT Industries, and Wipro, Bangalore, VMware
6.	Data Science & Engineering	- Designed for the HRD requirements of a diverse spectrum of IT Industries and Intuit; Avaya; BEL; Wipro Technologies; CitiusTech Healthcare Technology; Cognizant Technology Solutions; Comcast India Engineering; CISCO; HCL
7.	Design Engineering	- Designed for the HRD needs of a diverse spectrum of Engineering Industries, SKF and John Deere, Pune
8.	Digital Manufacturing	- Designed for the HRD needs of a diverse spectrum of Digital Industries
9.	Embedded Systems	- Designed for the HRD needs of a diverse spectrum of IT Industries, Aricent Technologies; Cisco, Bangalore; UTC Bangalore and Hyderabad.
10.	Environmental Engineering	- Goa State Pollution Control Board, Goa
11.	Manufacturing Management	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
12.	Microelectronics	- Designed for the HRD needs of a diverse spectrum of IT Industries; Synopsys, Bangalore; Samsung, Gurgaon; Aricent Technologies
13.	Pharmaceutical Operations and Management	- Designed for the HRD needs of a diverse spectrum of Pharmaceutical Industries, and Sun Pharmaceutical Industries, Vadodara; Lupin, Mumbai
14.	Quality Management	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
15.	Sanitation Science, Technology and Management	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
16.	Software Engineering	- Wipro Technologies, Dell, SAP Labs, Sabre, EMC, Oracle, Lowe's Services, Bangalore; Avaya, Tech Mahindra, Pune; Capgemini; Qualcomm, Hyderabad; Hexaware; Mindtree; Cognizant Technology Solutions

17. Software Systems	-	Designed for the HRD requirements of a diverse spectrum of IT Industries; Wipro Technologies, Bangalore; TCS, Hyderabad; Cisco, Synopsys, Bangalore; Samsung, Gurgaon; Aricent Technologies, Mercedes-Benz, Bangalore; ATMECS; Cognizant Technology Solutions; Mindtree; Hexaware Technologies; Jio Platforms
18. Systems Engineering	-	Wipro Infotech, Bangalore

M.B.A. Programmes		
1. Business Analytics	-	Designed for the HRD needs of a diverse spectrum of IT Industries; Citus; Hinudstan Zink
2. Consultancy Management	-	Designed for the HRD needs of a diverse spectrum of consulting firms
3. Digital Business	-	Designed for the HRD needs of business organizations
4. Finance	-	Designed for the HRD needs of business organizations; Hindustan Zink
5. FinTech	-	Designed for the HRD needs of business organizations
6. Hospital and Health Systems Management	-	Designed for the HRD needs of a diverse spectrum of Hospitals and Healthcare organizations
7. Manufacturing Management	-	Designed for the HRD needs of a diverse spectrum of Engineering Industries and Bosch
8. Quality Management	-	Designed for the HRD needs of a diverse spectrum of Engineering Industries

Diploma	
1. Software Development	Designed for the HRD needs of a diverse spectrum of IT Industries

Post Graduate Diploma Programmes		
1. Automotive Cyber Security	-	Designed for the HRD needs of a diverse spectrum of Automotive Industries
2. Business Analytics	-	Designed for the HRD needs of a diverse spectrum of IT Industries
3. Electric Vehicles	-	Designed for the HRD needs of a diverse spectrum of Electronics Industries
4. Finance		Designed for the HRD needs of a diverse spectrum of business organizations
5. FinTech		Designed for the HRD needs of business organizations
6. Manufacturing Management	-	Designed for the HRD needs of a diverse spectrum of Manufacturing organizations; Bosch

7. Smart Manufacturing	-	Designed for the HRD needs of a diverse spectrum of Manufacturing organizations
8. Smart Mobility	-	Designed for the HRD needs of a diverse spectrum of Automotive Industries
Post Graduate Certificate Programmes		
1. Artificial Intelligence and Machine Learning	-	Designed for the HRD needs of a diverse spectrum of IT industries
2. Big Data & Analytics	-	Designed for the HRD needs of a diverse spectrum of IT industries
3. Big Data Engineering	-	Designed for the HRD needs of a diverse spectrum of IT industries
4. Full Stack Engineering		Designed for the HRD needs of a diverse spectrum of IT industries
5. General Management	-	Designed for the HRD needs of a diverse spectrum of Engineering industries
6. Internet of Things	-	Designed for the HRD needs of a diverse spectrum of IT industries
7. Manufacturing Practice	-	Designed for the HRD needs of a diverse spectrum of Manufacturing organizations
8. Non-sewered Sanitation	-	Designed for the HRD needs of a diverse spectrum of Engineering industries
Certificate Programmes		
1. Manufacturing Practice	-	Designed for the HRD needs of a diverse spectrum of Manufacturing organizations
2. General Management	-	Designed for the HRD needs of a diverse spectrum of Engineering industries

Note: The Institute looks for the viable minimum number (around 50) of candidates sponsored by an organization or a group of organizations in any centre for a degree programme. Any organization interested in having a dialogue with the Institute for offering any collaborative and innovative programme directed towards the human resource development needs of their industry may write to the Institute. The Institute has an open mind to offer any of the existing programmes or devise any other new programme.

Admission Modality

1. The Institute is one of the very few universities in India, which has ventured into work integrated learning programmes in science and technology areas. In order to maintain the standard as well as rigour required in these areas, the Institute could cater only to those inputs, which have the facilities and environment for such a learning process. So the Institute treats these degree programmes as continuing technical education programmes for employed professionals. Hence admissions are given normally to candidates who are already employed in relevant professional domains and whose employing organizations sponsor them in their academic pursuit subject to the candidates having the required academic qualifications and relevant work experience. The Institute looks for candidates who have the necessary computer, laboratory and other physical facilities including access to Email and Internet, as well as certain intellectual input in terms of guidance by superior / co-officer / professional expert preferably from the workplace of the candidate who will be termed as Mentor, while the candidate is in pursuit of studies.

II. These degree programmes are work-integrated learning programmes. Hence, for students to get admission to these programmes, they must be engaged in work in the relevant professional areas. The final offer of admission would be based on candidate's educational background, academic achievements, work profile, relevant work experience, profile of the employing organization and Mentor's profile.

III. If the number of applications for a particular programme is less than a critical number, that programme may not be offered in that semester.

IV. Once the candidate accepts the admission offer and confirms registration, any request for deferment of admission to a subsequent semester cannot be entertained. The candidate can only withdraw from the registered semester.

Fees Structure

The fees schedule applicable for all programmes is as follows:

Admission Fees : Rs. 16,500/-

Each Semester Fees : Rs. 63,500/-

A candidate who has been offered admission will have to pay Rs. 80,000/- (Admission fees and Semester fees for the Starting Semester of the programme) immediately on receiving the Admit Offer Letter. Any candidate who desires to discontinue from the programme after confirmation of admission & registration for the courses specified in the admit offer letter will forfeit the total amount of fees paid.

Note 1: Certain specific facilities such as access to a digital library or virtual laboratories, if provided, may be charged extra in addition to the above mentioned fees.

Note 2: For the examination centre at Dubai, in addition to the semester fees, for each semester there will be an examination centre fees of 1000 UAE Dirhams or equivalent per semester out of which 500 UAE Dirhams is to be paid at the time of appearing in Mid-semester Tests at Dubai exam centre for that semester, and the remaining 500 UAE Dirhams is to be paid at the time of appearing in Comprehensive Examinations at Dubai exam centre for that semester.

Educational Process

The education in the work integrated learning programmes is characterized by person-centered approach where the rigour and standards are maintained on par with Institute's system of education on-campus. These programmes judiciously combine the flexibility and ingenuity of the continuing education system with the regular features of the on-campus education system. Also, the learning and evaluation process draws upon the successful and established methodologies followed by the Institute.

The work integrated learning environment of a student consists of two broad-based facets:

1. Academic Environment created by BITS faculty drawn from different disciplines.

2. Student's own Work Environment from which assignments, projects, seminars etc., may

emerge to integrate theory and practice. A (locally-based) Mentor imparts structured guidance and conducts certain evaluation components (see Role of Mentor' below).

Central to the educational philosophy of the Institute being the dialectical link between theory and practice, the student's own work environment provides an ideal ground where theory could be meaningfully combined with practice through Assignments, Case Studies, Laboratory-Oriented Projects, Work Experience, In-service Training, Internship, Thesis-Seminar, Project Work and Dissertation. These evaluation components and courses search for evidence of self-study, time planning, conceptual understanding & application of the concepts in a real-life situation, self-reliant articulation, enthusiasm for, awareness of and participation in new pedagogy. One of the distinctive features of this system is the complete formalization of pursuit of education at the work-learning environment. An organization creates a work learning environment by providing academic sponsorship for the candidates as well as infrastructural facilities such as place for conducting formal classes / mentor interactions / examination apart from library, computer and laboratory access. The work learning environment form a strict requirement in order to infuse a strong component of teacher-student contact through course instructors as well as Mentor (a senior officer of the student's own organization). Thus work-learning environment is a very important component of the person-centered learning process. There is in the design, a clear arrangement of periodic personal discussion in the work-learning environment with the students so that their progress is directly monitored by planned interaction. Further, the students at the work-learning environment receive help from mentors. Throughout the student's learning process, which is conducted in his own work place, through systematic self-study, and self-learning process, the student remains continually in contact with the course instructors for any clarifications. Thus the operation is an imaginative combination of the contact hours and tutoring of the on-campus system with the student-centered self-study feature of the off-campus system and an organizational and pedagogic commitment of the collaborating organizations. The student is at once, a full-time student as well as full-time employee.

Work Integrated Learning: For each course offered by the Institute, there would be an Instructor, who is a BITS faculty, drawn from the relevant discipline. He is charged with the responsibility of the conduct of that course. This will be in terms of preparing question papers, evaluation of answer papers and answering student's queries. He will also prepare instruction manuals, question bank, supplementary notes, etc. wherever required in order to strengthen the course.

For each course, there will be a handout, which will spell out the plan of study and evaluation scheme, apart from other details. The evaluation schedule is also announced in the beginning of the semester itself. All details pertaining to the operation of the course including study plan are shared with the students through this document.

The BITS, Pilani model of cooperative education has a structured method of integrating education with practical work experience, faculty-student interaction as well as mentor-employer involvement. Further, the BITS model of education deploys ICT both in synchronous and asynchronous modes. Synchronous instruction through Internet based desktop video conferencing enables effective interaction between students and faculty. Asynchronous instruction, including on-demand lectures and electronic mail through list servers, is more flexible as it accommodates multiple learning levels and schedules. In addition, intensive residential contact classes are held for various programmes at the Institute campus as well as at the locations of various organizations. Thus, the BITS, Pilani model emphasizes on acquisition of knowledge and skills through mediated information and instruction, encompassing all technologies, in the work-integrated learning environment.

The Role of a Mentor: A Mentor is a senior officer of the student-employee who has been nominated by his employing organization or is a person in a senior position willing to undertake and discharge the academic responsibilities on his own volition. It is expected of the Mentor to possess adequate qualifications to guide the student. Typically for the B.Tech. / M.Sc. programmes, the mentor is expected to have

minimum educational qualification of the level of Integrated First Degree of BITS or its equivalent such as B.E./ B.Tech. / B.S. / M.Sc. / A.M.I.E.,and for the M.B.A. / M.Tech. programmes the mentor is expected to have a minimum educational qualification of the level of Higher Degree of BITS or its equivalent such as M.E. / M.Tech. / M.S / M.Phil.

The Mentors would assist the course instructors in terms of the following:

b) Achieving the set of academic objectives specified by the instructors;

c) Verifying if a student is indeed adhering to the plan of study given in the handout;

d) Monitoring involvement of the student in self-study, time planning, understanding of concepts and their use, developing self-reliant articulation, awareness of and enthusiasm for new pedagogy, responsibility to meet deadlines, develops familiarity with the library, etc.

e) Conducting certain evaluation components like Seminars, Assignments, Case Studies and Projects.

Additional features include:

(a) Courseware (pre-recorded digital content) developed by BITS faculty for certain courses.

(b) Course Handouts which provide a detailed plan of study, evaluation scheme, and experiential learning components. ***It is the responsibility of each student to acquire textbooks and other reference materials recommended for each course.***

(c) Curricula designed on S&T approach for modernizing the workbench by purposeful acquisition of scientific methods and modern skills.

(d) Intensive contact sessions (where required) conducted at any of the BITS campuses or at the collaborating organizations. The contact sessions could include one or more of the following:

- Special Lectures
- Field, Library and Laboratory work
- Projects
- Tutorials
- Case discussions
- Seminars
- Social activities.

Evaluation Methodology

Evaluation for a given course is internal and continuous and has the following features:

- Quizzes, Assignments, Projects, Case Studies, spread over a semester for making the course relevant and meaningful to the work learning environment of the students;
- Written examinations – one at the mid-semester point and acomprehensive examination at the end of semester. These examinations are conducted at specified exam centres of BITS in a centralized manner under the supervision of BITS faculty.
- For programmes offered for individuals, the Institute presently has examination centres at Bangalore, Chennai, Coimbatore, Delhi, Goa, Hyderabad, Kolkata, Mumbai, Pilani and Pune in India, and at Dubai in UAE.
- Strict adherence to the evaluation schedule as announced through the course handout at the start of the semester.
- The Institute follows continuous system of internal evaluation and letter grades A, A-, B, B-, C, C-, D, E carrying grade points 10, 9, 8, 7, 6, 5, 4, 2 respectively are awarded for all courses other than Dissertation / Project Work / Project for which only non-letter grades namely EXCELLENT, GOOD, FAIR, POOR are awarded. If a student does not offer adequate opportunity for evaluation in a course, reports such as RRA (Require to Register Again) may be awarded.
- The final grading in a course is done by tabulating in descending order (equivalently a histogram) the total marks of all students in a particular course. The performance of the course will be analyzed in terms of average, highest and lowest marks and dividing lines between various clusters. Gaps between clusters and the nature of clusters will guide drawing the dividing lines between various grades. In a normal class of large size, the C-band will usually include the average mark. This is not a hard and fast rule and exceptions

may arise in cases of small classes or a skewed histogram etc.

- The Cumulative Grade Point Average (CGPA) on a 10 Scale basis is used to describe the overall performance of a student in all courses for which LETTER GRADES are awarded.

$$CGPA = \frac{U_1G_1 + U_2G_2 + U_3G_3 + ... + U_nG_n}{U_1 + U_2 + U_3 + ... + U_n}$$

Where U_1, U_2, U_3, … U_n denote units associated with the courses taken by the student and G_1, G_2, G_3,…G_n denote grade points of the letter grades awarded in the respective courses. Non-Letter grades do not go into computation of CGPA.

- In the case of Integrated First Degree programmes the final division for the degree is decided on the basis of CGPA and there are three classifications, namely Distinction (CGPA 9.00 or more), First Division (CGPA 7.00 or more but less than 9.00) and Second Division (CGPA 4.50 or more but less than 7.00). However, no Division will be awarded in diploma, higher degrees and Ph.D. programmes.
- Subject to fulfilling the Academic Regulations of the Institute, the student will be issued at the end of each semester a grade sheet and at the end of the programme a Transcript and Provisional Certificate followed by the Final Degree Certificate. The grade sheet / transcript – provisional certificate will be withheld when a student has not paid his dues or when there is a pending case of breach of discipline or a case of unfair means against him.
- The minimum academic requirements for higher degree programmes stipulate that a student obtains a CGPA of 5.50 and no E grade in any course. For the Integrated First Degree programmes such as B.S. and B.Tech. programmes, a student should obtain a CGPA of 4.50 and no E grade in any course. Students who fail to meet the minimum academic requirements are placed under the purview of Academic Monitoring Board (AMB), which monitors their progress, and gives guidance so that they are properly rehabilitated at the earliest.
- The Institute's Academic Regulations must be consulted for additional details.

Some Stipulations

(a) All degrees offered through Work Integrated Learning Programmes are equivalent to the corresponding degrees offered on-campus, and for admissions to any higher degree programme of the Institute, these degrees will not be distinguished from on-campus degrees.

(b) In any examination, as far as possible, the direct interactive process of the evaluation would be made at a place nearest to the work location of the candidates. Wherever there is not adequate number of candidates, the Institute will be free to demand that all candidates come to one of the campuses or other examination centers for this purpose.

(c) In case of organization specific collaborative programmes, a student who is admitted to the Institute because of sponsorship from an organization will cease to be a student if he discontinues employment from the organization. In case of other programmes, the student may be allowed to continue if the new organization in which he is employed agrees to sponsor him for the degree and if the work integrated learning environment is relevant to the degree programme. However, if the person becomes unemployed he may not be continued because of the requirement of work integrated learning environment for the degree, which may no longer be available to the student.

(d) Any student admitted to a programme may be allowed to transfer to another programme provided he is eligible for the same and is supported by his work environment and sponsorship of his employer.

(e) Since every student admitted to work integrated learning programme is treated as a full-time student and a full time employee, it is essential that such a student be not enrolled for any degree or diploma programme, part-time or otherwise, in any other university. If it is found that a student is admitted / registered in some other university for degree programme, then his admission / registration will be cancelled.

Operating Definitions of Certain Key Terms

1. A course is a component of knowledge, which serves as the irreducible minimum building block in the curriculum or syllabus.
2. A programme of studies is a set of courses constituting the requirements of a degree.
3. A regular student is one who is enrolled for a degree programme.
4. A collaborating organization is an organization that helps the Institute in setting up the necessary facilities and in the running of classes and laboratories for all students. Such an organization may simultaneously be also a sponsoring organization.
5. A sponsoring organization is an organization, which fulfills one or more of the following features:
   a) The organization is the employer of the student and pays fully / partly the fees/dues of the student and also provides facilities required for the learning process.
   b) The organization is an employer of the student but does not pay the fees/dues of the student. Nonetheless the organization agrees to encourage and actively participate in the special nature of the educational process for the mutual benefit of the organization and the employee.
6. An Associate Student is one who is allowed to register in any of the courses offered in each semester with an ultimate goal of obtaining a diploma/degree or without any such ambition. The treatment of these students will be different from that of the casual students in that these students will be registered on credit and not on audit basis and may be admitted for a degree or a diploma, if situation so warrants. Further, admission procedure and the fee structure may also differ in contrast to the casual students. Presently the Institute considers only sponsored candidates from structured collaborative programmes for admission as Associate Student.

Duration: This may vary from programme to programme depending upon the input qualification, experience, nature as well as the need of the collaborating organizations including the viability and feasibility of course offerings.

The curriculum details of programmes and semesterwise pattern of courses given in the following pages indicate the currently operational details for various programmes, which are subject to change if the situation warrants.

B.Tech. Programmes

The structure of the B.Tech. programmes for working professionals is given below:

a. **Normal Input:** Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.
b. **Curriculum requirements:** Completion of the B.Tech. degree would require completion of coursework of minimum 24 courses (84 units minimum) and Project Course (10 units minimum), adding up to a total of 100 units (minimum).
c. **Nominal duration:** 7 semesters.
   Note: Wherever feasible summer terms (maximum 2) may be introduced in lieu of 1 semester
d. **Curriculum Structure** for B.Tech. programmes for working professionals:

Category	Number of Courses Required	Number of Units Required
Foundation Courses (Math, Science, Engineering, HSS and GA)	3-10	6-40
Discipline Core	8-18	26-60
Discipline Elective	3-9	9-36
Other Electives#	0-5	0-16
Coursework Sub-Total	24 courses (min)	84 units (min)
Project Courses*	1-2	10-20
Total	25 courses (min)	100 units (min)

* Project Courses may include Design Projects, Lab Projects or Project Work.

* Concurrent Registration of at most 2 courses along with the final semester Project may be permitted subject to the constraint that the total credits in that semester does not exceed 18.

Other electives refer to a set of elective courses included or customized per the needs of specific programmes, which are in addition to the primary area/discipline of study.

In addition, the Department(s) may offer **Concentrations** for a specific programme if applicable:

Concentration (if applicable):

i. 3 courses / 9 units (min.) to 6 courses / 24 units (max.) to be chosen from the pool of Discipline electives
ii. Some Concentration courses may be mandatory and some may be electives

B.Tech. (Electronics Engineering)

Type of Input: Employed professionals with a Technical Diploma in Electrical & Electronics, Electronics & Instrumentation, Electronics & Communication or equivalent with a minimum of 1-year experience and adequate preparation in Maths.

Curriculum Requirements:
Completion of the programme would require:

1. 24 Courses (totalling to a minimum of 84 units) towards coursework, and
2. Project Work (16 units)
3. Concentrations: Communication Technologies, Embedded IoT and Edge, Processor Architectures [Students may graduate without any concentration.]
4. For concentrations: Minimum 5 elective courses from the pool of electives in a particular thread including mandatory electives in that concentration (denoted by #), totaling a minimum of 18 units.
5. Total number of electives: 9 with minimum 30 units and not more than 7 electives from any single concentration

Program Structure:

Foundation Courses (6)

Course No.	Course Title	Units
BTEE ZC212	Engineering Mathematics	3
BTEE ZC216	Probability Theory and Random Process	4
BTEE ZC214	Object Oriented Programming	4
BTEE ZC213	Engineering Physics	3
BTEE ZC215	Principles of Management	3
BTEE ZC211	Elements of Electrical and Electronic Circuits	4

Core Courses (9)

Course No.	Course Title	Units
BTEE ZC217	Digital Electronics and Microprocessors	4
BTEE ZC311	Analog Electronics	4
BTEE ZC218	Signals and Systems	3
BTEE ZC314	Electromagnetic Theory	3
BTEE ZC312	Communication Systems	4
BTEE ZC313	Digital Control Systems	4
BTEE ZC315	Introduction to Digital Signal Processing	4
BTEE ZC316	Microwave and Antenna Theory	3
BTEE ZC411	Computer Networks	4

Concentrations:

1) Communication Technologies
2) Embedded IoT and Edge
3) Processor Architectures

Pool of Electives for Concentration 1: Communication Technologies
Communication Systems are evolving to support new business cases such as industrial revolution 4.0, massive machine-type communication, tactile internet, AR/VR, etc. The pool of courses in the communication thread provides the foundation and skills for understanding the technologies in modern wireline and wireless communication systems.

Course No.	Course Title	Units
BTEE ZC319	Information Theory and Coding#	4
BTEE ZG516	Wireless & Mobile Communication#	5
BTEE ZC322	Telecommunication Switching Systems and Networks#	3
BTEE ZG513	Network Security	4
BTEE ZC416	Mobile Telecommunication Networks	4
BTEE ZG514	Optical Communication	4
BTEE ZC418	Satellite Communication	3
BTEE ZC317	Communication & Networking Technologies for IoT	4

Requirements:

- 5 courses are to be chosen from the designated pool of electives for this concentration
- # indicates mandatory electives for this concentration

Pool of Electives for Concentration 2: Embedded IoT and Edge

Smart living is the driving factor for connecting sensors to the internet, leading to a plethora of applications/use cases such as smart agriculture, smart cities, smart environment etc. This thread offers courses to equip professionals with skills related to sensing technologies, signal conditioning and building intelligent systems.

Course No.	Course Title	Units
BTEE ZC414	Introduction to Edge Computing#	4
BTEE ZC320	Introduction to IoT#	4
BTEE ZC317	Communication & Networking Technologies for IoT#	4
BTEE ZC412	Digital Image Processing	3
BTEE ZG512	Machine Learning	4
BTEE ZC419	Sensor Technologies	4
BTEE ZC415	Machine Learning for Edge	4
BTEE ZG515	Real-Time Operating Systems	5
BTEE ZC318	Computer Architecture	4

Requirements:

- 5 courses are to be chosen from the designated pool of electives for this concentration
- # indicates mandatory electives for this concentration

Pool of Electives for Concentration 3: Processor Architectures

The advent of computationally intensive applications such as AI/ML, self-driving cars, etc has resulted in customized processors such as GPUs, TPUs, Hardware accelerators etc. The courses in this thread will provide professionals with the foundational knowledge and skill required to understand the processor architectures for different applications.

Course No.	Course Title	Units
BTEE ZG511	Embedded System Design#	4
BTEE ZC318	Computer Architecture#	4
BTEE ZC321	Semiconductor Devices and Technologies#	4
BTEE ZC417	Modern Processor Architectures	3
BTEE ZC420	SoC Design & EDA	4
BTEE ZC413	FPGA-based System Design	4
BTEE ZG515	Real-Time Operating Systems	5

Requirements:

- 5 courses are to be chosen from the designated pool of electives for this concentration
- # indicates mandatory electives for this concentration

Project

Course No.	Course Title	Units
BTEE ZC425T	Project Work	16

Semester-wise pattern of courses

Year	First Semester			Second Semester		
	Course No.	**Course Title**	**Units**	**Course No.**	**Course Title**	**Units**
I	BTEE ZC212	Engineering Mathematics	3	BTEE ZC216	Probability Theory and Random Process	4
	BTEE ZC214	Object Oriented Programming	4	BTEE ZC217	Digital Electronics and Microprocessors	4
	BTEE ZC213	Engineering Physics	3	BTEE ZC215	Principles of Management	3
	BTEE ZC211	Elements of Electrical and Electronic Circuits	4	BTEE ZC218	Signals and Systems	3
		Total	14		Total	14
II	BTEE ZC311	Analog Electronics	4	BTEE ZC316	Microwave and Antenna Theory	3
	BTEE ZC314	Electromagnetic Theory	3	BTEE ZC315	Introduction to Digital Signal Processing	4
	BTEE ZC313	Digital Control Systems	4		Elective 1	3 (min)
	BTEE ZC312	Communication Systems	4		Elective 2	3 (min)
		Total	15		Total	13 (min)
III	BTEE ZC411	Computer Networks	4		Elective 6	4 (min)
		Elective 3	4 (min)		Elective 7	4 (min)
		Elective 4	3 (min)		Elective 8	3 (min)
		Elective 5	3 (min)		Elective 9	3 (min)
		Total	14 (min)		Total	14 (min)
IV	BTEE ZC425T	Project Work	16			
		Total	**100(min)**			

B. TECH. (ENGINEERING DESIGN))

Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

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Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements :

Foundation Courses	:9 courses	(32 units min.)
Discipline Core	:11 courses	(40 units min.)
Discipline Electives	:4 courses	(12 units min.)
Coursework sub total	:24 courses	(84 units min.)
Project Work	:16 units	

Category-wise Programme Structure:

Category	Course No.	Course Title	Units
Foundation Courses (9)			
Mathematics Foundation	ED* ZC233	Calculus	4
	ED* ZC235	Linear Algebra & Optimization	3
Technical Arts / Professional Courses	ED* ZC164	Computer Programming	4
	ED* ZC241	Technical Report Writing	3
	ED* ZC 231	Principles of Management	3
Engineering Foundation	ED* ZC232	Engineering Materials	3
	ED* ZC261	Mechanical Technology	4
	ED* ZC211	Electrical and Electronics Technology	4
	ED* ZC251	Engineering Measurements	4
Discipline Courses			
Core (11)	ED* ZC321	Mechanics of Solids	3
	ED* ZC245	Fluid Mechanics & Machines	4
	ED* ZC332	Mechanical Engineering Design-I	4
	ED* ZC322	Kinematics & Dynamics of Machines	3
	ED* ZC311	Manufacturing Processes	4
	ED* ZC453	Product Design & Development	4
	ED* ZC342	Mechanical Engineering Design-II	4
	ED* ZC434	Quality Control, Assurance & Reliability	4
	ED* ZC433	Mechanical Vibrations & Acoustics	3
	ED* ZC441	Automotive Vehicles	3
	ED* ZC436	Computer Aided Design	4
Electives (any 4)	ED* ZC471	Management Information Systems	3
	ED* ZC324	Mechatronics & Automation	4
	ED* ZC325	Fluid Power Systems	4
	ED* ZC452	Composite Materials and Design	4
	ED* ZC454	Reverse Engineering and Rapid Prototyping	4

B. TECH. (ENGINEERING DESIGN)

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	ED* ZC211	Electrical and Electronics Technology	4	ED* ZC164	Computer Programming	4
	ED* ZC232	Engineering Materials	3	ED* ZC235	Linear Algebra and Optimization	3
	ED* ZC233	Calculus	4	ED* ZC251	Engineering Measurements	4
	ED* ZC261	Mechanical Technology	3	ED* ZC321	Mechanics of Solids	3
		Total	14		Total	14
II	ED* ZC245	Fluid Mechanics and Machines	4	ED* ZC342	Mechanical Engineering Design-II	4
	ED* ZC311	Manufacturing Processes	4	ED* ZC436	Computer Aided Design	4
	ED* ZC322	Kinematics & Dynamics of Machines	3	ED* ZC453	Product Design & Development	4
	ED* ZC332	Mechanical Engineering Design-I	4		Discipline Elective	3(min.)
		Total	15		Total	15
III	ED* ZC433	Mechanical Vibrations & Acoustics	3	ED* ZC241	Technical Report Writing	3
	ED* ZC434	Quality Control, Assurance & Reliability	4	ED* ZC231	Principles of Management	3
	ED* ZC441	Automotive Vehicles	3		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	13		Total	12
	ED* ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

B. TECH. (ENGINEERING TECHNOLOGY)

Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	:10 courses	(35 units min.)
Discipline Core	:9 courses	(34 units min.)
Discipline Electives	:5 courses	(15 units min.)
Coursework sub total	:24	(84units min.)
Project Work	:16 units	

Category-wise Programme Structure:

Sub-Category	Course No.	Course Title	Units
Foundation Courses (10)			
Mathematics Foundation	MATH ZC233	Calculus	4
	MATH ZC234	Linear Algebra & Optimization	3
	AAOC ZC111	Probability and Statistics	3
Technical Arts / Professional Courses	TA ZC164	Computer Programming	4
	TA ZC312	Technical Report Writing	3
	MGTS ZC211	Principles of Management	3
Engineering Foundation	ENGG ZC243	Engineering Materials	3
	ENGG ZC241	Mechanical Technology	4
	ENGG ZC112	Electrical & Electronics Technology	4
	ENGG ZC233	Engineering Measurements	4
Discipline Courses			
Core (9)	ET ZC413	Engineering Design	4
	ET ZC423	Essentials of Project Management	3
	ET ZC344	Instrumentation & Control	4
	ENGG ZC242	Maintenance & Safety	3
	ET ZC235	Manufacturing Processes	4
	ET ZC343	Materials Management	4
	ET ZC416	Production Planning & Control	4
	ET ZC434	Quality Control, Assurance & Reliability	4
	ET ZC449	IoT in Manufacturing	4
Electives (any 5)	ET ZC352	Energy Management	4
	ET ZC362	Environmental Pollution Control	3
	EA ZC412	Flexible Manufacturing Systems	4

	BITS ZC471	Management Information Systems	3
	ET ZC417	Manufacturing Excellence	4
	ET ZC323	Mechatronics & Automation	4
	ES ZC343	Microprocessors & Microcontrollers	3
	ET ZC448	Additive Manufacturing	4
	ET ZC442	Advanced Driver Assistance Systems	4
	ET ZC443	Connected Cars	4
	ET ZC424	Plant Layout and Design	4
	ET ZC419	Electric & Hybrid Vehicles	4

Semesterwise Pattern

Year	First Semester		U	Second Semester		U
I	ENGG ZC112	Electrical & Electronics Technology	4	AAOC ZC111	Probability & Statistics	3
	ENGG ZC243	Engineering Materials	3	ENGG ZC233	Engineering Measurements	4
	MATH ZC233	Calculus	4	MATH ZC234	Linear Algebra & Optimization	3
	TA ZC164	Computer Programming	4	ENGG ZC241	Mechanical Technology	4
		Total	15		Total	14
II	ENGG ZC242	Maintenance & Safety	3	ET ZC344	Instrumentation & Control	4
	ET ZC235	Manufacturing Processes	4	ET ZC343	Materials Management	4
	ET ZC413	Engineering Design	4	ET ZC423	Essentials of Project Management	3
	ET ZC416	Production Planning & Control	4	ET ZC449	IoT in Manufacturing	4
		Total	15		Total	15
III	ET ZC434	Quality Control, Assurance & Reliability	4	MGTS ZC211	Principles of Management	3
		Discipline Elective	3(min.)	TA ZC312	Technical Report Writing	3
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	13(min)		Total	12(min)
	BITS ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

B. TECH. (INFORMATION SYSTEMS)
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

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Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	:8 courses	(27 units min.)
Discipline Core	:10 courses	(39 units min.)
Discipline Electives	:6 courses	(18 units min.)
Course work sub total	: 24	(84 units min.)
Project Work	: 16 units	

Category-wise Programme Structure:

Sub-category	Course No.	Course Title	Units
Foundation Courses(8)			
Mathematics Foundation	MATH ZC234	Linear Algebra & Optimization	3
	AAOC ZC111	Probability and Statistics	3
	MATH ZC222	Discrete Structures for Computer Science	3
	MATH ZC233	Calculus	4
Technical Arts/ Professional Courses	TA ZC163	Computer Programming	4
	TA ZC312	Technical Report Writing	3
	MGTS ZC211	Principles of Management	3
Engineering Foundation	ESZC264	Digital Electronics and Microprocessors	4
Discipline Courses			
Core (10)	IS ZC467	Computer Networks	4
	IS ZC353	Computer Organization & Architecture	4
	IS ZC363	Data Structures & Algorithms	4
	IS ZC337	Database Systems & Applications	4
	IS ZC373	Compiler Design	4
	IS ZC313	Object Oriented Programming & Design	4
	IS ZC364	Operating Systems	4
	IS ZC343	Software Engineering	4
	IS ZC327	Systems Programming	4
	IS ZC328	Software Testing	3
Electives (6)	BITS ZC471	Management Information Systems	3
	IS ZC423	Software Development for Portable Devices	3
	IS ZC415	Data Mining	3

	ISZC472	Computer Graphics	3
	IS ZC447	Data Storage Technologies & Networks	4
	EA ZC473	Multimedia Computing	3
	IS ZC462	Network Programming	3
	IS ZC422	Parallel Computing	3
	IS ZC424	Software for Embedded Systems	3

Semesterwise Pattern

Year	First Semester		U	Second Semester		U
I	MATH ZC222	Discrete Structures for Computer Science	3	IS ZC313	Object Oriented Programming & Design	4
	MATH ZC233	Calculus	4	IS ZC327	Systems Programming	4
	TA ZC163	Computer Programming	4	MATH ZC234	Linear Algebra & Optimization	3
	ES ZC263	Digital Electronics and Microprocessors	4	IS ZC363	Data Structures and Algorithms	4
		Total	15	Total		15
II	IS ZC353	Computer Organization & Architecture	4	IS ZC373	Compiler Design	4
	IS ZC337	Database Systems & Applications	4	IS ZC343	Software Engineering	4
	IS ZC364	Operating Systems	4	IS ZC467	Computer Networks	4
	AAOC ZC111	Probability and Statistics	3	IS ZC328	Software Testing	3
		Total	15	Total		15
III		Discipline Elective	3(min.)	MGTS ZC211	Principles of Management	3
		Discipline Elective	3(min.)	TA ZC312	Technical Report Writing	3
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	12(min)		Total	12(min)
	BITS ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

B. TECH. MANUFACTURING TECHNOLOGY

Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	:9 courses	(32 units min.)
Discipline Core	:11 courses	(40 units min.)
Discipline Electives	:4 courses	(12 units min.)
Coursework sub total	:24 courses	(84 units min.)
Project Work	:16 units (min.)	

Category-wise Programme Structure:

Category	Course No.	Course Title	Units
Foundation Courses (9)			
Mathematics Foundation	MT* ZC233	Calculus	4
	MT* ZC235	Linear Algebra & Optimization	3
Technical Arts / Professional Courses	MT* ZC221	Computer Programming	4
	MT* ZC241	Technical Report Writing	3
	MT* ZC 231	Principles of Management	3
Engineering Foundation	MT* ZC236	Engineering Materials	3
	MT* ZC251	Mechanical Technology	4
	MT* ZC112	Electrical and Electronics Technology	4
	MT* ZC213	Engineering Measurements	4
Discipline Courses			
Core (11)	MT* ZC261	Mechanics of Solids	3
	MT* ZC245	Fluid Mechanics & Machines	4
	MT* ZC342	Machine Design	4
	MT* ZC344	Metal Forming and Machining	4
	MT* ZC315	Casting and Welding	4
	MT* ZC331	Production Planning & Control	4
	MT* ZC418	Lean Manufacturing	4
	MT* ZC434	Quality Control, Assurance & Reliability	4
	MT* ZC448	Additive Manufacturing	4
	MT* ZC421	Essentials of Project Management	3
	MT* ZC449	IoT in Manufacturing	4
Electives (any 4)	MT* ZC412	Flexible Manufacturing Systems	4
	MT* ZC324	Mechatronics & Automation	4

	MT* ZC343	Materials Management	4
	MT* ZC346	Instrumentation & Control	4
	MT* ZC347	Microprocessors and Microcontrollers	3
	MT* ZC471	Manufacturing Excellence	4
	MT* ZC311	Automobile Technology-I	4
	MT* ZC312	Automobile Technology-II	4
	MT* ZC332	Operations Research	4
	MT* ZC234	Maintenance & Safety	3
	MT* ZC452	Composite Materials and Design	4

Semesterwise Pattern

Year	First Semester		U	Second Semester		U
I	MT* ZC233	Calculus	4	MT* ZC235	Linear Algebra and Optimization	3
	MT* ZC261	Mechanics of Solids	3	MT* ZC251	Mechanical Technology	4
	MT* ZC236	Engineering Materials	3	MT* ZC213	Engineering Measurements	4
	MT* ZC112	Electrical and Electronics Technology	4	MT* ZC221	Computer Programming	4
Total			14	Total		15
II	MT* ZC245	Fluid Mechanics & Machines	4	MT* ZC449	IoT in Manufacturing	4
	MT* ZC315	Casting and Welding	4	MT* ZC331	Production Planning and Control	4
	MT* ZC344	Metal Forming and Machining	4	MT* ZC342	Machine Design	4
	MT* ZC448	Additive Manufacturing	4		Discipline Elective	3(min.)
Total			16	Total		15
III	MT* ZC418	Lean Manufacturing	4	MT* ZC241	Technical Report Writing	3
	MT* ZC434	Quality Control Assurance and Reliability	4	MT* ZC231	Principles of Management	3
	MT* ZC421	Essentials of Project Management	3		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
Total			14(min)	Total		12(min)
	MT* ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Kirloskar Oil Engines, Kolhapur, Bharat Forge, Pune, Tata Motors, Jamshedpur; TACO, Pune; Maruti Suzuki, Gurgaon; Mahindra Motor Vehicles, Cummins, Pune

B. TECH. (POWER ENGINEERING)

Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

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Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	: 9 courses (31 units min.)
Discipline Core	: 10 courses (36 units min.)
Discipline Electives	: 5 courses (17 units min.)
Coursework sub total	: 24 courses (84units min.)
Project Work	: 16 units

Sub- Category	Course No	Course Title	Unit
Foundation Courses (9)			
Mathematics Foundation	POW*ZC233	Calculus	4
	POW*ZC234	Linear Algebra & Optimization	3
General Awareness / Technical Arts	POW*ZC164	Computer Programming	4
	POW*ZC232	Principles of Management	3
	POW*ZC321	Technical Report Writing	3
Engineering Foundation	POW* ZC112	Electrical & Electronics Technology	4
	POW* ZC343	Microprocessors & Microcontrollers	3
	POW* ZC231	Thermodynamics	3
	POW* ZC242	Engineering Measurements	4
Discipline Courses (10)			
Core (10)	POW*ZC434	Quality Control, Assurance & Reliability	4
	POW*ZC313	Power Plant Engineering	4
	POW*ZC314	Prime Movers & Fluid Machines	4
	POW*ZC342	Power System Engineering I	3
	POW*ZC344	Instrumentation & Control	4
	POW*ZC421	Essentials of Project Management	3
	POW*ZC431	Maintenance & Safety	3
	POW* ZC316	Power Electronics	4
	POW*ZC441	Power System Engineering II	3
	POW* ZC315	Transport Phenomena	4

Electives (any 5)	POW*ZC332	Energy Management	4
	POW*ZC411	Environmental Pollution Control	3
	POW*ZC412	Power System Operation and Control	3
	POW*ZC413	Process Control	3
	POW*ZC422	Power System Drawing & Design	3
	POW*ZC452	Renewable Energy	3
	POW*ZC471	Power Electronics & Drives	3
	POW*ZC481	Plant Layout & Design	4

Semesterwise Pattern

Year	First Semester		U	Second Semester		U
I	POW* ZC112	Electrical & Electronics Technology	4	POW* ZC234	Linear Algebra & Optimization	3
	POW* ZC164	Computer Programming	4	POW* ZC242	Engineering Measurements	4
	POW* ZC231	Thermodynamics	3	POW* ZC343	Microprocessors & Microcontrollers	3
	POW* ZC233	Calculus	4	POW* ZC315	Transport Phenomena	4
		Total	15		Total	14
II	POW* ZC342	Power System Engineering I	3	POW* ZC434	Quality Control, Assurance & Reliability	4
	POW* ZC344	Instrumentation & Control	4	POW* ZC314	Prime Movers and Fluid Machines	4
	POW* ZC431	Maintenance & Safety	3	POW* ZC441	Power System Engineering II	3
	POW* ZC313	Power Plant Engineering	4		Discipline Elective	3(min.)
		Total	14		Total	14
III	POW* ZC316	Power Electronics	4	POW* ZC321	Technical Report Writing	3
	POW* ZC421	Essentials of Project Management	3	POW* ZC232	Principles of Management	3
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	13		Total	12
	POW* ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Aditya Birla Group, Tata Power, JSW Energy – Mumbai

B. TECH. (PROCESS ENGINEERING)

Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	:8 courses	(28 units min.)
Discipline Core	:9 courses	(35 units min.)
Discipline Electives	:7 courses	(21 units min.)
Coursework sub total	:24 courses	(84 units min.)
Project Work	:16 units	

Category-wise Programme Structure:

Category	Course No.	Course Title	Units
Foundation Courses (8)			
Mathematics Foundation	PE* ZC233	Calculus #	4
	PE* ZC235	Linear Algebra & Optimization #	3
	PE* ZC113	Probability and Statistics	3
Technical Arts / Professional Courses	PE* ZC164	Computer Programming #	4
	PE* ZC211	Principles of Management #	3
	PE* ZC313	Technical Report Writing #	3
Engineering Foundation	PE* ZC231	Engineering Materials #	3
	PE* ZC213	Engineering Measurements #	4
	PE* ZC112	Electrical & Electronics Technology #	4
Discipline Courses			
Core	PE* ZC321	Chemical Process Calculations	3
	PE* ZC311	Chemical Engineering Thermodynamics	4
	PE* ZC318	Fundamentals of Transport Processes	4
	PE* ZC319	Unit Operations – I	4
	PE* ZC352	Energy Management	4
	PE* ZC452	Process Plant Safety and Environment	4
	PE* ZC453	Process Control & Instrumentation	4
	PE* ZC322	Process Design Principles	4
	PE* ZC412	Process Equipment Design	4
Elective Courses			
Electives	PE* ZC434	Quality Control Assurance & Reliability	4
	PE* ZC314	Power Plant Engineering	4
	PE* ZC234	Manufacturing Processes	4
	PE* ZC411	Production Planning and Control	4
	PE* ZC342	Materials Management	4
	PE* ZC353	Industrial Engineering	3
	PE* ZC423	Essentials of Project Management	3
	PE* ZC361	Environmental Pollution Control	3
	PE* ZC383	Extractive Metallurgy	3
	PE* ZC385	Fertilizer Technology	3

	PE* ZC382	Cement Technology	3
	PE* ZC384	Fibre & Cellulosic Technology	3
	PE* ZC214	Pharmaceutical Analysis	3
	PE* ZC221	Disinfection & Sterilization Processes	3
	PE* ZC344	Pharmaceutical Quality Control & Regulatory Affairs	3
	PE* ZC252	Mineral Beneficiation & Agglomeration	3
	PE* ZC262	Iron Making	3
	PE* ZC273	Advances in Material Science & Testing	3
	PE* ZC312	Steel Making & Casting	3
	PE* ZC362	Steel Processing	3
	PE* ZC320	Unit Operations – II	4
	PE* ZC323	Corrosion Engineering	3
	PE* ZC324	Chemical Reaction Engineering	3
	PE* ZC272	Furnace Technology	3
	PE* ZC442	Advances in Materials Science	3

Mandatory Foundation Course

Semesterwise Pattern

Year	First Semester		U	Second Semester		U
I	PE* ZC112	Electrical & Electronics Technology	4	PE* ZC352	Energy Management	4
	PE* ZC231	Engineering Materials	3	PE* ZC213	Engineering Measurements	4
	PE* ZC233	Calculus	4	PE* ZC235	Linear Algebra & Optimization	3
	PE* ZC164	Computer Programming	4	PE* ZC321	Chemical Process Calculations	3
		Total	15		Total	14
II	PE* ZC311	Chemical Engineering Thermodynamics	4	PE* ZC322	Process Design Principles	4
	PE* ZC318	Fundamentals of Transport Processes	4	PE* ZC412	Process Equipment Design	4
	PE* ZC319	Unit Operations – I	4		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	15		Total	15
III	PE* ZC452	Process Plant Safety & Environment	4	PE* ZC313	Technical Report Writing	3
	PE* ZC453	Process Control & Instrumentation	4	PE* ZC211	Principles of Management	3
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	14		Total	12
	PE* ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Aditya Birla Group, Mumbai; JSW Steel, Toranagallu; Vedanta, Jharsuguda; BPCL, Mumbai

B.Tech. (Software Systems and Engineering)

Type of Input: Employed professionals holding B.Sc. degree in relevant disciplines with strong mathematics background, and minimum one year of work experience in IT services or product industry. The graduate must have studied at least three Math courses in B.Sc. including at least two of the following: Calculus, Probability & Statistics, Linear Algebra, Optimization

Curriculum Requirements:
Completion of the programme would require:

a) 27 courses (totalling minimum of 95 units) towards course work (including a minimum of 4 discipline electives) and
b) Project (10 Units)

Program Structure:

Foundation Courses (3)

Course No.	Course Title	Units
BTSSE ZC212	Basic Electronics Circuits	4
BTSSE ZC215	Environmental Studies	3
BTSSE ZC213	Discrete Structures for Computer Science	3

Core Courses (16)

Course No.	Course Title	Units
BTSSE ZC216	Introduction to Computing Systems	3
BTSSE ZC217	Introduction to Progressive Web Apps	4
BTSSE ZC314	Data Structures & Algorithms	4
BTSSE ZC218	Introduction to Scripting	4
BTSSE ZC313	Computer Organization & Architecture	4
BTSSE ZC324	Software Engineering	4
BTSSE ZC436	Software Design Principles	4
BTSSE ZC323	Operating Systems	4
BTSSE ZC317	Incremental Software Development	4
BTSSE ZC315	Database Systems & Applications	4
BTSSE ZC413	Computer Networks	4
BTSSE ZC211	Algorithm Design	3
BTSSE ZC312	Compilers and Code Automation	4
BTSSE ZC311	Cloud Systems and Services	4
BTSSE ZC325	Software Testing and Automation	4
BTSSE ZC318	Information Security	3

Discipline Electives (20)
The Discipline Electives below are grouped according to their sub-domains into Software Engineering, Data, Systems and other horizontal sub-domains. This is only a logical grouping to provide clarity on the nature of electives, and does not impose any constraint on selection by students. A minimum of 4 courses has to be chosen from the list of discipline electives.

Course No.	Course Title	Units
Software Engineering		
BTSSE ZC435	Software Deployment	4
BTSSE ZC417	Full Stack Web Development	4
BTSSE ZG512	Cloud Native Development	3
BTSSE ZG511	Advanced Topics in Software Engineering	4
BTSSE ZC433	Security Practices in SDLC	4
Data		
BTSSE ZC414	Data Analytics and Visualization	4
BTSSE ZC411	Applied Data Mining and Machine Learning	4
BTSSE ZC424	Introduction to Search Engines	4
BTSSE ZC321	Modern Databases	4
BTSSE ZC425	Introduction to Statistical Inference	3
Systems		
BTSSE ZC322	Multi-Core Programming and GPGPU Programming	3
BTSSE ZC437	Systems Programming for Constrained Devices	4
BTSSE ZC416	Distributed Systems	4
BTSSE ZC415	Distributed Programming	4
Horizontal Domains		
BTSSE ZC320	Microprocessors and Interfacing	4
BTSSE ZC319	Introduction to IoT	4
BTSSE ZC316	Human Computer Interaction	3
BTSSE ZC422	Introduction to Augmented and Virtual Reality	4
BTSSE ZC430	Multimedia Computing	3
BTSSE ZC434	Social Network Analysis	4

Other Electives (11)

Other Electives are courses offered in vertical domains such as BFSI, healthcare, cyber law and public health.

Course No.	Course Title	Units
BTSSE ZC418	Fundamentals of Finance and Accounts	3
BTSSE ZC431	Principles of Economics	3
BTSSE ZC426	Investment Management	3
BTSSE ZC421	Information Law and Cyber Law	3
BTSSE ZC429	Legal Software	4
BTSSE ZC420	Health Systems Management and Environmental Health	4
BTSSE ZC432	Public Health & Diseases	4
BTSSE ZC419	Health Informatics	4
BTSSE ZC423	Introduction to Digital Manufacturing	4
BTSSE ZC427	IoT for Manufacturing	4
BTSSE ZC412	Automotive Software	4

Project

Course No.	Course Title	Units
BTSSE ZC428T	Project	10

Semester wise Pattern of courses

Year	First Semester			Second Semester		
	Course No.	Course Title	Units	Course No.	Course Title	Units
I	BTSSE ZC216	Introduction to Computing Systems	3	BTSSE ZC314	Data Structures & Algorithms	4
	BTSSE ZC213	Discrete Structures for Computer Science	3	BTSSE ZC217	Introduction to Progressive Web Apps	4
	BTSSE ZC218	Introduction to Scripting	4	BTSSE ZC313	Computer Organization & Architecture	4
	BTSSE ZC212	Basic Electronics Circuits	4	BTSSE ZC215	Environmental Studies	3
		Total	14		Total	15
II	BTSSE ZC324	Software Engineering	4	BTSSE ZC315	Database Systems & Applications	4
	BTSSE ZC436	Software Design Principles	4	BTSSE ZC413	Computer Networks	4
	BTSSE ZC323	Operating Systems	4	BTSSE ZC211	Algorithm Design	3
	BTSSE ZC317	Incremental Software Development	4	BTSSE ZC312	Compilers and Code Automation	4
		Total	16		Total	15
III	BTSSE ZC311	Cloud Systems and Services	4	DE/OE-II		4 (min)
	BTSSE ZC325	Software Testing and Automation	4	DE/OE-III		4 (min)
	BTSSE ZC318	Information Security	3	DE/OE-IV		4 (min)
	DE/OE-I		3(min)	DE/OE-V		3 (min)
		Total	14 (min)		Total	15 (min)
IV	BTSSE ZC428T	Project	10			
	DE/OE-VI		3 (min)			
	DE/OE-VII		3 (min)			
	Total		16 (min)			

* DE refers to Discipline Elective; OE refers to Other Elective
* Discipline electives (Minimum 4) – To be chosen from the elective pool of Courses offered under categories such as software related, data related, systems related, and horizontal sub-domains.
* Other electives - Courses offered under vertical domains such as BFSI, healthcare, law and public health.

Master of Science (M.Sc.) programmes

Program Structure:

Normal Input: Three-year undergraduate degree in relevant disciplines.

Curriculum requirements: Completion of the **M.Sc.** degree programme would require completion of coursework of minimum 15 courses (52 units minimum) and one Project / Thesis / Practice School (8 – 20 units), adding up to a total of 72 units minimum.

Nominal duration: The nominal duration of a M.Sc. programme will be 4 semesters.

Curriculum Structure for M.Sc. programs:

Category	**Number of Courses Required**	**Number of Units Required**
I Foundation Courses	2-8	6-32
II Discipline Courses		
Discipline Core	5-10	15-40
Discipline Electives	2-6	6-20
Coursework Sub-Total	**15 courses (min)**	**52 units (min)**
III Project / Thesis / Practice School	1	8 -20
Total	**16 courses (min)**	**72 units (min)**

Note: Concurrent registration in two courses (upto 8 units) alongwith Project is to be permitted.

M.Sc. (BUSINESS ANALYTICS)
Curriculum Structure

Type of Input: Employed professionals working in a variety of business domains, holding a three year undergraduate degree in relevant disciplines with adequate preparation in mathematics, with minimum one year work experience in relevant domains.

Nominal Duration: Five Semesters

Curriculum Structure

Foundation courses

Course No.	Course Title	Units
BA* ZG522	Business Data Mining	4
BA* ZG521	Financial Management	4
BA* ZC413	Introduction to Statistical Methods	3
BA* ZC471	Management Information Systems	3
BA* ZC411	Marketing	4
BA* ZC412	Models and Applications in Operations Research	4
BA* ZG621	Supply Chain Management	4

Core courses

Course No.	Course Title	Units
BA* ZG524	Advanced Statistical Methods	4
BA* ZC415	Analytics for Competitive Advantage	4
BA* ZG525	Big Data Analytics	4
BA* ZG523	Introduction to Data Science	3
BA* ZC414	Optimization Methods for Analytics	4
BA* ZG512	Predictive Analytics	4

Pool of electives

Course No.	Course Title	Units
BA* ZC418	Advanced Financial Modeling	4
BA* ZC420	Data Visualization	3
BA* ZC417	Financial Risk Analytics	4
BA* ZC425	HR Analytics	4
BA* ZC416	Investment Banking Analytics	4
BA* ZC422	Marketing Analytics	4
BA* ZC421	Marketing Models	4
BA* ZC423	Retail Analytics	4
BA* ZC424	Supply Chain Analytics	4
BA* ZC426	Real-time Analytics	4
BA* ZG537	Text Analytics	4

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	BA* ZC411	Marketing	4	BA* ZG521	Financial Management	4
	BA* ZC471	Management Information Systems	3	BA* ZG522	Business Data Mining	4
	BA* ZC412	Models and Applications in Operational Research	4	BA* ZG621	Supply Chain Management	4
	BA* ZC413	Introduction to Statistical Methods	3	BA* ZG523	Introduction to Data Science	3
		Total	14		Total	15
II	BA* ZG524	Advanced Statistical Methods	4	BA* ZC415	Analytics for Competitive Advantage	4
	BA* ZG525	Big Data Analytics	4		Elective 1	(3 min)
	BA* ZG512	Predictive Analytics	4		Elective 2	(3 min)
	BA* ZC414	Optimization Methods for Analytics	4		Elective 3	(3 min)
		Total	16		Total	13 (min)
III	BA* ZG625T	Elective 4	(3 min)			
		Project	10			
		Total	13 (min)			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

M.Sc. (INFORMATION SYSTEMS)

Curriculum Structure

Normal Input: Employed professionals holding a B.Sc. or BCA degree with adequate preparation in Mathematics, and having minimum one year work experience in relevant domains.

Nominal duration: 5 semesters.

Curriculum Requirements :

Foundation Courses : 5 courses (17 units min.)
Discipline Core : 9 courses (36 units min.)
Discipline Electives : 4 courses (12 units min.)
Coursework sub total :18 courses (65units min.)
Project :8 units

Category-wise Programme Structure:

Sub- Category	Course No	Course Title	Unit
Foundation Courses (5)			
Mathematics Foundation	MATH ZC234	Linear Algebra & Optimization	3
	AAOC ZC111	Probability and Statistics	3
	MATH ZC222	Discrete Structures for Computer Science	3
General Awareness / Technical Arts	TA ZC163	Computer Programming	4
Engineering Foundation	ESZC264	Digital Electronics and Microprocessors	4
Discipline Courses			
Core	IS ZC373	Compiler Design	4
	IS ZC467	Computer Networks	4
	IS ZC353	Computer Organization & Architecture	4
	IS ZC363	Data Structures & Algorithms	4
	IS ZC337	Database Systems & Applications	4
	IS ZC313	Object Oriented Programming & Design	4
	IS ZC364	Operating Systems	4
	IS ZC343	Software Engineering	4
	IS ZC327	Systems Programming	4
Electives (4)	CS ZG551	Advanced Compilation Techniques	5
	CS ZG623	Advanced Operating Systems	5
	IS ZC444	Artificial Intelligence	3
	BITS ZC471	Management Information Systems	3
	IS ZC472	Computer Graphics	3
	EA ZC473	Multimedia Computing	3
	IS ZC415	Data Mining	3
	IS ZC422	Parallel Computing	3
	IS ZC423	Software Development for Portable Devices	3
	IS ZC424	Software for Embedded Systems	3
	IS ZC447	Data Storage Technologies & Networks	4
	IS ZC462	Network Programming	3

M.Sc. (INFORMATION SYSTEMS)

Semesterwise Pattern

Normal Input: Employed professionals holding a B.Sc. or BCA degree with adequate preparation in Mathematics, having minimum one year work experience in relevant domains.

Nominal duration: 5 semesters.

Year	First Semester		U	Second Semester		U
I	MATH ZC222	Discrete Structures for Computer Science	3	IS ZC313	Object Oriented Programming & Design	4
	MATH ZC234	Linear Algebra & Optimization	3	IS ZC327	Systems Programming	4
	TA ZC163	Computer Programming	4	AAOC ZC111	Probability and Statistics	3
	ES ZC263	Digital Electronics and Microprocessors	4	IS ZC363	Data Structures and Algorithms	4
		Total	15		Total	14
II	IS ZC353	Computer Organization & Architecture	4	IS ZC373	Compiler Design	4
	IS ZC337	Database Systems & Applications	4	IS ZC343	Software Engineering	4
	IS ZC364	Operating Systems	4	IS ZC467	Computer Networks	4
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	15		Total	15
III	BITS ZC426T	Project	8			
		Discipline Elective	3(min.)			
		Discipline Elective	3(min.)			
		Total	14(min)			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

B.Sc. Programmes for Trainees / Working Professionals

Normal Input:	Trainees / Employed professionals who have completed their 10+2 (in Science stream) or equivalent educational qualification with minimum 60% aggregate marks.
Completion requirement	Successful completion of the B.Sc. degree programme would require completion of minimum of 23 courses (105 units minimum) with a CGPA of at least 4.50.
Nominal duration	The nominal duration of a B.Sc. programme will be 8 semesters.

Curriculum Structure of B.Sc. Programmes

Category	**Number of Courses Required**	**Number of Units Required**
I. Foundation Courses	8-12	24-40
II. Discipline Courses		34-58
Discipline Core	10-16	
Electives	4-6	12-24
Coursework Sub-Total	**28 courses (min)**	**90 units (min)**
III. Project Courses	Min 1 and Max 2	15-20 units
Total	**29 courses (min)**	**105 Units (min)**

Note: Concurrent registration in at most two courses (upto 8 units) along with a Project Course may be permitted if the total units in that semester do not exceed 15.

B.Sc. (Computer Science)

Input Qualification (for the online offering of B.Sc. Computer Science).

For Applicants from India

1) Candidates should have passed the class 12th examination in any stream under the 10+2 system from a recognized central or state board from India or its equivalent.
2) Candidates must have adequate proficiency in Maths. The Candidates Class 12th mark sheet issued by the respective board should show Maths as one of the subjects and that the candidate has secured minimum 60% marks in Maths.

   Or

   Candidates who have either **not studied maths in Class 12th** or **failed to secure minimum 60% marks in Maths in Class 12th** are expected to appear in a qualifying examination in mathematics to be conducted by BITS. The admission offer will be on the basis of the performance in the exam.
3) Candidates must have adequate proficiency in English. All applicants who have studied "English" as a subject till Class 10th will be considered eligible.

For Applicants from other countries:

1) Candidates should have passed the qualifying examination conducted by their respective country's or province's board of higher/senior secondary school education (High School Board) and must obtain an equivalence certificate from Association of Indian Universities that indicates that the certificate issued by their respective country's/province's board of school education is equivalent to class 12 certificate issued from recognized central or state board from India or its equivalent.
2) Candidates must have adequate proficiency in maths. The candidate's final year marks sheet issued by their respective country's / province's high school education board should show maths as one of the subject and that applicant has secured in maths either a minimum 60% marks or a minimum grade point of 6 on a scale of 10.

   Or

   Candidates who have either not studied maths at high school level or failed to secure in maths a minimum 60% marks or a minimum grade point of 6 on a scale of 10 in the final year examination conducted by their respective country's/province's recognised high school board are expected to appear in a qualifying examination in mathematics to be conducted by BITS. The admission offer will be on the basis of the performance in the exam.
3) Candidates must have adequate proficiency in English. Candidates must have had "English" as the primary medium of instruction for their high school studies. This will need to be supported by uploading a certificate issued by the school along with the application.

   or

   Must submit a valid IELTS or TOEFL score card with the application.

Normal Duration: Six Semesters.

Programme Structure:

Foundation courses

Course No.	Course Title	Units
	Humanities Foundation	
BCS ZC151	Writing Practice	3
BCS ZC113	Online Social Media#	2
BCS ZC114	Video Games - Technology and Social Impacts#	2
	Mathematics Foundation	
BCS ZC219	Discrete Mathematics	3
BCS ZC230	Linear Algebra and Optimization	3
BCS ZC233	Probability and Statistics	3
BCS ZC112	Introduction to Logic	2
	Science & Engineering Foundation	
BCS ZC223	General Biology$	3
BSC ZC240	General Physics$	3
BCS ZC111	Basic Electronics	2
	Other Courses	
BCS ZC220	Environmental Studies	3
BCS ZC229	Introduction to Economics@	3
BCS ZC235	Science, Technology and Modernity@	3

$One course must be chosen from this list of courses (Foundation Option 1 in the program chart)
One course must be chosen from this list of courses (Foundation Option 2 in the program chart).
@One course must be chosen from this list of courses (Foundation Option 3 in the program chart).

Discipline Core Courses

Course No.	Course Title	Units
BCS ZC313	Introduction to Programming	4
BCS ZC228	Introduction to Computing Systems	3
BCS ZC216	Computer Systems and Performance	3
BCS ZC215	Command Line Interfaces and Scripting	3
BCS ZC311	Data Structures and Algorithms	4
BCS ZC212	Algorithm Design	3
BCS ZC316	Object Oriented Programming	4
BCS ZC317	Relational Databases	4
BCS ZC234	Programming for Mobile Devices	3
BCS ZC238	Web Programming	3
BCS ZC232	Operating Systems	3
BCS ZC236	Software Design Principles	4
BCS ZC214	Building Database Applications	3
BCS ZC211	Software Development Practices	3
BCS ZC231	Network Programming and Client-Server Programming	3
BCS ZC222	Formal Languages and Applications	3

Pool of Electives

Course No.	Course Title	Units
BCS ZC224	Graphs and Networks	3
BCS ZC213	Automata and Computability	3
BCS ZC221	Experimental Algorithmics	3
BCS ZC227	Introduction to Bioinformatics	3
BCS ZC217	Data Visualization	3
BCS ZC312	Introduction to Data Analytics	4
BCS ZC315	Multicore and GPGPU Programming	4
BCS ZC237	TCP/IP and Internet	3
BCS ZC226	Information Security	3
BCS ZC225	Human Computer Interaction	3
BCS ZC218	Designing Multimodal Interfaces	3
BCS ZC314	Modern Databases	4

Elective courses enable students to gain technical proficiency and skills in specific subject areas or tracks by way of chosen courses

Project Type Courses

Course No.	Course Title	Units
BCS ZC241T	Study Project	5
BCS ZC428T	Project	10

Semester-wise Pattern:

Year	First Semester		U		Second Semester	U
I	BCS ZC313	Introduction to Programming	4	BCS ZC311	Data Structures and Algorithms	4
	BCS ZC219	Discrete Mathematics	3	BCS ZC316	Object Oriented Programming	4
	BCS ZC230	Linear Algebra and Optimization	3	BCS ZC215	Command Line Interfaces and Scripting	3
	BCS ZC228	Introduction to Computing Systems	3	BCS ZC233	Probability and Statistics	3
	BCS ZC111	Basic Electronics	2	BCS ZC112	Introduction to Logic	2
	BCS ZC239	Writing Practice	3		Foundation Option 1	3
	Units		18	Units		19
II	BCS ZC212	Algorithm Design	3	BCS ZC232	Operating Systems	3
	BCS ZC317	Relational Databases	4	BCS ZC214	Building Database Applications	3
	BCS ZC238	Web Programming	3	BCS ZC234	Programming Mobile Devices	3
	BCS ZC236	Software Design Principles	4	BCS ZC220	Environmental Studies	3
	BCS ZC216	Computer Systems and Performance	3	BCS ZC222	Formal Languages and Applications	3
		Foundation Option 2	2		Discipline Elective #1	3
	Units		19	Min Units		18
III	BCS ZC211	Software Development Practices	3		Foundation Option 3	3
	BCS ZC231	Network Programming and Client-Server Programming	3		Discipline Elective #4	3/4
		Discipline Elective #2	3/4	BCS ZC428T	Project	10
		Discipline Elective #3	3/4			
	BCS ZC241T	Study Project	5			
	Units		17-19	Units		16-17

B.Sc. (Design & Computing)

Input Qualification
Trainees / Employed professionals who have completed their 10+2 (including Mathematics and Physics) or equivalent educational qualification with minimum 60% aggregate marks (and minimum 60% marks each in Mathematics and Physics), and having at least one year of industry experience.

Normal Duration: Eight semesters

Program Structure

Foundation courses

Course No.	Course Title	Units
Humanities Foundation		
BSDC* ZC151	Writing Practice	3
BSDC* ZC231	Dynamics of Social Change	3
BSDC* ZC236	Symbolic Logic	3
BSDC* ZC242	Cultural Studies	3
BSDC* ZC322	Critical Analysis of Literature and Cinema	3
Mathematics Foundation		
BSDC* ZC111	Probability & Statistics	3
BSDC* ZC234	Linear Algebra and Optimization	3
BSDC* ZC355	Statistical Inferences and Applications	3
Science & Engineering Foundation		
BSDC* ZC112	Electrical Sciences	3
Other Courses		
BSDC* ZC142	Computer Programming	4
BSDC* ZC225	Environmental Studies	3

Discipline Core courses

Course No.	Course Title	Units
BSDC* ZC215	Digital Design	4
BSDC* ZC222	Discrete Structures for Computer Science	3
BSDC* ZC226	Creative Thinking	3
BSDC* ZC311	Information Security	3
BSDC* ZC312	Evolution of Design	3
BSDC* ZC313	Object Oriented Programming and Design	4
BSDC* ZC316	Computing and Design	3
BSDC* ZC317	Algorithm Design	3
BSDC* ZC328	Humanities and Design	3
BSDC* ZC353	Computer Organization and Architecture	4

BSDC* ZC356	Data Structures	4
BSDC* ZC365	Human Computer Interaction	3
BSDC* ZC412	Software Design Principles	4

Pool of Electives		
Course No.	**Course Title**	**Units**
BSDC* ZC211	Principles of Economics	3
BSDC* ZC214	Science, Technology and Modernity	3
BSDC* ZC224	Print and Audio-Visual Advertisement	3
BSDC* ZC314	Software Development for Portable Devices	3
BSDC* ZC315	Web Programming	3
BSDC* ZC327	Systems Programming	3
BSDC* ZC329	Design for Social Media	3
BSDC* ZC330	Appreciation of Art	3
BSDC* ZC342	Computer Mediated Communication	3
BSDC* ZC343	Software Engineering	4
BSDC* ZC344	Professional Ethics	3
BSDC* ZC350	Human Rights: History, Theory and Practice	3
BSDC* ZC351	Organizational Behaviour	3
BSDC* ZC352	Advanced Writing Course	3
BSDC* ZC354	Introduction to Architecture	3
BSDC* ZC364	Operating Systems	3
BSDC* ZC413	Database Design	4
BSDC* ZC432	Applied Statistical Methods	3
BSDC* ZC481	Computer Networks	3

Project Type Courses

Course No.	**Course Title**	**Units**
BSDC* ZC229T	Design Project	5
BSDC* ZC499T	Capstone Project	15

B.Sc. (Design & Computing)

Semester-wise Pattern

Course No.	Course Title	Units	Course No.	Course Title	Units
First Year					
BSDC* ZC151	Writing Practice	3	BSDC* ZC231	Dynamics of Social Change	**3**
BSDC* ZC236	Symbolic Logic	3	BSDC* ZC142	Computer Programming	**4**
BSDC* ZC112	Electrical Sciences	**3**	BSDC* ZC222	Discrete Structures for Computer Science	**3**
BSDC* ZC111	Probability & Statistics	3	BSDC* ZC225	Environmental Studies	**3**
	Total	**12**		**Total**	**13**
Second Year					
BSDC* ZC215	Digital Design	4	BSDC* ZC353	Computer Organization and Architecture	**4**
BSDC* ZC356	Data Structures	4	BSDC* ZC313	Object Oriented Programming and Design	**4**
BSDC* ZC234	Linear Algebra & Optimization	3	BSDC* ZC242	Cultural Studies	**3**
BSDC* ZC226	Creative Thinking	3	BSDC* ZC312	Evolution of Design	3
	Total	**14**		**Total**	**14**
Summer Term					
BSDC* ZC229T Design Project5 Units					
Third Year					
BSDC* ZC317	Algorithm Design	**3**	BSDC* ZC412	Software Design Principles	**4**
BSDC* ZC322	Critical Analysis of Literature and Cinema	**3**	BSDC* ZC316	Computing and Design	**3**
BSDC* ZC328	Humanities and Design	**3**	BSDC* ZC355	Statistical Inferences and Applications	**3**
	Elective	3/4		Elective	**3/4**
	Total	**12/13**		**Total**	**13/14**
Fourth Year					
BSDC* ZC311	Information Security	3	BSDC* ZC499T	Capstone Project	**15**
BSDC* ZC365	Human Computer Interaction	**3**			
	Elective	3/4			
	Elective	3/4			
	Total	**12/14**		**Total**	**15**

Note: In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing collaborating organization.

B.Sc. (Engineering Science)

Input Qualification

Trainees/ Employed professionals who have completed their 10+2 (including Math, Physics and Chemistry) educational qualification with minimum of 60% aggregate marks in Math, Physics and Chemistry and having at least 6 months of work experience.

Nominal Duration: Eight semesters

Programme Structure

Foundation Courses

Course No.	Course Title	Units
Humanities Foundation		
ES* ZC116	English Language Practice	3
ES* ZC220	Introduction to Economics	3
Mathematics Foundation		
ES* ZC111	Probability and Statistics	3
ES* ZC131	Engineering Mathematics - I	3
ES* ZC212	Engineering Mathematics - II	3
ES* ZC234	Linear Algebra & Optimization	3
Science and Engineering Foundation		
ES* ZC115	General Physics I	3
ES* ZC117	Chemistry - I	3
ES* ZC118	General Physics II	3
ES* ZC119	General Physics III	3
ES* ZC120	Chemistry - II	3
Other Courses		
ES* ZC142	Computer Programming	4
Foundation course required: 8-12 (Units:24-40)		**37**

Core Courses

Course No.	Course Title	Units
ES* ZC217	Materials Science -I	3
ES* ZC219	Materials Science –II	3
ES* ZC218	Introduction to Thermodynamics & Applications	4
ES* ZC333	Introduction to Transport Phenomena	3
ES* ZC319	Mechanisms	4
ES* ZC227	Basic Electrical and Electronics Engineering	4
ES* ZC320	Introduction to Industrial Instrumentation	4

ES* ZC232	Fundamentals of Engineering Measurements	3
ES* ZC225	Environmental Studies	3
ES* ZC321	Manufacturing Science	4
ES* ZC334	Numerical & Computational Methods	3
ES* ZC335	Integrated Engineering Science	3
Discipline Core Courses Required : 10-16 (Units: 34-58)		**41**

Pool of Electives

Course No.	Course Title	Units
ES* ZC336	Contemporary Manufacturing Processes	4
ES* ZC337	Digital Electronics & Microcontrollers	3
ES* ZC338	Digital Manufacturing	4
ES* ZC339	Engineering Design & Drawing	4
ES* ZC340	Introduction to Supply Chain Management	3
ES* ZC345	Maintenance for Productivity & Safety	3
ES* ZC346	Manufacturing Systems Design & Analysis	4
ES* ZC347	Quality Control & Metrology	4
ES* ZC348	Robotics & Automation	3

Project Type Courses

Course No.	Course Title	Units
ES* ZC229T	Project	5
ES* ZC498T	Capstone Project	10

B.Sc. (Engineering Science)

Semester wise Pattern

Course No.	Course Title	Units	Course No.	Course Title	Units
Semester I			**Semester II**		
First Year					
ES* ZC115	General Physics I	3	ES* ZC118	General Physics II	3
ES* ZC117	Chemistry - I	3	ES* ZC111	Probability and Statistics	3
ES* ZC116	English Language Practice	3	ES* ZC142	Computer Programming	4
ES* ZC131	Engineering Mathematics - I	3	ES* ZC120	Chemistry - II	3
	Total	12		**Total**	13
Second Year					
ES* ZC119	General Physics III	3	ES* ZC212	Engineering Mathematics - II	3
ES* ZC234	Linear Algebra & Optimization	3	ES* ZC218	Introduction to Thermodynamics & Applications	4
ES* ZC217	Materials Science - I	3	ES* ZC219	Materials Science - II	3
ES* ZC227	Basic Electrical & Electronics Engineering	4	ES* ZC220	Introduction to Economics	3
	Total	13		**Total**	13
Summer Term					
ES* ZC229T Project 5 Units					
Third Year					
ES* ZC232	Fundamentals of Engineering Measurements	3	ES* ZC225	Environmental Studies	3
ES* ZC319	Mechanisms	4	ES* ZC320	Introduction to Industrial Instrumentation	4
ES* ZC333	Introduction to Transport Phenomena	3	ES* ZC321	Manufacturing Sciences	4
ES* ZC334	Numerical & Computational Methods	3	ES* ZC335	Integrated Engineering Science	3
	Total	13		**Total**	14
Fourth Year					
	Elective I	3 (min)		Elective V	3 (min)
	Elective II	3 (min)	ES* ZC498T	Capstone Project	10
	Elective III	3 (min)			
	Elective IV	3 (min)			
	Total	12 (min)		**Total**	13 (min)

B.Sc. (Pharmaceutical Sciences)

Type of Input
Trainees / Employed professionals who have completed their 10+2 (including Mathematics/Biology, Physics, and Chemistry as subjects) or equivalent educational qualification, with minimum 60% aggregate marks.
Nominal Duration: Eight semesters

Programme Structure

Foundation Courses

Course No.	Course Title	Units
Humanities Foundation		
PS* ZC221	Business Communication	3
PS* ZC313	Technical Report Writing	3
PS* ZC343	Professional Ethics	3
Mathematics Foundation		
PS* ZC111	Probability and Statistics	3
PS* ZC113	General Mathematics - I	3
PS* ZC114	General Mathematics - II	3
PS* ZC235	Linear Algebra & Optimization	3
Science and Engineering Foundation		
PS* ZC318	Fundamentals of Transport Processes	4
Other Courses		
PS* ZC225	Environmental Studies	3

Core Courses

Course No.	Course Title	Units
PS* ZC112	Human Anatomy and Physiology	3
PS* ZC222	Pharmaceutical Quality & GMP	4
PS* ZC223	Fundamentals of Biochemistry and Microbiology	4
PS* ZC231	Physical and Inorganic Chemistry	3
PS* ZC234	Techniques in Pharmaceutical Analysis	4
PS* ZC241	Pharmaceutical Chemistry	3
PS* ZC244	Physical Pharmacy	3
PS* ZC311	Pharmaceutical Unit Operations – I	3
PS* ZC312	Pharmaceutical Unit Operations – II	3
PS* ZC314	Pharmaceutical Jurisprudence in India	3
PS* ZC331	Pharmaceutical Formulations – I	3
PS* ZC332	Pharmaceutical Formulations – II	4
PS* ZC341	Drug Discovery and Action	4
PS* ZC342	Medicinal Chemistry	3
PS* ZC344	Natural Drugs	3

Pool of Electives

Course No.	Course Title	Units
PS* ZC212	Basic Statistical Process Control	3
PS* ZC213	Scale-up of Pharmaceutical Operations	3
PS* ZC214	Utilities in Pharmaceutical Operations	3
PS* ZC224	Novel Drug Delivery Systems	3
PS* ZC232	Chemistry of Synthetic Drugs	3
PS* ZC233	Pharmaceutical Packaging	3
PS* ZC321	Chemical Process Calculations	3
PS* ZC322	Pharmaceutical Quality by Design	3
PS* ZC323	Sterile Pharmaceutical Products	3
PS* ZC324	Name Reactions in Chemical Synthesis	3
PS* ZC361	Environmental Pollution Control	3
PS* ZC414	Biopharmaceutics	3

Project Type Courses

Course No.	Course Title	Units
PS*ZC229T	Project	5
PS*ZC499T	Capstone Project	15

B.Sc. (Pharmaceutical Sciences)

Semesterwise Pattern

Course No.	Course Title	Units	Course No.	Course Title	Units
First Year					
PS* ZC113	General Mathematics - I	3	PS* ZC114	General Mathematics - II	3
PS* ZC231	Physical & Inorganic Chemistry	3	PS* ZC311	Pharmaceutical Unit Operations- I	3
PS* ZC112	Human Anatomy and Physiology	3	PS* ZC241	Pharmaceutical Chemistry	3
PS* ZC313	Technical Report Writing	3	PS* ZC221	Business Communication	3
	Total	12		**Total**	12
Second Year					
PS* ZC235	Linear Algebra & Optimization	3	PS* ZC111	Probability and Statistics	3
PS* ZC312	Pharmaceutical Unit Operations – II	3	PS* ZC331	Pharmaceutical Formulations – I	3
PS* ZC244	Physical Pharmacy	3	PS* ZC341	Drug Discovery and Action	4
PS* ZC223	Fundamentals of Biochemistry and Microbiology	4	PS* ZC234	Techniques in Pharmaceutical Analysis	4
	Total	13		**Total**	14
Summer Term					
PS* ZC229T Project5 Units					
Third Year					
PS* ZC332	Pharmaceutical Formulations – II	4	PS* ZC318	Fundamentals of Transport Processes	4
PS* ZC342	Medicinal Chemistry	3	PS* ZC344	Natural Drugs	3
PS* ZC314	Pharmaceutical Jurisprudence in India	3	PS* ZC222	Pharmaceutical Quality & GMP	4
	Elective	3/4		Elective	3/4
	Total	13/14		**Total**	14/15
Fourth Year					
PS* ZC343	Professional Ethics	3	PS* ZC499T	Capstone Project	15
PS* ZC225	Environmental Studies	3			
	Elective	3/4			
	Elective	3/4			
	Total	12-14		**Total**	15

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

B.Sc. (Hons) Program Structure

i) **Type of Input:** Students who have completed 10+2. Additional eligibility criteria may be prescribed by specific programs.
ii) **Nominal Duration:** 4 years
iii) **Programme Structure:**

Category	Number of Courses Required	Number of Units Required
I. Foundation Courses		
Mathematics Foundation	3-6	9-18
Science Foundation	1-6	3-20
Humanities Foundation	2-6	4-18
Others	0-3	2-10
Foundation (Sub-Total)	**8-12**	**24-40**
II. Discipline Courses		
Core	**14-21**	**47-67**
Discipline Electives	6 - 12	18-40
III. Open Electives	3-6	9-20
Coursework (Sub-Total)	**39 courses (min)**	**129 units (min)**
IV. Project Courses	1-3	15-20 units
Total	**41 courses (min)**	**144 Units (min)**

B.Sc. (Hons) in Computer Science

i) Input Qualification for the online offering of B.Sc. (Hons) in Computer Science.

Entry Option - 1:

Candidates who have completed 10+2 and seek admission to the B.Sc. (Hons) in Computer Science

For Applicants from India

1) Candidates should have passed the class 12th examination in any stream under the 10+2 system from a recognized central or state board from India or its equivalent.
2) Candidates must have adequate proficiency in Maths. The Candidates Class 12th mark sheet issued by the respective board should show Maths as one of the subjects and that the candidate has secured minimum 60% marks in Maths.

   Or

   Candidates who have either **not studied maths in Class 12th** or **failed to secure minimum 60% marks in Maths in Class 12th** are expected to appear in a qualifying examination in mathematics to be conducted by BITS. The admission offer will be on the basis of the performance in the exam.
3) Candidates must have adequate proficiency in English. All applicants who have studied "English" as a subject till Class 10th will be considered eligible.

For Applicants from other countries:

1) Candidates should have passed the qualifying examination conducted by their respective country's or province's board of higher/senior secondary school education (High School Board) and must obtain an equivalence certificate from Association of Indian Universities that indicates that the certificate issued by their respective country's/province's board of school education is equivalent to class 12 certificate issued from recognized central or state board from India or its equivalent.
2) Candidates must have adequate proficiency in maths. The candidate's final year marks sheet issued by their respective country's / province's high school education board should show maths as one of the subject and that applicant has secured in maths either a minimum 60% marks or a minimum grade point of 6 on a scale of 10.

   Or

   Candidates who have either not studied maths at high school level or failed to secure in maths a minimum 60% marks or a minimum grade point of 6 on a scale of 10 in the final year examination conducted by their respective country's/province's recognised high school board are expected to appear in a qualifying examination in mathematics to be conducted by BITS. The admission offer will be on the basis of the performance in the exam.
3) Candidates must have adequate proficiency in English. **Candidates must have had "English" as the primary medium of instruction for their high school studies.** This will need to be supported by uploading a certificate issued by the school along with the application. **or**

   Must submit a valid IELTS or TOEFL scorecard with the application.

Entry Option - 2:

Candidates who are initially admitted for the B.Sc. in Computer Science programme and are willing to opt for B.Sc. (Hons) in Computer Science:

Option to transition into B.Sc.(Hons) in Computer Science programme will be provided to candidates already admitted to the B.Sc. in Computer Science programme based on their request

Entry Option - 3:

Candidates who have taken intermediate exits from B.Sc. in Computer Science / B.Sc. (Honours) in Computer Science

Candidates who have taken intermediate exits from these programs will be eligible for admission to the B.Sc. (Honours) program in Computer Science, However they have to follow the curriculum at that point in time to

complete the degree requirements. Details of the admission modality and other operational aspects will be worked out and reported to senate.

ii) Programme Structure of B.Sc. (Hons) in Computer Science:

Category	Number of Courses	Units
I. Foundation Courses		
Mathematics Foundation	4	11
Science Foundation	2	5
Humanities Foundation	2	5
Others	2	6
Foundation (Sub-Total)	**10**	**27**
II. Discipline Courses		
Core	16	**53**
Discipline Electives	8(min)	27(min)
III. Open Electives	3(min)	**9**(min)
Coursework (Sub-Total)	**39(min)**	**129 (min)**
IV. Project Courses	2-3	**15/20**
Total	**41(min)**	**144 (min)**

Note: A specialization is awarded when a student chooses 4 Discipline Elective courses, in their VIIth and VIIIth semesters, for a minimum of 14 units, from a pool of courses in that specialization and Mini Project for 5 units. Details regarding specializations are provided later in the document.

iii) Normal Duration: Eight Semesters

iv) Intermediate Exits:

- Intermediate exit is permitted with the award of B.Sc. Computer Science when meeting the curriculum requirements for the same as approved by the Senate
- Intermediate exit is permitted with the award of a Diploma in Software Development when meeting the curriculum requirements for the same as approved by the Senate

v) List of courses & Semester-wise structure

The semester-wise structure and the courses for the B.Sc. (Hons) in Computer Science for the semester I to VI are the same as the structure B.Sc. Computer Science as already approved by the senate. In addition the following discipline electives will be added to the Pool of electives in the B.Sc. Computer Science Programme already approved. A new pool of electives categorised as other electives and a project course called mini Project will also be added additionally in to the B.Sc. (Hons) Computer Science Programme.

Discipline Electives: (22)

Course No.	Course Title	Units
BHCS ZC321	Software Testing and Automation	3
BHCS ZC319	Natural Language Processing	4
BHCS ZC423	Introduction to Social Media Analytics	4
BHCS ZC416	Cryptography	3
BHCS ZG511	Agile Software Processes	4
BHCS ZC418	Distributed Systems	4

BHCS ZC429	Open Source Software	3
BHCS ZC433	Topics in Algorithms and Complexity	4
BHCS ZC324	Compiler Design	4
BHCS ZG512	Network Security	4
BHCS ZC421	Introduction to Machine Learning #	4
BHCS ZC412	Artificial Intelligence #	3
BHCS ZC417	Deep Learning and Applications #	4
BHCS ZC434	Topics in Data Mining#	4
BHCS ZC414	Cloud Computing Fundamentals##	3
BHCS ZC422	Introduction to Networking for Cloud##	3
BHCS ZC420	Introduction to DevOps for Cloud##	4
BHCS ZC430	Scalable Services in Cloud##	4
BHCS ZC413	Backend and API Development###	4
BHCS ZC419	Frontend Development###	3
BHCS ZC415	Cross-platform Applications###	3
BHCS ZC432	Software Deployment###	4

Project Course (1)

Course No.	Course Title	Units
BHCS ZC427T	Mini Project*	5

\# - Mandatory electives for Artificial Intelligence and Machine Learning Specialization
- Mandatory electives for Full-Stack Development Specialization
- Mandatory electives for Cloud Computing Specialization
* - Mandatory elective for all the specializations

Open Electives (9)

Course No.	Course Title	Units
BHCS ZC327	Introduction to Calculus	3
BHCS ZC325	Differential Equations and Applications	3
BHCS ZC320	Numerical Analysis	3
BHCS ZC241	Microprocessors, Programming & Interfacing	4
BHCS ZC328	Introduction to IoT	4
BHCS ZC244	Accounting for Managers	3
BHCS ZC322	Corporate Finance	3
BHCS ZC323	Investment Management	3
BHCS ZC243	Signals & Systems	3

Semester-wise Pattern

Year	First Semester		U		Second Semester	U
I	BCS ZC313	Introduction to Programming	4	BCS ZC311	Data Structures and Algorithms	4
	BCS ZC219	Discrete Mathematics	3	BCS ZC316	Object Oriented Programming	4
	BCS ZC230	Linear Algebra and Optimization	3	BCS ZC215	Command Line Interfaces and Scripting	3
	BCS ZC228	Introduction to Computing Systems	3	BCS ZC233	Probability and Statistics	3
	BCS ZC111	Basic Electronics	2	BCS ZC112	Introduction to Logic	2
	BCS ZC239	Writing Practice	3		Foundation Option 1	3
		Units	18		Units	19
II	BCS ZC212	Algorithm Design	3	BCS ZC232	Operating Systems	3
	BCS ZC317	Relational Databases	4	BCS ZC214	Building Database Applications	3
	BCS ZC238	Web Programming	3	BCS ZC234	Programming Mobile Devices	3
	BCS ZC236	Software Design Principles	4	BCS ZC220	Environmental Studies	3
	BCS ZC216	Computer Systems and Performance	3	BCS ZC222	Formal Languages and Applications	3
		Foundation Option 2	2		Discipline Elective #1	3
		Units	19		Min Units	18
III	BCS ZC211	Software Development Practices	3		Foundation Option 3	3
	BCS ZC231	Network Programming and Client-Server Programming	3		Discipline Elective #4	3/4
		Discipline Elective #2	3/4	BCS ZC428T	Project	10
		Discipline Elective #3	3/4			
	BCS ZC241T	Study Project	5			
		Units	17-19		Units	16-17
IV		Discipline Elective	3/4		Discipline Elective	3/4
		Discipline Elective	3/4		Discipline Elective	3/4
		Open Elective	3/4		Discipline Elective/ Mini Project	3/5
		Open Elective	3/4		Open Elective / Discipline Elective	3/4
		Open Elective/Discipline Elective	3/4		Open Elective / Discipline Elective	3/4
		Discipline Elective$	3/4		Discipline Elective$	3/4
			17-20			17-20
	Minimum Units for Semesters VII and VIII					37

- Courses for Discipline Electives can be chosen from the list of Discipline Electives
  - **$-** These Discipline Electives may be dropped if the minimum required units for the respective

semesters are met by the choice of the remaining five courses.
    - A specialization is awarded when a student chooses 4 Discipline Elective courses, in their VIIth and VIIIth semesters, for a minimum of 14 units, from a pool of courses in that specialization and Mini Project for 5 units
- Open Electives must be chosen from the Open Elective pool.
- A minimum of 4 Discipline Electives (or 4 Discipline Electives and a Mini Project) and 3 Open Electives must be chosen in the VIIth and VIIIth semesters

vi) Details of Specialization

The online B.Sc. (Hons) in Computer Science program offers three specializations to choose from. The Specializations are (1) Artificial Intelligence and Machine Learning (2) Cloud Computing (3) Full-stack Development. The specialization is structured to have four mandatory courses in the specialization area and a mini project in the domain of specialization. The specialization enhances the depth of knowledge and skills in one of the demanding areas and thereby enhances a learner's employable skills. The learner also has the option to choose courses from across the specializations (on offer) and from disciplinary electives to meet his learning needs. The program's structure allows the specializations to be added/updated as required.

The details of each of the specializations are presented below

(1) Title of the Specialization: Artificial Intelligence and Machine Learning

Objective(s):

- To introduce the domain AI, various algorithms and their applications
- To introduce AI and ML concepts and techniques required for data-driven decision-making.

(2) Title of the specialization: Cloud Computing

Objective:
Provide an understanding of cloud computing fundamentals and experience with developing, deploying, and managing cloud applications.

(3) Title of the Specialization: Full-Stack Development
Objective(s):
Enable the students to

- Design and develop end-to-end web applications with full-stack frameworks involving frontend, backend, databases, and APIs as essential components
- Design and develop mobile applications using cross-platform frameworks
- Build, test, deploy, and release the applications using state-of-art DevOps practices and tools
- Understand and apply industry practices in agile software development

Four-semester M.Tech. programmes

Input Qualification:

The students admitted to the proposed four-semester M.Tech. programs must

(i) hold an Integrated First Degree of BITS or its equivalent and

(ii)be employed professionals with adequate work experience in a relevant industry.

Curriculum Requirements for M.Tech. programs

The nature of the input to these programs and the objectives / orientation of Work Integrated Learning Programs are different from those of the on-campus programs. These programs may be offered across a broad spectrum of (i) technical disciplines and specializations with as well as (ii) industry domains and cross-disciplinary subjects. It is also to be observed that learning and coursework in these programs are integrated within a professional / technical environment.

Based on these facts and observations, the curriculum has been designed in such a way to broadly enable different combinations of subjects at a higher degree level. In particular, the structure will enable Departments to offer an M.Tech. program in a broad discipline with or without specialization, or offer an M.Tech. program in a specialized area within a discipline or across multiple disciplines.

A. Completion of the program would require:

i. At least 12 courses (totaling at least 48 units) towards coursework nominally spread over three semesters and

ii. Dissertation (16 units) in one semester, that is usually the final semester.

B. The Department(s) offering a specific program must then categorize the coursework requirement as follows:

i. **Core**: 8 courses / 30 units (max.)

ii. **Specialization** (if applicable):

a. 3 courses / 12 units (min.) to 6 courses / 30 units (max.)

b. Some Specialization courses may be mandatory and some may be electives.

iii. Total of Core and Specialization courses may not exceed 10 courses (and 45 units).

iv. Rest of the coursework requirement may be obtained via general electives within the discipline but not necessarily within the specialization.

v. At most 3 courses out of the total of 12 taken by a student may be at the 4^{th} level – the rest must be higher degree courses (i.e. specifically, 5^{th} or 6^{th} level).

Eight-semester Integrated M.Tech. programme

Curriculum Structure for an Integrated M.Tech. programme:

The curriculum structure and requirements of the eight-semester Integrated M.Tech. programme will include the requirements of the corresponding Integrated First Degree programme and four-semester M.Tech. programme, with the following provisions:

1. The electives requirement of the Integrated First Degree programme will be subsumed by the coursework requirement of the Integrated M.Tech. programme, and
2. The Project Work requirement of the Integrated First Degree programme, will be subsumed by the Dissertation requirement of the Integrated M.Tech. programme.

Given these provisions, the following requirements for the curriculum are proposed:

Category	Number of Courses Required	Number of Units Required
I Foundation Courses	5-10	15-32
II Discipline Courses		
Discipline Core	12-16*	42-66*
Discipline Electives	6-12	20-36
Sub-Total	18 - 22 courses#	64 - 80 units
Course-Work Sub-Total	28 courses (min)	96 units (min)
III DISSERTATION	1	16
Total	29 courses (min)	112 units (min)

* Nominally, each course is of 3 units. But, at least two of the Discipline courses are required to be of 4 units or higher.

\# At least eight of these courses must be Higher Degree courses (i.e. specifically, 5^{th} or 6^{th} level)

Specializations (if applicable)

The Department(s) offering **specializations** within a specific Integrated M.Tech. programme should ensure that the following requirements are met:

1. Specialization (if applicable):
    a. 3 courses / 12 units (min.) to 6 courses / 30 units (max.)
    b. Some specialization courses may be mandatory and some may be electives.
2. Rest of the elective requirements may be obtained through general electives within the discipline, but not necessarily within the specialization.

M.Tech. Artificial Intelligence and Machine Learning

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E. / M.Sc. in relevant math and statistics oriented disciplines, with minimum one-year work experience in IT services and products industry.

Nominal Duration: Four Semesters

Curriculum Requirements:

Completion of the programme would require:
(a) 12 courses (totalling a minimum of 48 units) towards course work, and
(b) Dissertation (16 Units)
(c) Specializations available: Deep Learning, Natural Language Processing. [Students may graduate without any specialization.]

Programme Structure:

Core Courses

Course No.	Course Title	Units
AIML* ZC416	Mathematical Foundations for Machine Learning	4
AIML* ZC418	Introduction to Statistical Methods	4
AIML* ZG511	Deep Neural Networks	4
AIML* ZG512	Deep Reinforcement Learning	4
AIML* ZG557	Artificial and Computational Intelligence	5
AIML* ZG565	Machine Learning	4

Pool of Electives

Course No.	Course Title	Units
AIML* ZG523	MLOps	4
AIML* ZG524	Design of Algorithms	5
AIML* ZG525	Computer Vision	4
AIML* ZG526	Probabilistic Graphical Models	4
AIML* ZG527	Audio Analytics	4
AIML* ZG528	AI and ML for Robotics	4
AIML* ZG529	Data Management for Machine Learning	4
AIML* ZG531	Video Analytics	4
AIML* ZG532	Automated Reasoning	4
AIML* ZG548	Advanced Data Mining	4
AIML* ZG567	AI and ML techniques for Cyber Security	5
AIML* ZG577	Metaheuristics for Optimization	4

The following specializations are proposed for M.Tech. in Artificial Intelligence and Machine Learning

Specializations	Existing/New Specialization
Deep Learning	New
NLP	New

Pool of Electives for specialization 1: Deep Learning Specialization

Course No.	Course Title	Units
AIML* ZG513	Advanced Deep learning #	4
AIML* ZG514	Graph Neural Networks	4
AIML* ZG515	Distributed Machine Learning	4
AIML* ZG516	ML System Optimization	4
AIML* ZG517	Fair, Accountable, Transparent Machine Learning	4
AIML* ZG518	Computational Learning Theory	4

Note: 3 courses are required including the course marked in #

Pool of Electives for specialization 2: NLP Specialization

Course No.	Course Title	Units
AIML* ZG519	NLP Applications	4
AIML* ZG520	Speech Processing	4
AIML* ZG521	Conversational AI	4
AIML* ZG522	Social Media Analytics	4
AIML* ZG530	Natural Language Processing #	4
AIML* ZG537	Information Retrieval	4

Note: 3 courses are required including those marked with #

Project

Course No.	Course Title	Units
AIML* ZG628T	Dissertation	16

Semester-wise pattern of courses

Year	First Semester			Second Semester		
	Course No.	Course Title	Units	Course No.	Course Title	Units
I	AIML* ZC416	Mathematical Foundations for Machine Learning	4	AIML* ZG511	Deep Neural Networks	4
	AIML* ZC418	Introduction to Statistical Methods	4	AIML* ZG512	Deep Reinforcement Learning	4
	AIML* ZG557	Artificial and Computational Intelligence	5		Elective 1	
	AIML* ZG565	Machine Learning	4		Elective 2	
		Total	17		Total	16
II		Elective 3		AIML* ZG628T	Dissertation	16
		Elective 4				
		Elective 5				
		Elective 6				
		Total	16		Total	16

M. Tech. (Automotive Electronics)

Type of Input: Employed professionals holding a B.E./B.Tech. degree in Automotive/ EEE /ECE/Instrumentation/Mechatronics or equivalent, with minimum one year work experience in relevant domains.

Nominal Duration: Four Semesters

Programme Structure:

Core Courses

Course No.	Course Title	Units
AEL* ZC441	Automotive Vehicles	3
AEL* ZC442	Advanced Driver Assistance Systems	4
AEL* ZG510	Automotive Control Systems	5
AEL* ZG512	Embedded System Design	4
AEL* ZG513	Automotive Communication Systems	5
AEL* ZG533	Autotronics	5
AEL* ZG534	Automotive Networking	4

Pool of Electives

Course No.	Course Title	Units
AEL* ZC443	Connected Cars	4
AEL* ZG514	Robust and Intelligent Systems Design	5
AEL* ZG517	Automotive Systems Engineering	4
AEL* ZG518	Electric and Hybrid Vehicles	4
AEL* ZG519	Automotive Security	4
AEL* ZG531	Product Design	5
AEL* ZG554	Reconfigurable Computing	5
AEL* ZG557	Artificial and Computational Intelligence	5
AEL* ZG621	Safety Critical Advanced Automotive Systems	4
AEL* ZG626	Hardware Software Co-Design	5
AEL* ZG631	Automotive Diagnostics and Interfaces	5

Dissertation

Course No.	Course Title	Units
AEL* ZG628T	Dissertation	16

M. Tech. (Automotive Electronics)

Semesterwise pattern

Year	First Semester			Second Semester		
	Course No.	**Course Title**	**Units**	**Course No.**	**Course Title**	**Units**
I	AEL* ZC441	Automotive Vehicles	3	AEL* ZG510	Automotive Control Systems	5
	AEL* ZG533	Autotronics	5	AEL* ZG513	Automotive Communication Systems	5
	AEL* ZG512	Embedded System Design	4	AEL* ZG534	Automotive Networking	4
	AEL* ZC442	Advanced Driver Assistance Systems	4		Elective I	4/5
	Total		16	Total		18-19
II		Elective II	4/5	AEL* ZG628T	Dissertation	16
		Elective III	4/5			
		Elective IV	4/5			
		Elective V	4/5			
	Total		16-20	Total		16

M. Tech. Automotive Engineering

Curriculum Structure

Type of Input: Employed professionals in Automotive Industries and holding an Integrated First Degree of BITS in Mechanical Engineering or Electrical & Electronics Engineering or its equivalent, with minimum one-year work experience in relevant domains.

Nominal Duration: Four Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core courses: (5)

Course No.	Course Title	Units
AE ZG516	Advances in IC Engines	4
AE ZG524	Vehicle Dynamics	4
AE ZG517	Automotive Systems Engineering	4
AE ZG533	Autotronics	5
AE ZG518	Electric and Hybrid Vehicles	4

Pool of electives: (19)

Course No.	Course Title	Units
AE ZG633	Advances in Vehicle Body Structures	4
AE ZG621	Durability, Crash & Safety Engineering	4
AE ZG612	Advances in Materials, Composites & Plastics	4
AE ZG522	Advanced Vehicle Acoustics	4
AE ZG512	Embedded System Design	4
AE ZG519	Automotive Security	4
AE ZC442	Advanced Driver Assistance Systems	4
AE ZC443	Connected Cars	4
AE ZG614	Fracture Mechanics	5
AE ZG523	Project Management	4
AE ZG532	Computer Aided Engineering	5
AE ZG531	Product Design	5
AE ZG510	Automotive Control Systems	5
AE ZG535	Advanced Engineering Mathematics	5
AE ZG616	Applied Digital Signal Processing	5
AE ZG521	Power Electronics and Drives	4

AE ZG631	Automotive Diagnostics & Interfaces	5
AE ZG623	Safety Critical Advanced Automotive Systems	4
AE ZG557	Artificial and Computational Intelligence	5

Semester-wise pattern of courses

Year	First Semester			Second Semester		
	Course #	**Course Title**	**Units**	**Course #**	**Course Title**	**Units**
I	AE ZG533	Autotronics	5	AE ZG518	Electric and Hybrid Vehicles	4
	AE ZG516	Advances in IC Engines	4		Elective II	5
	AE ZG524	Vehicle Dynamics	4		Elective III	4-5
		Elective I	4-5		Elective IV	4-5
		Total	17 (min)		Total	17 (min)
II	AE ZG517	Automotive Systems Engineering	4	AE ZG628T	Dissertation	16
		Elective V	4-5			
		Elective VI	4-5			
		Elective VII	4-5			
		Total	16 (min)		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Tata Technologies and Tata Motors, Pune; Mercedes Benz, Bangalore

M.Tech. (Cloud Computing)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E. / M. Sc. with minimum one-year work experience in IT services and products industry with experience in computing, especially systems and programming is expected.

Nominal Duration: Four Semesters

Curriculum Requirements:

Completion of the programme would require:
(a) 12 courses (totaling a minimum of 48 units) towards course work, and
(b) Dissertation (16 Units)

Programme Structure

Core Courses (6)

Course No.	Course Title	Units
CC* ZG501	Introduction to Parallel and Distributed Programming	4
CC* ZG502	Cloud Infrastructure and Systems Software	5
CC* ZG503	Network Fundamentals for Cloud	4
CC* ZG522	Big Data Systems	5
CC* ZG526	Distributed Computing	5
CC* ZG527	Cloud Computing	5

Pool of Electives (13)

Course No.	Course Title	Units
CC* ZC447	Data Storage Technology and Networks	4
CC* ZG504	Security Fundamentals for Cloud	4
CC* ZG505	Cloud Economics	4
CC* ZG506	API-driven Cloud Native Solutions	5
CC* ZG507	DevOps for Cloud	5
CC* ZG508	Design and Operation of Data Centers	5
CC* ZG515	Data Warehousing	5
CC* ZG532	Introduction to Data Science	5
CC* ZG538	Infrastructure Management	4
CC* ZG556	Stream Processing and Analytics	5
CC* ZG566	Secure Software Engineering	5
CC* ZG583	Scalable Services	5
CC* ZG586	Edge Computing	5

Course No.	Course Title	Units
CC* ZG628T	Dissertation	16

Semester-wise pattern of courses

Year	First Semester			Second Semester		
	Course No.	**Course Title**	**Units**	**Course No.**	**Course Title**	**Units**
I	CC* ZG501	Introduction to Parallel and Distributed Programming	4	CC* ZG502	Cloud Infrastructure and Systems Software	5
	CC* ZG503	Network Fundamentals for Cloud	4	CC* ZG526	Distributed Computing	5
	CC* ZG522	Big Data Systems	5		Elective 1	
	CC* ZG527	Cloud Computing	5		Elective 2	
		Total	18		Total	Min 18
II		Elective 3		CC* ZG628T	Dissertation	16
		Elective 4				
		Elective 5				
		Elective 6				
		Total	Min 18		Total	16

M. Tech. (Computing Systems & Infrastructure)

Curriculum

Type of Input

The students admitted to the M.Tech. Computing Systems & Infrastructure programme must:

(i) Hold an Integrated First Degree of BITS or its equivalent in relevant disciplines, and

(ii) Be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: Four Semesters

Programme Structure

Core Courses (6)

Course No.	Course Title	Units
CSI* ZG525	Advanced Computer Networks	5
CSI* ZG527	Cloud Computing	5
CSI* ZG522	Design and Operation of Data Centers	5
CSI* ZG538	Infrastructure Management	4
CSI* ZG524	Middleware Technologies	4
CSI* ZG513	Network Security	4

Pool of Electives (11)

Course No.	Course Title	Units
CSI* ZC447	Data Storage Technologies and Networks	4
CSI* ZC463	Cryptography	3
CSI* ZG511	IT Infrastructure Projects & Processes	3
CSI* ZG523	Introduction to Data Science	3
CSI* ZG528	Cyber Physical Systems	4
CSI* ZG514	Data Warehousing	5
CSI* ZG515	Introduction to DevOps	4
CSI* ZC462	Network Programming	3
CSI* ZG656	Networked Embedded Applications	4
CSI* ZG533	Service-Oriented Computing	4
CSI* ZC424	Software Development for Portable Devices	3
CSI* ZG582	Telecom Network Management	5
CSI* ZG526	Web Technologies	4
CSI* ZG520	Wireless & Mobile Communication	5
CSI* ZG518	Database Design & Applications	5

M. Tech. (Computing Systems & Infrastructure)

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	CSI* ZG513	Network Security	4	CSI* ZG522	Design and Operation of Data Centers	5
	CSI* ZG527	Cloud Computing	5	CSI* ZG525	Advanced Computer Networks	5
		Elective 1	(3 min)		Elective 3	(3 min)
		Elective 2	(3 min)		Elective 4	(3 min)
		Total	15		Total	16
II	CSI* ZG524	Middleware Technologies	4	CSI* ZG628T	Dissertation	16
	CSI* ZG538	Infrastructure Management	4			
		Elective 5	(3 min)			
		Elective 6	(3 min)			
		Total	14		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Wipro Bangalore

Integrated M. Tech. (Computing Systems & Infrastructure)

Type of Input

The students admitted to the Integrated M.Tech. Computing Systems & Infrastructure programme must:

(i) Hold a B.Sc. / BCA degree or its equivalent in relevant disciplines with adequate background in Mathematics, and

(ii) Be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: Eight Semesters

Programme Structure

Foundation Courses (5)

	Course NO.	Course Title	Units
Mathematics Foundation	CSI* ZC132	Linear Algebra & Optimization	3
	CSI* ZC213	Probability & Statistics	3
	CSI* ZC252	Discrete Structures for Computer Science	3
Engineering Foundation	CSI* ZC263	Digital Electronics & Microprocessors	4
Technical Arts / Professional Course	CSI* ZC163	Computer Programming	4

Core Courses (15)

Course No.	Course Title	Units
CSI* ZG525	Advanced Computer Networks	5
CSI* ZG527	Cloud Computing	5
CSI* ZC467	Computer Networks	4
CSI* ZC353	Computer Organization & Architecture	4
CSI* ZC447	Data Storage Technologies & Networks	4
CSI* ZC363	Data Structures & Algorithms	4
CSI* ZC337	Database Systems & Applications	4
CSI* ZG522	Design and Operation of Data Centers	5
CSI* ZG538	Infrastructure Management	4
CSI* ZG511	IT Infrastructure Projects & Processes	3
CSI* ZG524	Middleware Technologies	4
CSI* ZG513	Network Security	4
CSI* ZC313	Object Oriented Programming & Design	4
CSI* ZC364	Operating Systems	4
CSI* ZC327	Systems Programming	4

Pool of Electives (13)

Course No.	Course Title	Units
CSI* ZC311	Information Security	3
CSI* ZC424	Software Development for Portable Devices	3
CSI* ZC447	Data Storage Technology and Networks	4
CSI* ZC462	Network Programming	3
CSI* ZC463	Cryptography	3
CSI* ZG514	Data Warehousing	5
CSI* ZG515	Introduction to DevOps	4
CSI* ZG520	Wireless & Mobile Communication	5
CSI* ZG523	Introduction to Data Science	3
CSI* ZG526	Web Technologies	4
CSI* ZG528	Cyber Physical Systems	4
CSI* ZG532	Introduction to Data Science	5
CSI* ZG533	Service Oriented Computing	4
CSI* ZG582	Telecom Network Management	5
CSI* ZG656	Networked Embedded Applications	4

Integrated M. Tech. (Computing Systems & Infrastructure)

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	CSI* ZC132	Linear Algebra & Optimization	3	CSI* ZC213	Probability & Statistics	3
	CSI* ZC252	Discrete Structures for Computer Science	3	CSI* ZC353	Computer Organization & Architecture	4
	CSI* ZC163	Computer Programming	4	CSI* ZC363	Data Structures & Algorithms	4
	CSI* ZC263	Digital Electronics & Microprocessors	4	CSI* ZC327	Systems Programming	4
		Total	**14**		**Total**	**15**
II	CSI* ZC337	Database Systems & Applications	4	CSI* ZC313	Object Oriented Programming & Design	4
	CSI* ZC364	Operating Systems	4	CSI* ZC447	Data Storage Technologies & Networks	4
	CSI* ZC467	Computer Networks	4	CSI* ZG511	IT Infrastructure Projects & Processes	3
		Elective 1	(3 min)		Elective 2	(3 min)
		Total	**15 (min)**		**Total**	**(13 min)**
III	CSI* ZG513	Network Security	4	CSI* ZG522	Design and Operation of Data Centers	5
	CSI* ZG525	Advanced Computer Networks	5	CSI* ZG538	Infrastructure Management	4
	CSI* ZG527	Cloud Computing	5		Elective 4	(3 min)
		Elective 3	(3 min)		Elective 5	(3 min)
		Total	**(17 min)**		**Total**	**(15 min)**
IV	CSI* ZG524	Middleware Technologies	4	CSI* ZG628T	Dissertation	16
		Elective 6	(3 min)			
		Elective 7	(3 min)			
		Elective 8	(3 min)			
		Total	**(13 min)**		**Total**	**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Wipro Bangalore

M.Tech. (Data Science & Engineering)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ B.Tech. or M.Sc. / MCA with minimum one-year work experience in relevant domains.

Nominal Duration: Four Semesters

Programme Structure

Core Courses (6)

Course No.	Course Title	Units
DSE* ZC416	Mathematical Foundation for Data Science	4
DSE* ZC418	Introduction to Statistical Methods	4
DSE* ZG516	Computer Organization and Software Systems	5
DSE* ZG519	Data Structures and Algorithm Design	5
DSE* ZG522	Big Data Systems	5
DSE* ZG532	Introduction to Data Science	5

Pool of Electives

Course No.	Course Title	Units
DSE* ZG515	Data Warehousing	5
DSE* ZG521	Graphs – Algorithms and Mining	5
DSE* ZG524	Deep Learning	4
DSE* ZG526	Probabilistic Graphical Models	4
DSE* ZG527	Ethics for Data Science	4
DSE* ZG528	Optimization Techniques for Analytics	5
DSE* ZG529	Data Management for Machine Learning	4
DSE* ZG530	Natural Language Processing	4
DSE* ZG531	Design of Experiments for Data Science	4
DSE* ZG537	Information Retrieval	4
DSE* ZG555	Data Visualization and Interpretation	5
DSE* ZG556	Stream Processing and Analytics	5
DSE* ZG557	Artificial and Computational Intelligence	5
DSE* ZG565	Machine Learning #*	4
DSE* ZG568	Applied Machine Learning #*	4

Machine Learning course is a prerequisite for Deep Learning elective course.

Project

Course No.	Course Title	Units
DSE* ZG628T	Dissertation	16

Semester wise pattern of courses

Year	First Semester			Second Semester		
	Course No.	**Course Title**	**Units**	**Course No.**	**Course Title**	**Units**
I	DSE* ZC416	Mathematical foundations for Data Science	4	DSE* ZC418	Introduction to Statistical Methods	4
	DSE* ZG532	Introduction to Data Science	5		Elective - I	
	DSE* ZG516	Computer Organization and System Software	5		Elective - II	
	DSE* ZG519	Data Structures and Algorithm Design	5		Elective - III	
		Total	19		Total	16 (min)
II	DSE* ZG522	Big Data Systems	5	DSE* ZG628T	Dissertation	16
		Elective - IV				
		Elective - V				
		Elective - VI				
		Total	16 (min)		Total	16

Note: In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing collaborating organization.

M. Tech. Design Engineering

Curriculum Structure

Input Requirements

The students admitted to the four-semester M.Tech. Design Engineering must:

(i) hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. in relevant disciplines, and

(ii) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (5)

Course No.	Course Title	Units
DE* ZG512	Finite Element Methods	5
DE* ZG541	Product Design	5
DE* ZG561	Mechanisms and Robotics	5
DE* ZG611	Dynamics & Vibrations	5
DE* ZG631	Materials Technology & Testing	5

Pool of Electives (7)

Course No.	Course Title	Units
DE* ZC415	Introduction to MEMS	4
DE* ZG511	Mechatronics	5
DE* ZG513	Tribology	5
DE* ZG514	Fracture Mechanics	5
DE* ZG515	Computational Fluid Dynamics	5
DE* ZG521	World-Class Manufacturing	5
DE* ZG522	Advanced Composites	5
DE* ZG523	Project Management	4
DE* ZG525	Mechanical System Design	5
DE* ZG531	Concurrent Engineering	5
DE* ZG532	Quality Assurance and Reliability	5
DE* ZG535	Advanced Engineering Mathematics	5
DE* ZG542	Machine Tool Engineering	5

DE* ZG544	Design for Additive Manufacturing	5
DE* ZG545	Advanced Control Engineering	5
DE* ZG546	Model Based System Design	5
DE* ZG548	Design for Industrial Internet of Things	5
DE* ZG612	Advanced Finite Element Modelling & Analysis	5
DE* ZG621	Computer Aided Analysis & Design	5
DE* ZG641	Theory of Elasticity and Plasticity	5

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	DE* ZG541	Product Design	5	DE* ZG512	Finite Element Methods	5
	DE* ZG631	Materials Technology & Testing	5	DE* ZG611	Dynamics & Vibrations	5
		Elective	4 (min)		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	**18 (min)**		**Total**	**18 (Min)**
II	DE* ZG561	Mechanisms & Robotics	5	DE* ZG628T	Dissertation	16
		Elective	4 (min)			
		Elective	4 (min)			
		Elective	4 (min)			
		Total	**17 (min)**		**Total**	**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Designed for the HRD needs of a diverse spectrum of Engineering Industries. Collaborating Organizations: SKF and John Deere, Pune

M.Tech. (Digital Manufacturing)

Input Requirements

The students admitted to the four-semester M.Tech. Digital Manufacturing must:

(i) hold a B.E. / B.Tech. degree in EEE/Instrumentation/Mechatronics relevant disciplines, and

(ii) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards course work and
b) Dissertation (16 units)

The course work requirement for the programme would consist of a set of core courses (7) and elective courses (at least 5). The core course requirement is mandatory for all students in the programme. Rest of the course work must be completed through elective courses.

Programme Structure

Core Courses

Course No	Course Title	Units
DM* ZC472	Precision Engineering	3
DM* ZG511	Mechatronics	5
DM* ZG521	Design for Additive Manufacturing	5
DM* ZG531	High Precision Manufacturing	4
DM* ZG612	Advances in Materials, Composites and Plastics	4
DM* ZG622	Industrial IoT	4
DM* ZG631	Additive Manufacturing Process	5

Electives

Course No	Course Name	Units
DM* ZC412	Flexible Manufacturing Systems	4
DM* ZG512	Embedded System Design	4
DM* ZG522	Behavioral Operations	4
DM* ZG532	Big Data Analytics in Manufacturing	4
DM* ZG533	Manufacturing Planning and Control	5
DM* ZG534	Sustainable Manufacturing	5
DM* ZG535	Cyber Security in Manufacturing	4
DM* ZG541	Product Design	5
DM* ZG561	Mechanisms and Robotics	5

M.Tech. (Digital Manufacturing)

Semester-wise Pattern

Year	Course No.	Course Title	U	Course No.	Course Title	U
I	**Semester I**			**Semester II**		
	DM* ZG511	Mechatronics	**5**	DM* ZC472	Precision Engineering	**3**
	DM* ZG521	Design for Additive Manufacturing	**5**	DM* ZG612	Advances in Materials, Composites and Plastics	**4**
	DM* ZG531	High Precision Manufacturing	**4**	DM* ZG622	Industrial IoT	**4**
		Elective – 1	**4 (min)**		Elective – 2	**4 (min)**
		Total	**18 (min)**		**Total**	**15 (min)**
II	**Semester III**			**Semester IV**		
	DM* ZG631	Additive Manufacturing Process	**5**	DM* ZG629T	Dissertation	**16**
		Elective – 3	**4 (min)**			
		Elective – 4	**4 (min)**			
		Elective – 5	**4 (min)**			
		Total	**17 (min)**		**Total**	**16**

M.Tech. (Embedded Systems)

Input Requirements

The students admitted to the four-semester M.Tech. Embedded Systems must:

(i) Employed Professionals holding an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, and

(ii) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (4)

Course No.	Course Title	Units
ES* ZC424	Software for Embedded Systems	3
ES* ZG512	Embedded System Design	4
ES* ZG553	Real Time Systems	5
ES* ZG641	Hardware Software Co-Design	5

Pool of Electives (25)

Course No.	Course Title	Units
ES* ZC441	Robotics	3
ES* ZC447	Data Storage Technologies & Networks	4
ES* ZC481	Computer Networks	4
ES* ZG511	Mechatronics	5
ES* ZG513	Network Security	4
ES* ZG514	Mechanisms & Robotics	5
ES* ZG520	Wireless & Mobile Communication	5
ES* ZG523	Project Management	4
ES* ZG524	Real Time Operating Systems	5
ES* ZG525	Avionics Systems	5
ES* ZG526	Advanced Computer Networks	5

Course No.	Course Title	Units
ES* ZG531	Pervasive Computing	4
ES* ZG532	Testability for VLSI	5
ES* ZG545	Control & Instrumentation for Systems	5
ES* ZG554	Reconfigurable Computing	5
ES* ZG556	DSP Based Control of Electric Drives	3
ES* ZG571	Optical Communication	5
ES* ZG573	Digital Signal Processing	3
ES* ZG611	Advanced Control Systems	5
ES* ZG612	Fault Tolerant System Design	5
ES* ZG613	Advanced Digital Signal Processing	5
ES* ZG621	VLSI Design	5
ES* ZG625	Safety Critical Embedded System Design	4
ES* ZG642	VLSI Architecture	4
ES* ZG651	Networked Embedded Applications	4

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization.

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	ES* ZG512	Embedded System Design	4	ES* ZC424	Software for Embedded System	3
	ES* ZG553	Real Time Systems	5		Elective	(3 min)
		Elective	(3 min)		Elective	(3 min)
		Elective	(3 min)		Elective	(3 min)
		Total	15 (min)		Total	12 (min)
II	ES* ZG641	Hardware Software Co-Design	5	ES* ZG628T	Dissertation	16
		Elective	(3 min)			
		Elective	(3 min)			
		Elective	(3 min)			
		Total	14 (min)		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Cisco, Bangalore; UTC Bangalore and Hyderabad

M.Tech. (Environmental Engineering)

Input requirements

Employed Professionals with minimum one year work experience in Environmental Science / Engineering and allied areas holding an Integrated First Degree of BITS or its equivalent such as B.E / B.Tech / or M.Sc. in relevant disciplines (Chemistry, Chemical Engineering, Civil Engineering, Biology, Microbiology, Biotechnology, Mechanical Engineering) with adequate preparation in Mathematics.

Normal Duration: 4 Semesters

Core Courses (5)

Course No	Course Title	Units
EE* ZG511	Environmental Chemistry	5
EE* ZG512	Environmental Biotechnology	5
EE* ZG513	Applied Transport Phenomena	5
EE* ZG514	Environmental Sampling and Analytical Methods	5
EE* ZG515	Environmental Management Systems	5

Pool of Electives (10)

Course No	Course Title	Units
EE* ZG521	Physico – Chemical Treatment Principles & Design for Wastewater systems	4
EE* ZG522	Biological Treatment Principles & Design for Wastewater systems	4
EE* ZG523	Environmental Statistics	4
EE* ZG611	Energy Generation and Management in Waste Treatment Plants	4
EE* ZG612	Environmental Remote Sensing and GIS	4
EE* ZG613	Environmental Systems Modelling	4
EE* ZG614	Air Pollution Control Technologies	4
EE* ZG621	Solid Waste Management	4
EE* ZG622	Environmental Process Engineering	4
EE* ZG623	Environmental Impact and Risk Assessment	4

M.Tech. Environmental Engineering

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	EE* ZG511	Environmental Chemistry	5	EE* ZG512	Environmental Biotechnology	5
	EE* ZG515	Environmental Management Systems	5		Elective	(4 min)
		Elective	(4 min)		Elective	(4 min)
		Elective	(4 min)		Elective	(4 min)
Total			18 (min)	Total		17 (min)
II	EE* ZG513	Applied Transport Phenomena	5	EE* ZG628T	Dissertation	16
	EE* ZG514	Environmental Sampling and Analytical Methods	5			
		Elective	(4 min)			
		Elective	(4 min)			
Total			18 (min)	Total		16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Goa Pollution Control Board, Goa

M.Tech. Manufacturing Management

Curriculum Structure

Input Qualification

The students admitted to the four-semester M.Tech. in Manufacturing Management must:

(i) hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, and

(ii) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Manufacturing Management Core (7)

Course No.	Course Title	Units
MM ZG515	Quantitative Methods	4
MM ZG522	Total Quality Management	4
MM ZG523	Project Management	4
MM ZG533	Manufacturing Planning and Control	5
MM ZG537	Lean Manufacturing	5
MM ZG541	Product Design	5
MM ZG621	Supply Chain Management	4

Pool of Electives (7)

Course No.	Course Title	Units
MM ZC412	Flexible Manufacturing Systems	4
MM ZC441	Human Resource Management *	4
MM ZC448	Additive Manufacturing	4
MM ZC449	IoT in Manufacturing	4
MM ZC472	Precision Engineering	3
MM ZG512	Manufacturing Strategy	4
MM ZG513	Maintenance Engineering	5
MM ZG514	Leadership and Managing Change *	4
MM ZG534	Sustainable Manufacturing	4

MM ZG535	Decision Analysis	4
MM ZG539	Six Sigma	4
MM ZG611	Strategic Management & Business Policy *****	4
MM ZG627	Managerial Corporate Finance *****	4

Note: A student may be allowed to take upto 3 courses from among the specified management domain electives which are indicated by an '*****'.

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	MM ZG533	Manufacturing Planning & Control	5	MM ZG621	Supply Chain Management	4
	MM ZG522	Total Quality Management	4	MM ZG537	Lean Manufacturing	5
	MM ZG515	Quantitative Methods	4	MM ZG523	Project Management	4
	MM ZG541	Product Design	5		Elective	4 (min)
		Total	18		Total	17(min)
II		Elective	4 (min)	MM ZG628T	Dissertation	16
		Elective	4 (min)			
		Elective	4 (min)			
		Elective	4 (min)			
		Total	16(min)		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. (Microelectronics)

Curriculum Structure

Input Requirements

The students admitted to the four-semester M.Tech. Microelectronics must:

(iii) hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, and

(iv) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (5)

Course No.	Course Title	Units
MEL* ZG611	IC Fabrication Technology	5
MEL* ZG621	VLSI Design	5
MEL* ZG631	Physics & Modeling of Microelectronic Devices	5
MEL* ZG632	Analog IC Design	5
MEL* ZG641	CAD for IC Design	5

Pool of Electives (17)

Course No.	Course Title	Units
MEL* ZC415	Introduction to MEMS	4
MEL* ZG510	RF Microelectronics	5
MEL* ZG511	Design & Analysis of Algorithms	5
MEL* ZG512	Optoelectronic Devices, Circuit & Systems	5
MEL* ZG520	Wireless & Mobile Communication	5
MEL* ZG524	Real Time Operating Systems	5
MEL* ZG526	Embedded System Design	4
MEL* ZG531	Testability for VLSI	5
MEL* ZG553	Real Time Systems	5
MEL* ZG554	Reconfigurable Computing	5
MEL* ZG573	Digital Signal Processing	3
MEL* ZG613	Advanced Digital Signal Processing	5
MEL* ZG623	Advanced VLSI Design	5
MEL* ZG625	Advanced Analog and Mixed Signal Design	5

MEL* ZG642	VLSI Architecture	4
MEL* ZG651	Hardware Software Co-Design	5
MEL* ZG652	Networked Embedded Applications	4

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization

Semesterwise Pattern

Year	First Semester		U	Second Semester		U
I	MEL* ZG621	VLSI Design	5	MEL* ZG611	IC Fabrication Technology	5
	MEL* ZG631	Physics & Modeling of Microelectronic Devices	5	MEL* ZG632	Analog IC Design	5
		Elective	(4 min)	MEL* ZG641	CAD for IC Design	5
		Elective	(4 min)		Elective	(5 min)
		Total	18 (min)		Total	20 (min)
II		Elective	(4 min)	MEL*ZG628T	Dissertation	16
		Elective	5 (min)			
		Elective	5 (min)			
		Elective	5 (min)			
		Total	19 (min)		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Samsung, Gurgaon

Integrated M.Tech. (Microelectronics)

Normal Duration: Eight Semesters

Type of Input: The students admitted to the Integrated M.Tech. Microelectronics programme must:

(a) hold a B.Sc. degree or its equivalent in relevant disciplines with adequate coursework in Mathematics and Physics

(b) be employed professionals with minimum one-year work experience in relevant domains.

Curriculum structure

Foundation Courses: (6)

Type of foundation	Course No.	Course Title	Units
Mathematics Foundation	MEL* ZC234	Linear Algebra and Optimization	3
	MEL* ZC222	Discrete Structures for Computer Science	3
	MEL* ZC111	Probability & Statistics	3
Engineering Foundation	MEL* ZC112	Electrical Sciences	3
	MEL* ZC411	Signals and Systems	3
Technical Arts/Professional Course	MEL* ZC164	Computer Programming	4

Core Courses: (13)

Course No.	Course Title	Units
MEL* ZC215	Digital Design	4
MEL* ZC363	Data Structures and Algorithms	4
MEL* ZC321	Control Systems	3
MEL* ZC244	Microelectronic Circuits	3
MEL* ZC241	Microprocessor and Interfacing	4
MEL* ZC364	Analog Electronics	4
MEL* ZC342	Computer Architecture	4
MEL* ZG573	Digital Signal Processing	3
MEL* ZG621	VLSI Design	5
MEL* ZG631	Physics & Modeling of Microelectronic Devices	5
MEL* ZG611	IC Fabrication Technology	5
MEL* ZG632	Analog IC Design	5
MEL* ZG641	CAD for IC Design	5

Pool of Electives: (22)

Course No.	Course Title	Units
3rd and 4th level courses		
MEL* ZC464	Machine Learning	3
MEL* ZC382	Communication Systems	4
MEL* ZC214	Electronic Devices	3
MEL* ZC444	Artificial Intelligence	3
MEL* ZC415	Introduction to MEMS	4
MEL* ZC477	Modeling of Field Effect Nano-Devices	3
5th and 6th level courses		
MEL* ZG510	RF Microelectronics	5
MEL* ZG511	Design & Analysis of Algorithms	5
MEL* ZG512	Optoelectronic Devices, Circuit & Systems	5
MEL* ZG520	Wireless & Mobile Communication	5
MEL* ZG526	Embedded System Design	4
MEL* ZG531	Testability for VLSI	5
MEL* ZG553	Real Time Systems	5
MEL* ZG554	Reconfigurable Computing	5
MEL* ZG613	Advanced Digital Signal Processing	5
MEL* ZG623	Advanced VLSI Design	5
MEL* ZG625	Advanced Analog and Mixed Signal Design	5
MEL* ZG642	VLSI Architecture	4
MEL* ZG651	Hardware Software co-Design	5
MEL* ZG656	Networked Embedded Applications	4
MEL* ZG626	High-Speed Signaling: Jitter Modeling, Analysis, and Budgeting	4
MEL* ZG627	Power Integrity Analysis and Management for Integrated Circuits	4

Integrated M.Tech. (Microelectronics)

Semester wise Pattern

Year	Course No.	Course Title	U	Course No.	Course Title	U
		Semester I			**Semester II**	
I	MEL* ZC234	Linear Algebra and Optimization	**3**	MEL* ZC111	Probability & Statistics	**3**
	MEL* ZC112	Electrical Sciences	**3**	MEL* ZC215	Digital Design	**4**
	MEL* ZC164	Computer Programming	**4**	MEL* ZC363	Data Structures and Algorithm	**4**
	MEL* ZC222	Discrete Structures for Computer Science	**3**	MEL* ZC321	Control Systems	**3**
		Total	**13**		**Total**	**14**
		Semester III			**Semester IV**	
II	MEL* ZC244	Microelectronic Circuits	**3**	MEL* ZC364	Analog Electronics	**4**
	MEL* ZC411	Signals & Systems	**3**	MEL* ZG573	Digital Signal Processing	**3**
	MEL* ZC241	Microprocessor and Interfacing	**4**	MEL* ZC342	Computer Architecture	**4**
		Elective	**3 (min)**		Elective	**3 (min)**
		Total	**13 (min)**		**Total**	**14 (min)**
		Semester V			**Semester VI**	
III	MEL* ZG621	VLSI Design	**5**	MEL* ZG632	Analog IC Design	**5**
	MEL* ZG631	Physics & Modeling of Microelectronic Devices	**5**	MEL* ZG641	CAD For IC Design	**5**
	MEL* ZG611	IC Fabrication Technology	**5**		Elective	**3 (min)**
		Elective	**3 (min)**		Elective	**3 (min)**
		Total	**18 (min)**		**Total**	**16(min)**
		Semester VII			**Semester VIII**	
IV		Elective	**3 (min)**	MEL* ZG628T	Dissertation	**16**
		Elective	**3 (min)**			
		Elective	**4 (min)**			
		Elective	**4 (min)**			
		Total	**14 (min)**		**Total**	**16**

Note: In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

M.Tech. (Pharmaceutical Operations and Management)

Curriculum Structure

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with minimum one-year work experience in relevant domains.

Normal Duration: Four Semesters

Core Courses

Course No.	Course Title	Units
POM* ZG534	Advanced Pharmaceutical Technology	5
POM* ZG515	Pharmaceutical Administration and Management	5
POM* ZG525	Pharmaceutical Process Development and Scale-up	4
POM* ZG522	Quality Assurance and Regulatory Affairs	5

Pool of Electives

Course No.	Course Title	Units
POM* ZG551	Advanced Physical Pharmaceutics	5
POM* ZG511	Disinfection and Sterilization	4
POM* ZG512	Dosage Form Design	5
POM* ZG513	Financial Management	4
POM* ZC441	Human Resource Management	4
POM* ZG545	Intellectual Property Rights and Pharmaceuticals	3
POM* ZC471	Management Information Systems	3
POM* ZG531	Manufacturing Organization and Management	5
POM* ZG541	Modern Analytical Techniques	4
POM* ZG542	Production and Operations Management	4
POM* ZG523	Project Management	4
POM* ZG521	Statistical Process Control	5
POM* ZG611	Strategic Management & Business policy	5
POM* ZG621	Supply Chain Management	4
POM* ZG631	TQM Tools and Techniques	5

Dissertation

Course No.	Course Title	Units
POM*ZG628T	Dissertation	16

M.Tech. (Pharmaceutical Operations and Management)

Semesterwise Pattern

Year	First Semester		U	Second Semester		U
I	POM*ZG515	Pharmaceutical Administration and Management	5	POM*ZG534	Advanced Pharmaceutical Technology	5
	POM*ZG522	Quality Assurance & Regulatory Affairs	5		Elective	(5 min)
		Elective	(5 min)		Elective	(3 min)
		Elective	(5 min)		Elective	(3 min)
Total			20 (min)	Total		16 (min)
II	POM*ZG525	Pharmaceutical Process Development & Scale-up	4	POM* ZG628T	Dissertation	16
		Elective	(4 min)			
		Elective	(4 min)			
		Elective	(5 min)			
Total			17 (min)	Total		16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Designed for the HRD needs of a diverse spectrum of Pharmaceutical Industries. Collaborating Organizations: Lupin, Mumbai; Sun Pharmaceutical Industries, Vadodara

M.Tech. (Quality Management)

Curriculum Structure

Input Qualification

The students admitted to the four-semester M.Tech. in Quality Management must:

I. hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, and

II. be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Quality Management Core (7)

Course No.	Course Title	Units
QM ZG515	Quantitative Methods	4
QM ZG523	Project Management	4
QM ZG524	Quality Management Systems	5
QM ZG526	Operations Management	5
QM ZG528	Reliability Engineering	5
QM ZG531	Statistical Quality Control	5
QM ZG532	Total Quality Management	4

Pool of Electives(7)

Course No.	Course Title	Units
QM ZC441	Human Resource Management	4
QM ZG514	Leadership & Managing Change	4
QM ZG535	Decision Analysis	4
QM ZG536	Design of Experiments	4
QM ZG611	Strategic Management & Business Policy	4
QM ZG621	Supply Chain Management	4
QM ZG661	Software Quality Management	4
QM ZG663	Concurrent Engineering	5
QM ZC472	Precision Engineering	3
QM ZG539	Six Sigma	4

Project

Course No.	Course Title	Units
BITS ZG628T	Dissertation	16

M.Tech. (Quality Management)

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	QM ZG524	Quality Management Systems	5	QM ZG531	Statistical Quality Control	5
	QM ZG532	Total Quality Management	4	QM ZG526	Operations Management	5
	QM ZG515	Quantitative Methods	4	QM ZG523	Project Management	4
	QM ZG528	Reliability Engineering	5		Elective	(4 min)
		Total	18		Total	18 (min)
II		Elective	(4 min)	QM ZG628T	Dissertation	16
		Elective	(4 min)			
		Elective	(4 min)			
		Elective	(4 min)			
		Total	16 (min)		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. (Sanitation Science, Technology and Management)

Type of Input: Integrated First degree of BITS or its equivalent in the areas of Civil / Chemical Engineering, or an M.Sc. in Chemistry / Biology / Environmental Science with minimum one year of work experience in relevant domains. Exceptions can be made if a candidate's first degree is outside the above mentioned fields, but has substantial experience in the field of sanitation.

Nominal Duration: Four Semesters

Programme Structure:

Core Courses

Course No.	Course Title	Units
SSTM* ZG511	Sanitation Technology	5
SSTM* ZG512	Sanitation and Public Health	5
SSTM* ZG513	Sanitation Governance, Behavioral Change and Advocacy	5
SSTM* ZG514	Sanitation Financing & Project management	5
SSTM* ZG515	Emergency Sanitation & Leadership	5
SSTM* ZG516	Environmental Sampling and Analytical Methods	5

Pool of Electives

Course No.	Course Title	Units
SSTM* ZG521	Environmental Chemistry	5
SSTM* ZG522	Environmental Biotechnology	5
SSTM* ZG523	Biological Treatment Principles and Design of Waste Water Systems	4
SSTM* ZG524	Environmental Statistics	4
SSTM* ZG525	Environmental Systems Modelling	4
SSTM* ZG526	Solid Waste Management	4
SSTM* ZG527	Environmental Management Systems	5
SSTM* ZG528	Environmental Impact and Risk Assessment	4

Dissertation

Course No.	Course Title	Units
SSTM* ZG628T	Dissertation	16

M.Tech. (Sanitation Science, Technology and Management)

Semesterwise pattern

Year	First Semester			Second Semester		
	Course No.	**Course Title**	**Units**	**Course No.**	**Course Title**	**Units**
I	SSTM* ZG511	Sanitation Technology	5	SSTM* ZG514	Sanitation Financing & Project Management	5
	SSTM* ZG512	Sanitation and Public Health	5	SSTM* ZG515	Emergency Sanitation & Leadership	5
		Elective I	4 to 5	SSTM* ZG516	Environmental Sampling and Analytical Methods	5
		Elective II	4 to 5		Elective III	4 to 5
	Total		18-20	Total		19-20
II	SSTM* ZG513	Sanitation Governance, Behavioral Change and Advocacy	5	SSTM* ZG628T	Dissertation	16
		Elective IV	4/5			
		Elective V	4/5			
		Elective VI	4/5			
	Total		17/20	Total		16

M.Tech. (Software Engineering) (4-semester)
Curriculum Structure

Type of Input: Employed professionals holding B Tech., BE, M.Sc., MCA or equivalent in relevant disciplines with minimum one year of work experience in relevant domains.

Nominal Duration: Four Semesters

List of Core Courses (5)

Course No.	Course Title	Units
SE* ZG651	Software Architecture	5
SE* ZG527	Cloud Computing	5
SE* ZG544	Agile Software Processes	4
SE* ZG685	Software Product Management	5
SE* ZG501	Software Quality Assurance and Testing	4

The specializations for M.Tech. in Software Engineering

Specializations
Full Stack Engineering (FSE)
Software Product Management (SPM)

Specialization Requirements:

a) For any specialization, 4 courses (including mandatory electives marked #) are to be selected for that specialization.
b) For graduating without a specialization, at least 3 courses from those marked # (from either specialization) to be selected.

Note:

a) Student can also obtain the degree without any specialization.
b) # indicates mandatory elective for this specialization

Pool of Electives for specialization 1: Full Stack Engineering (FSE) (12)

Course No.	Course Title	Units
SE* ZG585	Cross Platform Application Development	4
SE* ZG514	Introduction to DevOps#	4
SE* ZG583	Scalable Services#	5
SE* ZG552	Software Testing Methodologies	4
SE* ZG503	Full-stack Application Development#	4
SE* ZG518	Database Design & Applications	5
SE* ZG504	API-based Products	4
SE* ZG505	User Experience Design	4
SE* ZG530	Design of Conversational Experiences	4
SE* ZG506	API-driven Cloud Native Solutions	5
SE* ZG587	Open Source Software Engineering	4
SE* ZG512	Object Oriented Analysis and Design	4

Pool of Electives for specialization 2: Software Product Management (SPM) (9)

Course No.	Course Title	Units
SE* ZG507	Product Discovery and Requirements Engineering#	4
SE* ZG508	Product Strategy and Planning#	4
SE* ZG509	Communication, Estimation and Negotiation#	4
SE* ZG510	Product Analytics	5
SE* ZG504	API-based Products	4
SE* ZG505	User Experience Design	4
SE* ZC410	Marketing	4
SE* ZG622	Software Project Management	4
SE* ZG587	Open Source Software Engineering	4

General Pool of Electives (10)

Course No.	Course Title	Units
SE* ZG519	Data Structures & Algorithms Design	5
SE* ZG555	Data visualization and Interpretation	5
SE* ZG557	Artificial and Computational Intelligence	5
SE* ZG569	Blockchain Technologies & Systems	4
SE* ZG681	Cyber Security	4
SE* ZG515	Data Warehousing	5
SE* ZG568	Applied Machine Learning	4
SE* ZG566	Secure Software Engineering	5
SE* ZG589	Middleware Technologies	4
SE* ZG502	Advanced topics in Software Engineering	4

Project

Course No.	Course Title	Units
SE*ZG628T	Dissertation	16

Curriculum Requirements:

Completion of the programme would require:

a) 12 courses (totaling minimum of 48 units) towards course work, and
b) Dissertation (16 Units)

Semester-wise pattern of courses

Year	First Semester			Second Semester		
	Course No.	Course Title	U	Course No.	Course Title	U
I	SE* ZG651	Software Architecture	5	SE*ZG501	Software Quality Assurance and Testing	4
	SE* ZG527	Cloud Computing	5		Elective 1	12 (min)
	SE* ZG544	Agile Software Processes	4		Elective 2	
	SE* ZG685	Software Product Management	5		Elective 3	
		Total	19		Min Total	16
II		Elective 4	16 (min)	SE*ZG628T	Dissertation	16
		Elective 5				
		Elective 6				
		Elective 7				
		Min Total	16		Total	16

M. Tech. Software Engineering (8-semesters)

Program Structure

Type of Input:	Employed professionals holding B.Sc. / BCA degree or its equivalent in relevant disciplines with adequate background in Mathematics and minimum one year of work experience in relevant domains.
Nominal Duration:	Eight Semesters

Foundation Courses

Category	Course No.	Course Title	Units
Mathematics Foundation	SE* ZC234	Linear Algebra & Optimization[$]	3
	SE* ZC111	Probability and Statistics[$]	3
	SE* ZC222	Discrete Structures for Computer Science[$]	3
Engineering Foundation	SE* ZC263	Digital Electronics and Microprocessors[$]	4
Technical Arts / Professional Courses	SE* ZC211	Principles of Management	3
	SE* ZC312	Technical Report Writing	3
	SE* ZC163	Computer Programming[$]	4

[$]Mandatory Foundation Courses

Core Courses (14)

Course No.	Course Title	Units
SE* ZC313	Object Oriented Programming & Design	4
SE* ZC333	Systems Programming	4
SE* ZC337	Database Systems & Applications	4
SE* ZC344	Software Engineering	4
SE* ZC353	Computer Organization & Architecture	4
SE* ZC363	Data Structures & Algorithms	4
SE* ZC364	Operating Systems	4
SE* ZC373	Compiler Design	4
SE* ZC467	Computer Networks	4
SE* ZG527	Cloud Computing	5
SE* ZG544	Agile Software Processes	4
SE* ZG501	Software Quality Assurance and Testing	4
SE* ZG651	Software Architectures	5
SE* ZG685	Software Product Management	5

The specializations for Integrated M.Tech. Software Engineering

Specializations
Full Stack Engineering (FSE)
Software Product Management (SPM)

Specialization Requirements:

a) For any specialization, 4 courses (including mandatory electives marked #) are to be selected for that specialization.
b) For graduating without a specialization, at least 3 courses from those marked # (from either specialization) to be selected.

Note:

a) Student can also obtain the degree without any specialization.
b) [#]indicates mandatory elective for this specialization

Pool of Electives for specialization 1: Full Stack Engineering (FSE) (12)

Course No.	Course Title	Units
SE* ZG585	Cross Platform Application Development	4
SE* ZG514	Introduction to DevOps#	4
SE* ZG583	Scalable Services#	5
SE* ZG552	Software Testing Methodologies	4
SE* ZG503	Full-stack Application Development#	4
SE* ZG518	Database Design & Applications	5
SE* ZG504	API-based Products	4
SE* ZG505	User Experience Design	4
SE* ZG530	Design of Conversational Experiences	4
SE* ZG506	API-driven Cloud Native Solutions	5
SE* ZG587	Open Source Software Engineering	4
SE* ZG512	Object Oriented Analysis and Design	4

Pool of Electives for specialization 2: Software Product Management (SPM) (9)

Course No.	Course Title	Units
SE* ZG507	Product Discovery and Requirements Engineering#	4
SE* ZG508	Product Strategy and Planning#	4
SE* ZG509	Communication, Estimation and Negotiation#	4
SE* ZG510	Product Analytics	5
SE* ZG504	API-based Products	4
SE* ZG505	User Experience Design	4
SE* ZC410	Marketing	4
SE* ZG622	Software Project Management	4
SE* ZG587	Open Source Software Engineering	4

General Pool of Electives (12)

Course No.	Course Title	Units
SE* ZC425	Data Mining	3
SE* ZC472	Computer Graphics	3
SE* ZG519	Data Structures & Algorithms Design	5
SE* ZG555	Data visualization and Interpretation	5
SE* ZG557	Artificial and Computational Intelligence	5
SE* ZG569	Blockchain Technologies & Systems	4
SE* ZG681	Cyber Security	4
SE* ZG515	Data Warehousing	5
SE* ZG568	Applied Machine Learning	4
SE* ZG566	Secure Software Engineering	5
SE* ZG589	Middleware Technologies	4
SE* ZG502	Advanced topics in Software Engineering	4

Project

Course No.	Course Title	Units
SE* ZG628T	Dissertation	16

Curriculum Requirements:
Completion of the programme would require:

a) 28 courses (totaling minimum of 103 units) towards course work, and
b) Dissertation (16 Units)

Semester-wise pattern of courses

Year	First Semester			Second Semester		
	Course No.	**Course Title**	**U**	**Course No.**	**Course Title**	**U**
I	SE* ZC222	Discrete Structures for Computer Science	3	SE* ZC313	Object Oriented Programming & Design	4
	SE* ZC234	Linear Algebra & Optimization	3	SE* ZC333	Systems Programming	4
	SE* ZC163	Computer Programming	4	SE* ZC353	Computer Organization & Architecture	4
	SE* ZC263	Digital Electronics & Microprocessors	4	SE* ZC363	Data Structures & Algorithms	4
		Total	14		Total	16
II	SE* ZC111	Probability & Statistics	3	SE* ZC373	Complier Design	4
	SE* ZC337	Database Systems & Applications	4	SE* ZC344	Software Engineering	4
	SE* ZC364	Operating Systems	4	SE* ZC467	Computer Networks	4
		Elective	3(Min)		Elective	3(Min)
		Total	Min 14		Total	Min 15
III	SE* ZG651	Software Architectures	5	SE* ZG685	Software Product Management	5
	SE* ZG527	Cloud Computing	5	SE* ZG501	Software Quality Assurance and Testing	4
		Elective	3(min)		Elective	3(min)
		Elective	3(min)		Elective	3(min)
		Total	Min 16		Total	Min 15
IV	SE* ZG544	Agile Software Processes	4	SE* ZG628T	Dissertation	16
		Elective	3(min)			
		Elective	3(min)			
		Elective	3(min)			
		Total	Min 13		Total	16

Collaborating organizations: Wipro Technologies, Dell, SAP Labs, Sabre, EMC, Oracle, Bangalore; Avaya,Tech Mahindra, Pune; Capgemini, Mumbai; Qualcomm, Hyderabad

M.Tech. Software Systems (4-semester) with specializations

Curriculum Structure

Input Requirements
Employed professionals holding an Integrated First Degree of BITS or its equivalent in relevant disciplines, with minimum one-year work experience in relevant domains.

Normal duration: Four semesters

Programme Structure

Core Courses

Course No.	Course Title	Units
SS* ZG518	Database Design & Applications *	5
SS* ZG519	Data Structures & Algorithms Design *	5
SS* ZG526	Distributed Computing	5
SS* ZG653	Software Architectures	5

* Dean, WILP may be permitted the operational flexibility of substituting these courses with others from the elective pool(s) based on certain input criteria.

General Pool of Electives

Course No.	Course Title	Units
SS* ZC444	Artificial Intelligence	3
SS* ZG514	Object Oriented Analysis & Design	4
SS* ZG516	Computer Organization and Software Systems	5
SS* ZG547	Usability Engineering	5
SS* ZG554	Distributed Data Systems	5
SS* ZG562	Software Engineering and Management	5
SS* ZG599	Natural Language Processing	4

Specialization for M.Tech. Software Systems

i) Pool of courses for Specialization 1: Networks and Cloud

Course No.	Course Title	Units
SS* ZC447	Data Storage Technologies and Networks	4
SS* ZC462	Network Programming	3
SS* ZC467	Computer Networks #	4
SS* ZG513	Network Security	4
SS* ZG520	Wireless and Mobile Communication	5
SS* ZG522	Design and Operation of Data Centres	5
SS* ZG525	Advanced Computer Networks	5
SS* ZG527	Cloud Computing #	5
SS* ZG578	Mobile Networks	4
SS* ZG580	Software Defined Networks	5
SS* ZG586	Edge Computing	5
SS* ZG589	Middleware Technologies	4

Requirements:
- 5 courses / 19 units (min) are to be chosen from the designated pool of courses for this specialization.
- # indicates mandatory course for this specialization. Other courses form the pool of electives.

ii) Pool of courses for Specialization 2: Security

Course No.	Course Title	Units
SS* ZC463	Cryptography	3
SS* ZG513	Network Security	4
SS* ZG566	Secure Software Engineering	5
SS* ZG567	AI and ML Techniques in Cyber Security	5
SS* ZG569	Blockchain Technologies & Systems	4
SS* ZG570	Cloud, IoT and Enterprise Security	5
SS* ZG575	Ethical Hacking	3
SS* ZG576	Identity and Access Management Technologies	4
SS* ZG588	Cyber Crimes, Forensics and Incident Handling	4
SS* ZG681	Cyber Security#	4

Requirements:

- 5 courses / 18 units (min) are to be chosen from the designated pool of courses for this specialization.
- # indicates mandatory course for this specialization. Other courses form the pool of electives.

iii) Pool of courses for Specialization 3: Internet of Things

Course No.	Course Title	Units
SS* ZG512	Embedded Systems Design#	4
SS* ZG527	Cloud Computing	5
SS* ZG528	Cyber Physical Systems#	4
SS* ZG556	Stream Processing and Analytics	5
SS* ZG584	Data Management for IoT	5
SS* ZG574	Embedded Network Security	4
SS* ZG585	Cross Platform Application Development	4
SS* ZG656	Networked Embedded Applications	4

Requirements:

- 5 courses / 20 units (min) are to be chosen from the designated pool of courses for this specialization.
- # indicates mandatory course for this specialization. Other courses form the pool of electives.

iv) Pool of courses for Specialization 4: Data Analytics

Course No.	Course Title	Units
SS* ZC416	Mathematical Foundations for Data Science #	4
SS* ZC425	Data Mining	3
SS* ZG515	Data Warehousing	5
SS* ZG529	Deep Learning	4
SS* ZG599	Natural Language Processing	4
SS* ZG536	Advanced Statistical Techniques for Analytics	4
SS* ZG537	Information Retrieval	4
SS* ZG568	Applied Machine Learning	4
SS* ZG577	Metaheuristics for Optimization	4

Requirements:

- 5 courses / 18 units (min) are to be chosen from the designated pool of courses for this specialization.
- # indicates mandatory course for this specialization. Other courses form the pool of electives.

v) Pool of courses for Specialization 5: Embedded Systems

Course No.	Course Title	Units
SS* ZC427	Software for Embedded Systems	4
SS* ZG512	Embedded System Design #	4
SS* ZG553	Real Time Systems	5
SS* ZG579	Real Time Scheduling	4
SS* ZG626	Hardware Software Co-Design	5
SS* ZG656	Networked Embedded Applications	4
SS* ZG682	Embedded Middleware Design	5
SS* ZG683	Fault Tolerant Embedded System	4
SS* ZG684	Parallel Embedded Architectures	4

Requirements:

- 5 courses / 20 units (min) are to be chosen from the designated pool of courses for this specialization.
- # indicates mandatory course for this specialization. Other courses form the pool of electives.

Semesterwise pattern

Year	Semester I		U	Semester II		U
I	SS* ZG519	Data Structures & Algorithms Design	5	SS* ZG653	Software Architectures	5
	SS* ZG518	Database Design & Applications	5	Elective 2		3(min)
	SS* ZG526	Distributed Computing	5	Elective 3		3(min)
	Elective 1		3(min)	Elective 4		4(min)
	Total		**18(min)**	**Total**		**15 (min)**
II	Elective 5		3(min)	SS* ZG628T	Dissertation	16
	Elective 6		3(min)			
	Elective 7		4(min)			
	Elective 8		4(min)			
	Total		**14(min)**	**Total**		**16**

Designed for the HRD requirements of a diverse spectrum of IT Industries. Collaborative Organizations: Wipro Technologies, Bangalore; TCS, Hyderabad; Cisco, Bangalore; Samsung , Gurgaon

Integrated M.Tech. (Software Systems)

Curriculum Structure

Input Qualification

The students admitted to the **M.Tech. Software Systems (8 Semesters)** programme must:

i) hold a B.Sc. / BCA degree or its equivalent in relevant disciplines with adequate background in Mathematics, and

ii) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: Eight semesters

Programme Structure

Foundation Courses

Category	Course No.	Course Title	Units
Mathematics Foundation	SS* ZC234	Linear Algebra & Optimization $	3
	SS* ZC111	Probability and Statistics $	3
	SS* ZC222	Discrete Structures for Computer Science $	3
Engineering Foundation	SS* ZC263	Digital Electronics and Microprocessors $	4
Technical Arts / Professional Courses	SS* ZC241	Principles of Management	3
	SS* ZC312	Technical Report Writing	3
	SS* ZC163	Computer Programming $	4

$ Mandatory Foundation Courses

Core courses (12)

Course No.	Course Title	Units
SS* ZC313	Object Oriented Programming & Design	4
SS* ZC327	Systems Programming	4
SS* ZC328	Software Testing	3
SS* ZC337	Database Systems & Applications	4
SS* ZC343	Software Engineering	4
SS* ZC353	Computer Organization & Architecture	4
SS* ZC363	Data Structures & Algorithms	4
SS* ZC364	Operating Systems	4
SS* ZC373	Compiler Design	4
SS* ZC467	Computer Networks	4
SS* ZG526	Distributed Computing	5
SS* ZG653	Software Architectures	5

General Pool of Electives

Course No.	Course Title	Units
SS* ZC444	Artificial Intelligence	3
SS* ZG514	Object Oriented Analysis & Design	4
SS* ZG516	Computer Organization and Software Systems	5
SS* ZG547	Usability Engineering	5
SS* ZG554	Distributed Data Systems	5
SS* ZG562	Software Engineering and Management	5
SS* ZG599	Natural Language Processing	4

Specialization for M.Tech. Software Systems (8 semesters)

i) Pool of courses for Specialization 1: Networks and Cloud

Course No.	Course Title	Units
SS* ZC447	Data Storage Technologies and Networks	4
SS* ZC462	Network Programming	3
SS* ZC467	Computer Networks #	4
SS* ZG513	Network Security	4
SS* ZG520	Wireless and Mobile Communication	5
SS* ZG522	Design and Operation of Data Centres	5
SS* ZG525	Advanced Computer Networks	5
SS* ZG527	Cloud Computing #	5
SS* ZG578	Mobile Networks	4
SS* ZG580	Software Defined Networks	5
SS* ZG586	Edge Computing	5
SS* ZG589	Middleware Technologies	4

Requirements:

- 5 courses / 19 units (min) are to be chosen from the designated pool of courses for this specialization.
- # indicates mandatory course for this specialization. Other courses form the pool of electives.

ii) Pool of courses for Specialization 2: Security

Course No.	Course Title	Units
SS* ZC463	Cryptography	3
SS* ZG513	Network Security	4
SS* ZG566	Secure Software Engineering	5
SS* ZG567	AI and ML Techniques in Cyber Security	5

SS* ZG569	Blockchain Technologies & Systems	4
SS* ZG570	Cloud, IoT and Enterprise Security	5
SS* ZG575	Ethical Hacking	3
SS* ZG576	Identity and Access Management Technologies	4
SS* ZG588	Cyber Crimes, Forensics and Incident Handling	4
SS* ZG681	Cyber Security#	4

Requirements:

- 5 courses / 18 units (min) are to be chosen from the designated pool of courses for this specialization.
- # indicates mandatory course for this specialization. Other courses form the pool of electives.

iii) Pool of courses for Specialization 3: Internet of Things

Course No.	Course Title	Units
SS* ZG512	Embedded Systems Design#	4
SS* ZG527	Cloud Computing	5
SS* ZG528	Cyber Physical Systems#	4
SS* ZG556	Stream Processing and Analytics	5
SS* ZG584	Data Management for IoT	5
SS* ZG574	Embedded Network Security	4
SS* ZG585	Cross Platform Application Development	4
SS* ZG656	Networked Embedded Applications	4

Requirements:

- 5 courses / 20 units (min) are to be chosen from the designated pool of courses for this specialization.
- # indicates mandatory course for this specialization. Other courses form the pool of electives.

iv) Pool of courses for Specialization 4: Data Analytics

Course No.	Course Title	Units
SS* ZC416	Mathematical Foundations for Data Science #	4
SS* ZC425	Data Mining	3
SS* ZG515	Data Warehousing	5
SS* ZG529	Deep Learning	4
SS* ZG599	Natural Language Processing	4
SS* ZG536	Advanced Statistical Techniques for Analytics	4
SS* ZG537	Information Retrieval	4
SS* ZG568	Applied Machine Learning	4

SS* ZG577	Metaheuristics for Optimization	4

Requirements:

- 5 courses / 18 units (min) are to be chosen from the designated pool of courses for this specialization.
- # indicates mandatory course for this specialization. Other courses form the pool of electives.

v) Pool of courses for Specialization 5: Embedded Systems

Course No.	Course Title	Units
SS* ZC427	Software for Embedded Systems	4
SS* ZG512	Embedded System Design #	4
SS* ZG553	Real Time Systems	5
SS* ZG579	Real Time Scheduling	4
SS* ZG626	Hardware Software Co-Design	5
SS* ZG656	Networked Embedded Applications	4
SS* ZG682	Embedded Middleware Design	5
SS* ZG683	Fault Tolerant Embedded System	4
SS* ZG684	Parallel Embedded Architectures	4

Requirements:

- 5 courses / 20 units (min) are to be chosen from the designated pool of courses for this specialization.
- # indicates mandatory course for this specialization. Other courses form the pool of electives.

Integrated M.Tech. (Software Systems)

Semesterwise Pattern

Year	First Semester		Units	Second Semester		Units
I	SS* ZC222	Discrete Structures for Computer Science	3	SS* ZC313	Object Oriented Programming & Design	4
	SS* ZC234	Linear Algebra & Optimization	3	SS* ZC327	Systems Programming	4
	SS* ZC163	Computer Programming	4	SS* ZC353	Computer Organization & Architecture	4
	SS* ZC263	Digital Electronics & Microprocessors	4	SS* ZC363	Data Structures & Algorithms	4
		Total	14		Total	16
II	SS* ZC111	Probability & Statistics	3	SS* ZC373	Complier Design	4
	SS* ZC337	Database Systems & Applications	4	SS* ZC343	Software Engineering	4
	SS* ZC364	Operating Systems	4	SS* ZC481	Computer Networks	4
		Elective	3 (Min)	SS*ZC328	Software Testing	3
		Total	14(Min)		Total	15
III	SS* ZG526	Distributed Computing	5	SS*ZG653	Software Architectures	5
		Elective	3(min)		Elective	3(min)
		Elective	4(min)		Elective	4(min)
		Elective	4(min)		Elective	4(min)
		Total	16(min)		Total	16(min)
IV		Elective	4(min)	SS* ZG628T	Dissertation	16
		Elective	4(min)			
		Elective	4(min)			
		Elective	4(min)			
		Total	16(min)		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Designed for the HRD requirements of a diverse spectrum of IT Industries. Collaborative Organizations: Wipro Technologies, Bangalore; TCS, Hyderabad; Cisco, Bangalore; Samsung, Gurgaon

M.Tech. (Systems Engineering)

Curriculum Structure

Input Requirements

Employed professionals holding an Integrated First Degree of BITS or its equivalent in relevant disciplines, with minimum one-year work experience in relevant domains.

Normal duration : Four Semesters

Programme Structure

Core Courses : None.

Pool of Electives

Course No.	Course Title	Units
SE* ZG527	Cloud Computing	5
SE* ZC425	Data Mining	3
SE*ZC447	Data Storage Technologies & Networks	4
SE*ZG514	Data Warehousing	5
SE* ZC451	Internetworking Technologies	3
SE*ZC473	Multimedia Computing	3
SE*ZC462	Network Programming	3
SE*ZG513	Network Security	4
SE* ZG512	Object Oriented Analysis & Design	4
SE* ZG531	Pervasive Computing	4
SE* ZG524	Real Time Operating Systems	5
SE* ZG548	Advanced Data Mining	4
SE* ZG553	Real Time Systems	5
SE* ZG622	Software Project Management	4
SE* ZG661	Software Quality Management	4
SE* ZG552	Software Testing Methodologies	4
SE* ZG582	Telecom Network Management	5
SE* ZG520	Wireless & Mobile Communication	5

Note: In the above programme, the symbol '*' in the course numbers, can be substituted by the letters representing the collaborating organization.

M.Tech. (Systems Engineering)

Semesterwise Pattern

Year	First Semester		U	Second Semester		U
I	SE* ZG514	Data Warehousing	5	SE* ZG661	Software Quality Management	4
	SE* ZG512	Object Oriented Analysis & Design	4	SE* ZG531	Pervasive Computing	4
	SE* ZG524	Real Time Operating Systems	5	SE* ZC425	Data Mining	3
	SE* ZG520	Wireless & Mobile Communication	5	SE* ZG552	Software Testing Methodologies	4
		Total	19		Total	15
II	SE* ZG622	Software Project Management	4	SE* ZG628T	Dissertation	16
	SE* ZG527	Cloud Computing	5			
	SE* ZG582	Telecom Network Management	5			
	SE* ZG513	Network Security	4			
		Total	18		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborative Organizations: Wipro Infotech, Bangalore

MBA programmes

Input Qualification:

The students admitted to the proposed four-semester MBA programs must:

(i) hold an Integrated First Degree of BITS or its equivalent and

(ii)be employed professionals with adequate work experience in relevant domains.

Curriculum Requirements for MBA programs

The nature of the input to these programs and the objectives / orientation of Work Integrated Learning Programs are different from those of the on-campus programs. Students interested in these programs are seeking continuing higher management education and focus in the chosen technical domain of study, which would enable their career progression within their industry. It is also to be observed that learning and coursework in these programs are integrated within a professional / technical environment.

Based on these facts and observations the curriculum has been designed to be in strong alignment with on-campus program at the core but with sufficient flexibility for customization to meet specific requirements of a target student population.

Completion of the program would require:

(i) At least 13 courses (totaling at least 52 units) towards coursework, and

(ii) Project (12 units).

The Department concerned may identify 4 to 8 courses out of the coursework requirement for each program as the **Management Core** requirement, and 4 to 6 courses of the coursework requirement for each program as the **Domain Core** requirement. The core requirements are mandatory for all students in a given program. However in certain highly specialized areas, some variation in the core requirements may be permitted. Rest of the coursework must be completed through elective courses.

The curriculum requirements common to all MBA programs is given below:

Category	No. of Units Required	No. of Courses Required
Management Core	24-40	6-8
Domain Core	16-25	4-6
Electives	3-15	1-3
Subtotal	52 (min)	13 (min)
Project	12	1
Total	64 (min)	14 (min)

Project: As Project is based on the work environment of the student, the number of units for Project may be kept as 12. Normally, the Project is to be undertaken in the final semester of the program.

MBA (Business Analytics)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ M.Sc. in relevant disciplines, with minimum one year work experience in relevant domains
(OR)
Employed professionals holding a three year undergraduate degree in such areas as Mathematics, Statistics, Science, Economics, Commerce, and Business Management, and having studied at least one course in mathematics or statistics at the high school or higher level, and with minimum two years of work experience in relevant business domains.

Nominal Duration: Four Semesters

Curriculum Requirements:

Completion of the programme would require:

(a) At least 14 courses (totaling minimum of 56 units) towards course work, and

(b) Project (8 Units)

Programme Structure:

Management Core (8 Courses)

Course No.	Course Title	Units
MBA* ZC411	Marketing	4
MBA* ZC415	Financial and Management Accounting	4
MBA* ZC416	Managerial Economics	4
MBA* ZC417	Quantitative Methods	4
MBA* ZG511	Managing People & Organizations	4
MBA* ZG521	Financial Management	4
MBA* ZG526	Operations Management	4
MBA* ZG611	Strategic Management and Business Policy	4

Business Analytics Core (4 Courses)

Course No.	Course Title	Units
MBA* ZC413	Analytics for Competitive Advantage	4
MBA* ZG512	Predictive Analytics	4
MBA* ZG536	Foundations of Data Science	4
MBA* ZG538	Advanced Statistical Methods	4

Pool of Electives

Course No.	Course Title	Units
MBA* ZG517	Financial Analytics	4
MBA* ZG523	Project Management	4
MBA* ZG539	Data Visualization and Communication	4
MBA* ZG563	Analytics for HR	4

MBA* ZG564	Models in Marketing	4
MBA* ZG565	Supply Chain Analytics	4
MBA* ZG566	Analytics for Marketing	4
MBA* ZG567	Analytics for Retail Industry	4
MBA* ZG568	Operations Research Models	4
MBA* ZG569	Analytics for Investment Banking	4
MBA* ZG570	Financial Risk Models	4
MBA* ZG571	Analytical Models in Finance	4

Project

Course No.	Course Title	Units
MBA* ZG622T	Project	8

Suggested Semesterwise pattern of courses

Year	First Semester			Second Semester		
	Course No.	Course Title	Units	Course No.	Course Title	Units
I	MBA* ZC415	Financial and Management Accounting	4	MBA* ZC411	Marketing	4
	MBA* ZC416	Managerial Economics	4	MBA* ZG538	Advanced Statistical Methods	4
	MBA* ZC417	Quantitative Methods	4	MBA* ZG536	Foundations of Data Science	4
	MBA* ZG511	Managing People & Organizations	4	MBA* ZG611	Strategic Management and Business Policy	4
		Total	**16**		**Total**	**16**
II	MBA* ZG512	Predictive Analytics	4		Elective 1	4
	MBA* ZC413	Analytics for Competitive Advantage	4		Elective 2	4
	MBA* ZG521	Financial Management	4	MBA* ZG622T	Project	8
	MBA* ZG526	Operations Management	4			
		Total	**16**		**Total**	**16**

MBA (Consultancy Management)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ M. Sc. in relevant disciplines, with minimum one year work experience in relevant business domains.
(OR)
Employed professionals holding a three year undergraduate degree in such areas as Mathematics, Statistics, Science, Economics, Commerce, and Business Management, and having studied at least one course in mathematics or statistics at the high school or higher level, and with minimum two years of work experience in relevant business domains.

Nominal Duration: Four Semesters

Curriculum Requirements

Completion of the programme would require:
(a) At least 14 courses (totaling at least 56 units) towards coursework; and
(b) Project (8 units)

Programme Structure:

Management Core (8 Courses)

Course No.	Course Title	Units
MBA* ZC411	Marketing	4
MBA* ZC415	Financial and Management Accounting	4
MBA* ZC416	Managerial Economics	4
MBA* ZC417	Quantitative Methods	4
MBA* ZG511	Managing People & Organizations	4
MBA* ZG521	Financial Management	4
MBA* ZG526	Operations Management	4
MBA* ZG611	Strategic Management and Business Policy	4

Consultancy Core (4 Courses)

Course No.	Course Title	Units
MBA* ZG515	Consulting and People Skills	4
MBA* ZG525	Business Process Analysis	4
MBA* ZG541	Consultancy Practice	4
MBA* ZG634	Strategic Change Management	4

Pool of Electives

Course No.	Course Title	Units
MBA* ZG513	Enterprise Resource Planning	4
MBA* ZG514	Leadership and Managing Change	4
MBA* ZG523	Project Management	4
MBA* ZG535	Decision Analysis	4
MBA* ZG540	International Business and Trade	4
MBA* ZG542	Entrepreneurship and New Ventures	4
MBA* ZG543	Family Business Management	4
MBA* ZG544	Mergers, Acquisitions, and Corporate Restructuring	4
MBA* ZG621	Supply Chain Management	4

Project

Course No.	Course Title	Units
MBA* ZG622T	Project	8

Suggested Semesterwise pattern of courses

Year	Semester I		U	Semester II		U
I	MBA* ZC415	Financial and Management Accounting	4	MBA* ZC411	Marketing	4
	MBA* ZC416	Managerial Economics	4	MBA* ZG521	Financial Management	4
	MBA* ZC417	Quantitative Methods	4	MBA* ZG526	Operations Management	4
	MBA* ZG511	Managing People & Organizations	4	MBA* ZG541	Consultancy Practice	4
		Total	**16**		**Total**	**16**
II	MBA* ZG515	Consulting and People Skills	4		Elective 1	4
	MBA* ZG525	Business Process Analysis	4		Elective 2	4
	MBA* ZG611	Strategic Management & Business Policy	4	MBA* ZG622T	Project	8
	MBA* ZG634	Strategic Change Management	4			
		Total	**16**		**Total**	**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

MBA (Digital Business)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E. / M. Sc. in relevant disciplines, with minimum one year work experience in relevant business domains.
(OR)
Employed professionals holding a three year undergraduate degree in such areas as Mathematics, Statistics, Science, Economics, Commerce, and Business Management, and having studied at least one course in mathematics or statistics at the high school or higher level, and with minimum two years of work experience in relevant business domains.

Nominal Duration: Four Semesters

Curriculum Requirements:

Completion of the programme would require:
(a) At least 14 courses (totaling minimum of 56 units) towards course work, and
(b) Project (8 Units)

Programme Structure:

Management Core (8 Courses)

Course No.	Course Title	Units
MBA* ZC411	Marketing	4
MBA* ZC415	Financial and Management Accounting	4
MBA* ZC416	Managerial Economics	4
MBA* ZC417	Quantitative Methods	4
MBA* ZG511	Managing People & Organizations	4
MBA* ZG521	Financial Management	4
MBA* ZG526	Operations Management	4
MBA* ZG611	Strategic Management & Business Policy	4

Digital Business Core (4 Courses)

Course No.	Course Title	Units
MBA* ZG572	Digital Business Design	4
MBA* ZG573	Digital Strategies for Business	4
MBA* ZG574	Digital Customer Experience Management	4
MBA* ZG575	Digital Technologies and Analytics	4

Pool of Electives

Course No.	Course Title	Units
MBA* ZG516	Introduction to Fintech	4
MBA* ZG517	Financial Analytics	4
MBA* ZG553	Blockchain and Applications	4
MBA* ZG565	Supply Chain Analytics	4
MBA* ZG566	Analytics for Marketing	4
MBA* ZG576	Digital Marketing	4
MBA* ZG577	Artificial Intelligence and Machine Learning	4

MBA* ZG578	Digital Manufacturing and Logistics	4
MBA* ZG579	Entrepreneurial Finance	4

Project

Course No.	Course Title	Units
MBA* ZG622T	Project	8

Suggested Semester-wise pattern of courses

Year	First Semester			Second Semester		
	Course No.	Course Title	Units	Course No.	Course Title	Units
I	MBA* ZC415	Financial and Management Accounting	4	MBA* ZC411	Marketing	4
	MBA* ZC416	Managerial Economics	4	MBA* ZG521	Financial Management	4
	MBA* ZC417	Quantitative Methods	4	MBA* ZG611	Strategic Management and Business Policy	4
	MBA* ZG511	Managing People & Organizations	4	MBA* ZG572	Digital Business Design	4
		Total	16		Total	16
II	MBA* ZG573	Digital Strategies for Business	4		Elective 1	4
	MBA* ZG575	Digital Technologies and Analytics	4		Elective 2	4
	MBA* ZG574	Digital Customer Experience Management	4	MBA* ZG622T	Project	8
	MBA* ZG526	Operations Management	4			
		Total	16		Total	16

MBA in Finance

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ M. Sc. in relevant disciplines, with minimum one year work experience in relevant business domains.
(OR)
Employed professionals holding a three year undergraduate degree in such areas as Mathematics, Statistics, Science, Economics, Commerce, and Business Management, and having studied at least one course in mathematics or statistics at the high school or higher level, and with minimum two years of work experience in relevant business domains.

Nominal Duration: Four Semesters

Curriculum Requirements

Completion of the programme would require:
(a) At least 14 courses (totaling at least 56 units) towards coursework; and
(b) Project (8 units)

Programme Structure:

Management Core (8 Courses)

Course No.	Course Title	Units
MBA* ZC411	Marketing	4
MBA* ZC415	Financial and Management Accounting	4
MBA* ZC416	Managerial Economics	4
MBA* ZC417	Quantitative Methods	4
MBA* ZG511	Managing People & Organizations	4
MBA* ZG521	Financial Management	4
MBA* ZG526	Operations Management	4
MBA* ZG611	Strategic Management and Business Policy	4

Finance Core (4 Courses)

Course No.	Course Title	Units
MBA* ZG517	Financial Analytics	4
MBA* ZG518	Multinational Finance	4
MBA* ZG520	Security Analysis & Portfolio Management	4
MBA* ZG560	Global Financial Markets and Products	4

Pool of Electives

Course No.	Course Title	Units
MBA* ZG516	Introduction to FinTech	4
MBA* ZG519	Business Analysis and Valuation	4
MBA* ZG528	Venture Capital and Private Equity	4
MBA* ZG544	Mergers, Acquisitions, and Corporate Restructuring	4

MBA* ZG556	Advanced Risk Models	4
MBA* ZG558	Financial Risk Management	4
MBA* ZG559	Management of Banks & Financial Institutions	4
MBA* ZG561	Behavioural Finance	4
MBA* ZG562	Derivatives & Financial Engineering	4

Project

Course No.	Course Title	Units
MBA* ZG622T	Project	8

Suggested Semesterwise pattern of courses

Year	Semester I		U	Semester II		U
I	MBA* ZC415	Financial and Management Accounting	4	MBA* ZC411	Marketing	4
	MBA* ZC416	Managerial Economics	4	MBA* ZG521	Financial Management	4
	MBA* ZC417	Quantitative Methods	4	MBA* ZG526	Operations Management	4
	MBA* ZG511	Managing People & Organizations	4	MBA* ZG560	Global Financial Markets and Products	4
		Total	**16**		**Total**	**16**
II	MBA* ZG518	Multinational Finance	4		Elective 1	4
	MBA* ZG520	Security Analysis and Portfolio Management	4		Elective 2	4
	MBA* ZG517	Financial Analytics	4	MBA* ZG622T	Project	8
	MBA* ZG611	Strategic Management & Business Policy	4			
		Total	**16**		**Total**	**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

MBA in FinTech

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ M.Sc. in relevant disciplines, with minimum one year work experience in relevant domains
(OR)
Employed professionals holding a three year undergraduate degree in such areas as Mathematics, Statistics, Science, Economics, Commerce, and Business Management, and having studied at least one course in mathematics or statistics at the high school or higher level, and with minimum two years of work experience in relevant business domains.

Nominal Duration: Four Semesters

Curriculum Requirements:

Completion of the programme would require:
(c) At least 14 courses (totaling minimum of 56 units) towards course work, and
(d) Project (8 Units)

Programme Structure:

Management Core (8 Courses)

Course No.	Course Title	Units
MBA* ZC411	Marketing	4
MBA* ZC415	Financial and Management Accounting	4
MBA* ZC417	Quantitative Methods	4
MBA* ZG416	Managerial Economics	4
MBA* ZG511	Managing People & Organizations	4
MBA* ZG521	Financial Management	4
MBA* ZG526	Operations Management	4
MBA* ZG611	Strategic Management & Business Policy	4

FinTech Core (4 Courses)

Course No.	Course Title	Units
MBA* ZG516	Introduction to FinTech	4
MBA* ZG517	Financial Analytics	4
MBA* ZG553	Block Chain and Applications	4
MBA* ZG560	Global Financial Markets and Products	4

Pool of Electives

Course No.	Course Title	Units
MBA* ZC419	Financial Risk Analytics	4
MBA* ZG527	Entrepreneurship in FinTech	4
MBA* ZG529	Machine Learning for Finance	4
MBA* ZG530	InsurTech	4

MBA* ZG532	Deep Learning Application in Finance	4
MBA* ZG533	Technology Disruptions in FinTech	4
MBA* ZG554	Digital Banking and Beyond	4
MBA* ZG555	Algorithmic and High Frequency Trading	4
MBA* ZG557	FinTech in Wealth Management	4

Project

Course No.	Course Title	Units
MBA* ZG622T	Project	8

Suggested Semesterwise pattern of courses

Year	First Semester			Second Semester		
	Course No.	Course Title	Units	Course No.	Course Title	Units
I	MBA* ZC415	Financial and Management Accounting	4	MBA* ZC411	Marketing	4
	MBA* ZC416	Managerial Economics	4	MBA* ZG521	Financial Management	4
	MBA* ZC417	Quantitative Methods	4	MBA* ZG526	Operations Management	4
	MBA* ZG511	Managing People & Organizations	4	MBA* ZG516	Introduction to FinTech	4
		Total	16		Total	16
II	MBA* ZG517	Financial Analytics	4		Elective 1	4
	MBA* ZG560	Global Financial Markets and Products	4		Elective 2	4
	MBA* ZG553	Block Chain and Applications	4	MBA* ZG622T	Project	8
	MBA* ZG611	Strategic Management & Business Policy	4			
		Total	16		Total	16

MBA in Hospital & Health Systems Management

Input criteria: Employed professionals in the healthcare industry, holding an Integrated **First Degree of BITS** or its equivalent / MBBS or its equivalent, with at least one year of relevant work experience.

Nominal Duration: Four semesters

Curriculum requirements:
Completion of the programme would require:
(a) Atleast 13 courses (totaling atleast 52 units) towards coursework; and
(b) Project (12 units)

Programme Structure

MANAGEMENT CORE (5 Courses)

Course No.	Course Title	Units
MBA ZC415	Financial and Management Accounting	4
MBA ZG521	Financial Management	4
MBA ZC416	Managerial Economics	4
MBA ZC411	Marketing	4
MBA ZC417	Quantitative Methods	4

DOMAIN CORE (7 Courses)

Course No.	Course Title	Units
HHSM ZG513	Biostatistics & Epidemiology	4
HHSM ZG516	Epidemic & Disaster Management	4
HHSM ZG517	Healthcare Management	4
HHSM ZG614	Hospital Operations Management	4
HHSM ZG631	Introduction to Health Systems & Environmental Health	4
HHSM ZG615	Service Quality Excellence in Healthcare	4
HHSM ZG617	Strategic Management of Healthcare Organizations	4

ELECTIVES (1 course to be chosen from the pool of electives)

Course No.	Course Title	Units
MBA ZG535	Decision Analysis	4
MBA ZG514	Leadership & Managing Change	4
MBA ZG523	Project Management	4

PROJECT

Course No.	Course Title	Units
MBA ZG623T	Project	12

MBA in Hospital & Health Systems Management

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	MBA ZC415	Financial and Management Accounting	4	MBA ZG521	Financial Management	4
	MBA ZC416	Managerial Economics	4	HHSM ZG516	Epidemic & Disaster Management	4
	MBA ZC411	Marketing	4	HHSM ZG631	Introduction to Health Systems & Environmental Health	4
	MBA ZC417	Quantitative Methods	4	HHSM ZG615	Service Quality Excellence in Healthcare	4
	Total		**16**	**Total**		**16**
II	HHSM ZG513	Biostatistics & Epidemiology	4	MBA ZG623T	Project	12
	HHSM ZG517	Healthcare Management	4		Elective 1	4
	HHSM ZG614	Hospital Operations Management	4			
	HHSM ZG617	Strategic Management of Health care Organizations	4			
	Total		**16**	**Total**		**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

MBA in Manufacturing Management
Curriculum Structure

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ M.Sc. in relevant disciplines, with minimum one year work experience in relevant business domains.

Nominal Duration: Four Semesters

Curriculum Requirements

Completion of the programme would require:
(a) At least 14 courses (totaling at least 56 units) towards coursework; and
(b) Project (8 units)

Programme Structure:

Management Core (8 Courses)

Course No.	Course Title	Units
MBA* ZC411	Marketing	4
MBA* ZC415	Financial and Management Accounting	4
MBA* ZC416	Managerial Economics	4
MBA* ZC417	Quantitative Methods	4
MBA* ZG511	Managing People & Organizations	4
MBA* ZG521	Financial Management	4
MBA* ZG526	Operations Management	4
MBA* ZG611	Strategic Management and Business Policy	4

Manufacturing Core (4 Courses)

Course No.	Course Title	Units
MBA* ZG522	Total Quality Management	4
MBA* ZG537	Lean Manufacturing	5
MBA* ZG545	Product Design and Development	4
MBA* ZG621	Supply Chain Management	4

Pool of Electives

Course No.	Course Title	Units
MBA* ZG514	Leadership and Managing Change	4
MBA* ZG523	Project Management	4
MBA* ZG534	Sustainable Manufacturing	4
MBA* ZG547	Modern Manufacturing	4
MBA* ZG548	Manufacturing Strategy	4
MBA* ZG565	Supply Chain Analytics	4

Project

Course No.	Course Title	Units
MBA* ZG622T	Project	8

Suggested Semesterwise pattern of courses

Year	Semester I		U	Semester II		U
I	MBA* ZC415	Financial and Management Accounting	4	MBA* ZC411	Marketing	4
	MBA* ZC416	Managerial Economics	4	MBA* ZG521	Financial Management	4
	MBA* ZC417	Quantitative Methods	4	MBA* ZG545	Product Design and Development	4
	MBA* ZG511	Managing People & Organizations	4	MBA* ZG526	Operations Management	4
		Total	**16**		**Total**	**16**
II	MBA* ZG522	Total Quality Management	4		Elective 1	4
	MBA* ZG621	Supply Chain Management	4		Elective 2	4
	MBA* ZG537	Lean Manufacturing	5	MBA* ZG622T	Project	8
	MBA* ZG611	Strategic Management and Business Policy	4			
		Total	**17**		**Total**	**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

MBA in Quality Management
Curriculum Structure

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ M.Sc. in relevant disciplines, with minimum one year work experience in relevant business domains.

Nominal Duration: Four Semesters

Curriculum Requirements

Completion of the programme would require:
(a) At least 14 courses (totaling at least 56 units) towards coursework; and
(b) Project (8 units)

Programme Structure:

Management Core (8 Courses)

Course No.	Course Title	Units
MBA* ZC411	Marketing	4
MBA* ZC415	Financial and Management Accounting	4
MBA* ZC416	Managerial Economics	4
MBA* ZC417	Quantitative Methods	4
MBA* ZG511	Managing People & Organizations	4
MBA* ZG521	Financial Management	4
MBA* ZG526	Operations Management	4
MBA* ZG611	Strategic Management and Business Policy	4

Quality Core (4 Courses)

Course No.	Course Title	Units
MBA* ZG522	Total Quality Management	4
MBA* ZG531	Statistical Quality Control	5
MBA* ZG549	Managing Quality in Services Industry	4
MBA* ZG550	Quality Management Systems	4

Pool of Electives

Course No.	Course Title	Units
MBA* ZG514	Leadership and Managing Change	4
MBA* ZG523	Project Management	4
MBA* ZG621	Supply Chain Management	4
MBA* ZG661	Software Quality Management	4
MBA* ZG551	Quality Analytics	4
MBA* ZG552	Business Acumen for Managing Quality	4

Project

Course No.	Course Title	Units
MBA* ZG622T	Project	8

Suggested Semesterwise Pattern of Courses

Year	Semester I		U	Semester II		U
I	MBA* ZC415	Financial and Management Accounting	4	MBA* ZC411	Marketing	4
	MBA* ZC416	Managerial Economics	4	MBA* ZG521	Financial Management	4
	MBA* ZC417	Quantitative Methods	4	MBA* ZG522	Total Quality Management	4
	MBA* ZG511	Managing People & Organizations	4	MBA* ZG526	Operations Management	4
		Total	**16**		**Total**	**16**
II	MBA* ZG549	Managing Quality in Services Industry	4		Elective 1	4
	MBA* ZG550	Quality Management Systems	4		Elective 2	4
	MBA* ZG531	Statistical Quality Control	5	MBA* ZG622T	Project	8
	MBA* ZG611	Strategic Management and Business Policy	4			
		Total	**17**		**Total**	**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

POST GRADUATE DIPLOMA

Curriculum Structure:

Normal Input: Three-year undergraduate degree in relevant disciplines. with adequate work experience in relevant domains.

Nominal duration: Two semesters.

Curriculum Structure for Post-graduate Diploma programme:

Category	Number of Courses Required	Number of Units Required
Core	4-8	14-36
Electives	0-4	0-18
Total	**8 courses (min)**	**28 to 36 units**

Post Graduate Diploma
(Automotive Cyber Security)

Type of Input:
Candidates holding an Integrated First degree of BITS or its equivalent such as B.E./B.Tech in relevant disciplines.

Nominal Duration: Two semesters

List of Courses:

Course No.	Course Title	Units
PDACS ZC435	Introduction to Autotronics	3
PDACS ZC436	Automotive Networks and Communications	4
PDACS ZG574	Embedded Network Security	4
PDACS ZG519	Automotive Security	4
PDACS ZG575	Ethical Hacking	3
PDACS ZC437	Cyber Security and Cyber Laws	3
PDACS ZG513	Network Security	4
	Elective	3-4
	Elective	3-4
	Elective	3-4
	Total	**36 max.**

List of elective courses:

Course No.	Course Title	Units
PDACS ZC438	Software Engineering for Secure Systems	3
PDACS ZC439	Cloud and IoT Security	4
PDACS ZC440	AI and ML for Cyber Security	3
PDACS ZC463	Cryptography	3
PDACS ZC445	Information Security Project	3
PDACS ZG501	Network Security Project	3
PDACS ZC450	Cyber Forensics and Incident Handling	3
PDACS ZC454	Blockchain Technology	3

Semester-wise pattern of courses

Year	First Semester			Second Semester		
	Course No.	Course Title	U	Course No.	Course Title	U
I	PDACS ZC435	Introduction to Autotronics	3	PDACS ZC437	Cyber Security and Cyber Laws	3
	PDACS ZC436	Automotive Networks and Communications	4	PDACS ZG513	Network Security	4
	PDACS ZG574	Embedded Network Security	4		Elective 1	3-4
	PDACS ZG519	Automotive Security	4		Elective 2	3-4
	PDACS ZG575	Ethical Hacking	3		Elective 3	3
	Total		18	Total		18

Post Graduate Diploma
(Business Analytics)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ M.Sc. in relevant disciplines, with minimum one year work experience in relevant business domains
(OR)
Employed professionals holding a three year undergraduate degree in such areas as Mathematics, Statistics, Science, Economics, Commerce, and Business Management, and having studied at least one course in mathematics or statistics at the high school or higher level, and with minimum two years of work experience in relevant business domains.

Nominal Duration: Two Semesters

Programme Structure:

Core Courses

Course No.	Course Title	Units
PDBA* ZC413	Analytics for Competitive Advantage	4
PDBA* ZC417	Quantitative Methods	4
PDBA* ZG512	Predictive Analytics	4
PDBA* ZG536	Foundations of Data Science	4
PDBA* ZG538	Advanced Statistical Methods	4
PDBA* ZG539	Data Visualization and Communication	4

Pool of Electives

Course No.	Course Title	Units
PDBA* ZG517	Financial Analytics	4
PDBA* ZG523	Project Management	4
PDBA* ZG563	Analytics for HR	4
PDBA* ZG564	Models in Marketing	4
PDBA* ZG565	Supply Chain Analytics	4
PDBA* ZG566	Analytics for Marketing	4
PDBA* ZG567	Analytics for Retail Industry	4
PDBA* ZG568	Operations Research Models	4
PDBA* ZG569	Analytics for Investment Banking	4
PDBA* ZG570	Financial Risk Models	4
PDBA* ZG571	Analytical Models in Finance	4

Post Graduate Diploma
(Business Analytics)

Semesterwise pattern

Year	First Semester			Second Semester		
	Course No.	**Course Title**	**Units**	**Course No.**	**Course Title**	**Units**
I	PDBA* ZC417	Quantitative Methods	4	PDBA* ZG512	Predictive Analytics	4
	PDBA* ZG539	Data Visualization and Communication	4	PDBA* ZC413	Analytics for Competitive Advantage	4
	PDBA* ZG538	Advanced Statistical Methods	4		Elective 1	4
	PDBA* ZG536	Foundations of Data Science	4		Elective 2	4
		Total	16		Total	16

Post Graduate Diploma
(Electric Vehicles)

Type of input:
Candidates holding an integrated first degree of BITS Pilani or its equivalent such as B.E./B. Tech in relevant disciplines

Nominal duration: Two semesters

Program structure:
Core courses: (5)

Course No.	Course Title	Units
PDEV ZC411	Principles, Analysis and Design of Electric Vehicles	4
PDEV ZC412	Sensors, Communication and Signal Processing	4
PDEV ZG521	Power Electronics and Drives	4
PDEV ZG511	Battery Management Systems	4
PDEV ZG513	Model Based System Development	4

Pool of electives: (5)

Course No.	Course Title	Units
PDEV ZG514	Vehicle Diagnostics and Reliability	4
PDEV ZC442	Advanced Driver Assistance Systems	4
PDEV ZG519	Automotive Security	4
PDEV ZG621	Safety Critical Advanced Automotive Systems	4
PDEV ZG512	Machine Intelligence in Autonomous Vehicles	4

Semester-wise pattern

Year	First Semester			Second Semester		
	Course #	**Course Title**	**Units**	**Course #**	**Course Title**	**Units**
I	PDEV ZC411	Principles, Analysis and Design of Electric Vehicles	4	PDEV ZG513	Model Based System Development	4
	PDEV ZC412	Sensors, Communication and Signal Processing	4		Elective I	4
	PDEV ZG521	Power Electronics and Drives	4		Elective II	4
	PDEV ZG511	Battery Management Systems	4		Elective III	4
		Total	16		Total	16

Post Graduate Diploma
(Finance)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ M.Sc. in relevant disciplines, with minimum one year work experience in relevant business domains.
(OR)
Employed professionals holding a three year undergraduate degree in such areas as Mathematics, Statistics, Science, Economics, Commerce, and Business Management, and having studied at least one course in mathematics or statistics at the high school or higher level, and with minimum two years of work experience in relevant business domains.

Nominal Duration: Two Semesters

Curriculum Requirements

Completion of the programme would require:

- At least 8 courses (totaling at least 32 units) towards coursework

Programme Structure:

Core Courses

Course No.	Course Title	Units
PDFI* ZC415	Financial and Management Accounting	4
PDFI* ZG517	Financial Analytics	4
PDFI* ZG518	Multinational Finance	4
PDFI* ZG520	Security Analysis & Portfolio Management	4
PDFI* ZG521	Financial Management	4
PDFI* ZG560	Global Financial Markets and Products	4

Pool of Electives

Course No.	Course Title	Units
PDFI* ZG559	Management of Banks & Financial Institutions	4
PDFI* ZG516	Introduction to FinTech	4
PDFI* ZG519	Business Analysis and Valuation	4
PDFI* ZG528	Venture Capital and Private Equity	4
PDFI* ZG544	Mergers, Acquisitions, and Corporate Restructuring	4
PDFI* ZG556	Advanced Risk Models	4
PDFI* ZG558	Financial Risk Management	4
PDFI* ZG561	Behavioural Finance	4
PDFI* ZG562	Derivatives & Financial Engineering	4

Post Graduate Diploma
(Finance)

Semesterwise pattern

Year	First Semester		U	Second Semester		U
	Course No.	**Course Title**		**Course No.**	**Course Title**	
I	PDFI* ZC415	Financial and Management Accounting	4	PDFI* ZG518	Multinational Finance	4
	PDFI* ZG521	Financial Management	4	PDFI* ZG517	Financial Analytics	4
	PDFI* ZG560	Global Financial Markets and Products	4		Elective 1	4
	PDFI* ZG520	Security Analysis and Portfolio Management	4		Elective 2	4
	Total		**16**	**Total**		**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Post Graduate Diploma
(FinTech)

Type of Input:	Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./M.Sc. in relevant disciplines, with minimum one-year work experience in relevant domains (OR) Employed professionals holding a three year undergraduate degree in such areas as Mathematics, Statistics, Science, Economics, Commerce, and Business Management, and having studied at least one course in mathematics or statistics at the high school or higher level, and with minimum two years of work experience in relevant business domains.
Nominal Duration:	Two Semesters

Programme Structure:

Core Courses

Course No.	Course Title	Units
PDFT* ZC417	Quantitative Methods	4
PDFT* ZG516	Introduction to FinTech	4
PDFT* ZG517	Financial Analytics	4
PDFT* ZG521	Financial Management	4
PDFT* ZG553	Block Chain and Applications	4
PDFT* ZG560	Global Financial Markets and Products	4

Pool of Electives

Course No.	Course Title	Units
PDFT* ZC419	Financial Risk Analytics	4
PDFT* ZG527	Entrepreneurship in FinTech	4
PDFT* ZG529	Machine Learning for Finance	4
PDFT* ZG530	InsurTech	4
PDFT* ZG532	Deep Learning Application in Finance	4
PDFT* ZG533	Technology Disruptions in FinTech	4
PDFT* ZG554	Digital Banking and Beyond	4
PDFT* ZG555	Algorithmic and High Frequency Trading	4
PDFT* ZG557	FinTech in Wealth Management	4

Post Graduate Diploma
(FinTech)

Semesterwise pattern

Year	First Semester			Second Semester		
	Course No.	**Course Title**	**Units**	**Course No.**	**Course Title**	**Units**
I	PDFT* ZC417	Quantitative Methods	4	PDFT* ZG517	Financial Analytics	4
	PDFT* ZG521	Financial Management	4	PDFT* ZG553	Block Chain and Applications	4
	PDFT* ZG560	Global Financial Markets and Products	4		Elective 1	4
	PDFT* ZG516	Introduction to FinTech	4		Elective 2	4
	Total		16	Total		16

Post Graduate Diploma
(Manufacturing Management)

Type of Input:

1. Employed professionals holding a three-year undergraduate degree or its equivalent in relevant disciplines, with adequate work experience in relevant domains.
2. Employed professionals holding a three-year undergraduate degree or its equivalent in relevant disciplines, and a Post-graduate Certificate in Manufacturing Practice, with adequate work experience in relevant domains, for admission into the second semester of the programme with a credit transfer of up to 16 units from the said certificate.

Nominal Duration: Two Semesters

Programme Structure

Core courses

Course No.	Course Title	Units
PDMM* ZC415	Financial and Management Accounting	4
PDMM* ZG537	Lean Manufacturing	5
PDMM* ZC416	Managerial Economics	4
PDMM* ZG511	Managing People & Organizations	4
PDMM* ZC411	Marketing	4
PDMM* ZG526	Operations Management	4
PDMM* ZC417	Quantitative Methods	4
PDMM* ZG522	Total Quality Management	4

Semesterwise pattern

Course No.	Course Title	Units
First Semester		
PDMM*ZG511	Managing People & Organizations	4
PDMM*ZG522	Total Quality Management	4
PDMM*ZG526	Operations Management	4
PDMM*ZG537	Lean Manufacturing	5
Second Semester		
PDMM*ZC411	Marketing	4
PDMM*ZC415	Financial and Management Accounting	4
PDMM*ZC416	Managerial Economics	4
PDMM*ZC417	Quantitative Methods	4

Post Graduate Diploma
(Smart Manufacturing)

Type of Input:
Candidates holding an integrated first degree of BITS Pilani or its equivalent such as B.E./B. Tech in relevant disciplines
Nominal Duration: Two semesters

Program Structure:
Core Courses: (5)

Course No.	Course Title	Units
PDSM ZG511	Mechatronics	5
PDSM ZG622	Industrial Internet of Things	4
PDSM ZG532	Big Data Analytics in Manufacturing	4
PDSM ZG535	Cyber Security in Manufacturing	4
PDSM ZG515	Connected Manufacturing	4

Pool of electives: (5)

Course No.	Course Title	Units
PDSM ZG561	Mechanisms & Robotics	5
PDSM ZG516	Microfabrication Technologies	4
PDSM ZG565	Machine Learning	4
PDSM ZG569	Blockchain Technologies and Systems	4
PDSM ZG527	Cloud Computing	5

Semester-wise pattern of courses

Year	First Semester			Second Semester		
	Course #	Course Title	Units	Course #	Course Title	Units
I	PDSM ZG511	Mechatronics	5	PDSM ZG515	Connected Manufacturing	4
	PDSM ZG622	Industrial Internet of Things	4		Elective I	4
	PDSM ZG532	Big Data Analytics in Manufacturing	4		Elective II	4 (min)
	PDSM ZG535	Cyber Security in Manufacturing	4		Elective III	4 (min)
		Total	17		Total	16-18

Post Graduate Diploma
(Smart Mobility)

Type of Input:
Candidates holding an Integrated First degree of BITS Pilani or its equivalent such as B.E./B. Tech in relevant disciplines.

Nominal Duration: Two semesters

Program structure:
Core courses: (4)

Course No.	Course Title	Units
PDSMO ZC411	Introduction to Autotronics and Control	4
PDSMO ZC412	Automotive Networks & Communications	4
PDSMO ZG512	Embedded System Design	4
PDSMO ZC442	Advanced Driver Assistance Systems	4

Pool of electives: (6)

Course No.	Course Title	Units
PDSMO ZG519	Automotive Security	4
PDSMO ZG621	Safety Critical Advanced Automotive Systems	4
PDSMO ZG524	Vehicle Dynamics	4
PDSMO ZG513	Model Based System Development	4
PDSMO ZG512	Machine Intelligence in Autonomous Vehicles	4
PDSMO ZG514	Vehicle Diagnostics and Reliability	4

Semester-wise Pattern:

Year	First Semester			Second Semester		
	Course #	Course Title	Units	Course #	Course Title	Units
I	PDSMO ZC411	Introduction to Autotronics and Control	4		Elective 1	4
	PDSMO ZC412	Automotive Networks & Communications	4		Elective 2	4
	PDSMO ZG512	Embedded System Design	4		Elective 3	4
	PDSMO ZC442	Advanced Driver Assistance Systems	4		Elective 4	4
		Total	16		Total	16

Structure for Diploma Programme

Category	Number Of Courses	Number Of Units
Foundation Courses	6-10	20-40
Discipline Core	10-14	32-56
Electives	1-2	3-8
Coursework Sub-Total	**20 courses (min)**	**67 units (Min)**
Project	1-2	5-10
Total	**21 courses (min)**	**72 Units (Min)**

Diploma in Software Development

An intermediate exit option for the students admitted to the B.Sc. Computer Science Programme with a Diploma in Software Development having completed the requirements as per proposed structure. The students will have gained the knowledge/skills in the following areas.

- Foundation courses necessary to advance the learners knowledge in domains in computer science
- Understanding of computer systems and systems programming
- Programming and Problem solving skills
- Programming Languages at different levels of abstraction
- Application Development

Semester-wise Pattern for Diploma in Software Development.

Year	First Semester		U		Second Semester	U
I	BCS ZC313	Introduction to Programming	4	BCS ZC311	Data Structures and Algorithms	4
	BCS ZC219	Discrete Mathematics	3	BCS ZC316	Object Oriented Programming	4
	BCS ZC230	Linear Algebra and Optimization	3	BCS ZC215	Command Line Interfaces and Scripting	3
	BCS ZC228	Introduction to Computing Systems	3	BCS ZC233	Probability and Statistics	3
	BCS ZC111	Basic Electronics	2	BCS ZC112	Introduction to Logic	2
	BCS ZC239	Writing Practice	3		Foundation Option 1	3
	Units		18	Units		19
II	BCS ZC212	Algorithm Design	3	BCS ZC232	Operating Systems	3
	BCS ZC317	Relational Databases	4	BCS ZC214	Building Database Applications	3
	BCS ZC238	Web Programming	3	BCS ZC234	Programming Mobile Devices	3
	BCS ZC236	Software Design Principles	4	BCS ZC220	Environmental Studies	3
	BCS ZC216	Computer Systems and Performance	3	BCS ZC222	Formal Languages and Applications	3
		Foundation Option 2	2		Discipline Elective #1	3
	Units		19	Min Units		18
Summer Term						
BCS ZC242T Project 5 Units						

Post Graduate Certificate Programme
(Artificial Intelligence and Machine Learning)

Type of Input:	Employed professionals holding a M.Sc. degree with mathematics/statistics with adequate work experience in relevant domains or Employed professionals holding a four-year B.Tech. degree or its equivalent in relevant disciplines.
Expected Learning Hours:	~440 hours
Minimum Requirement for Certification	Successful completion of the certificate programme would require completion of all the courses with a minimum C- grade in each course
Marginal Deficiency	Students without sufficient exposure to Python programming language will have to complete the deficiency course/module on Python before the start of the certificate programme. However, the performance in the deficiency course/module will not be accounted in the calculation of CGPA and will not be part of the requirement for certification.

List of Courses

Course No.	Course Title	Units
PCAM* ZC211	Regression	2
PCAM* ZC111	Feature Engineering	1
PCAM* ZC311	Classification	3
PCAM* ZC221	Unsupervised Learning and Association Rule Mining	2
PCAM* ZC231	Text Mining	2
PCAM* ZC241	Deep Learning and Artificial Neural Networks	2
PCAM* ZC321	Capstone Project	3
	Total	15

Note: In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing collaborating organization.

Post Graduate Certificate Programme
(Big Data & Analytics)

Type of Input	Employed professionals holding a three-year undergraduate degree in relevant disciplines, with adequate preparation in Mathematics and Computer Programming, as well as adequate work experience in relevant domains.
(Expected) Learning Hours	~ 230 hours
Minimum Requirement for Certification	Successful completion of the Certificate Programme would require: 1. Completion of all courses with a minimum C- grade in each course. 2. Obtaining a minimum CGPA of 5.00
Marginal Deficiency	Students without sufficient exposure to courses like Data Structures & Algorithms, Database Systems, and Object Oriented Programming using Java would be prescribed deficiency modules. While the student must complete the deficiency modules before start of the program, the performance in the deficiency modules will not be accounted in the calculation of CGPA and will not be part of the requirement for certification.

List of Courses

Course No.	Course Title	Units
CBDA ZG511	The Hadoop Framework	1
CBDA ZG521	ETL & Batch Processing with Hadoop	2
CBDA ZG531	Big Data Analytics with Spark	3
CBDA ZG541	Capstone Project	2
	Total	**8**

Post Graduate Certificate Programme
(Big Data Engineering)

Type of Input:	Employed professionals holding a three-year undergraduate degree in relevant discipline, with adequate preparation in Mathematics and Computer Programming, as well as adequate work experience in relevant domains.
(Expected) Learning Hours	~ 315 hours
Minimum Requirement for Certification	Successful completion of the Certificate Programme would require: 1. Completion of all courses with a minimum C- grade in each course. 2. Obtaining a minimum CGPA of 5.00
Marginal Deficiency	Students without sufficient exposure to courses like Data Structures & Algorithms and Database Systems would be prescribed deficiency modules. While the student must complete the deficiency modules before start of the program, the performance in the deficiency modules will not be accounted in the calculation of CGPA and will not be part of the requirement for certification.

List of courses

Course No.	Course Title	Units
CBDE ZG511	Foundations of Big Data Systems	2
CBDE ZG521	Platforms for Big Data	2
CBDE ZG531	Processing Big Data - ETL & Batch Processing	2
CBDE ZG541	Processing of Real-Time Data and Streaming Data	1
CBDE ZG551	Big Data Analytics	1
CBDE ZG571	Capstone Project	3
	Total	**11**

Post Graduate Certificate Programme
(Full Stack Engineering)

Type of Input:	Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./B.Tech/M.Sc./MCA. Degree or its equivalent in relevant disciplines and adequate work experience in the software industry.
Expected Learning Hours and Units	~630 hours(21 Units)
Minimum Requirement for Certification	1. Successful completion of the certificate programme would require completion of all the courses with a minimum C- grade in each course 2. Obtaining a minimum CGPA of 5.00
Marginal Deficiency	Students without sufficient exposure to courses like Python Programming and Database Systems (SQL) would be prescribed deficiency modules. The performance in the deficiency modules will not be accounted in the calculation of CGPA and will not be part of the requirement for certification.

List of Courses

Course No.	Course Title	Units
CFSE ZG511	Overview of Full Stack Engineering	2
CFSE ZG521	Web Development	5
CFSE ZG531	Mobile Application Development	2
CFSE ZG541	Cloud Native Development	3
CFSE ZG551	Agile and DevOps	3
CFSE ZG561	Deployment of Microservices	2
CFSE ZG571	Capstone Project	4
	Total	21

Post Graduate Certificate Programme
(General Management)

Type of Input: Employed professionals holding a three-year undergraduate degree or its equivalent in relevant disciplines, with adequate work experience in relevant domains.

Expected Learning Hours: ~480 hours

Minimum Requirement for Certification : Successful completion of the Certificate Programme would require:
Obtaining a minimum CGPA of 5.50

Semesterwise Pattern

Course No.	Course Title	Units
PCGM* ZC411	Marketing	4
PCGM* ZC415	Financial and Management Accounting	4
PCGM* ZC417	Quantitative Methods	4
PCGM* ZC416	Managerial Economics	4

Post Graduate Certificate Programme
(Internet of Things)

Type of Input:	Employed professionals holding an Integrated First Degree of BITS or its equivalent in Electrical & Electronics Engineering or Computer Science or other relevant discipline with adequate work experience in relevant domains.
(Expected) Learning Hours	~ 650 hours
Minimum Requirement for Certification	Successful completion of the Certificate Programme would require: 1. Completion of all courses with a minimum C- grade in each course. 2. Obtaining a minimum CGPA of 5.00

List of courses

Course No.	Course Title	Units
CIOT ZG511	IoT Technology and Applications	3
CIOT ZG521	Hardware Architectures for IoT	4
CIOT ZG531	Communication and Networking Technologies in IoT	3
CIOT ZG541	Sensors, Actuators, and Signal Processing	3
CIOT ZG551	Software and Programming in IoT	4
CIOT ZG561	Data Management in IoT	2
CIOT ZG571	Capstone Project	3
	Total	22

Post Graduate Certificate Programme
(Manufacturing Practice)

Type of Input: Employed professionals holding a three-year undergraduate degree or its equivalent in relevant disciplines, with adequate work experience in relevant domains.

Expected Learning Hours: ~510 hours

Minimum Requirement for Certification : Successful completion of the Certificate Programme would require:
Obtaining a minimum CGPA of 5.50

Semesterwise Pattern

Course No.	Course Title	Units
PCMP* ZG511	Managing People & Organizations	4
PCMP* ZG526	Operations Management	4
PCMP* ZG537	Lean Manufacturing	5
PCMP* ZG522	Total Quality Management	4

Post Graduate Certificate Programme
(Non-sewered Sanitation)

Type of Input:	Employed professionals holding an Integrated First Degree of BITS or its equivalent in the areas of Civil, Chemical Engineering, Chemistry, Biology or other relevant discipline with adequate work experience in relevant domains.
(Expected) Learning Hours	~ 600 hours
Minimum Requirement for Certification	Successful completion of the Certificate Programme would require: Obtaining a minimum CGPA of 5.00

List of courses

Course No.	Course Title	Units
CNSS ZG511	Sanitation Technology	5
CNSS ZG512	Sanitation and Public Health	5
CNSS ZG513	Sanitation Governance, Behavioral Change and Advocacy	5
CNSS ZG515	Emergency Sanitation and Leadership	5
	Total	20

Certificate in Manufacturing Practice

Type of Input: Employed professionals holding a Technical Diploma or its equivalent, with adequate work experience in relevant domains.

Expected Learning Hours: ~390 hours

Minimum Requirement for Certification: Successful completion of the Certificate Programme would require:
Obtaining a minimum CGPA of 4.50

Semester wise pattern

Course No.	Course Title	Units
CMP* ZC411	Managing People & Organizations	3
CMP* ZC426	Operations Management	3
CMP* ZC437	Lean Manufacturing	4
CMP* ZC422	Total Quality Management	3

Certificate in General Management

Type of Input: Employed professionals holding a Technical Diploma or its equivalent, with adequate work experience in relevant domains.

Expected Learning hours: ~360 hours

Minimum Requirement for Certification: Successful completion of the Certificate Programme would require:
Obtaining a minimum CGPA of 4.50

Semesterwise Pattern

Course No.	Course Title	Units
CGM* ZC411	Marketing	3
CGM* ZC421	Financial and Management Accounting	3
CGM* ZC431	Quantitative Methods	3
CGM* ZC414	Managerial Economics	3

PART VI

COURSE DESCRIPTIONS

(On-Campus)

LEGEND

The numbers that appear at the end of each course title like 3 0 3, 0 9 3, 2 3 3 etc. indicate the lecture hours per week, the practical/seminar/project hours per week and the number of units in that order. Wherever a single number (with or without*) appears, it indicates only total units and its break up in terms of lectures and practicals/seminar/project may be announced from time to time through the timetable whenever it is needed.

PART VI: COURSE DESCRIPTIONS *(On-Campus) See enclosed CD for Contents*

Aeronautics 2
AN F311 Principles of Aerodynamics 2
AN F312 Aircraft Propulsion 2
AN F313 Flight Mechanics and Controls 2
AN F314 Introduction to Flight 2
AN F315 Aircraft Structures 2
Biological Sciences 2
Biotechnology 6
BITS 7
Civil Engineering 16
Chemical Engineering 25
Chemistry 32
Chinese 37
Computer Science 37
Design Engineering 43
Electronics and Communication Engineering 43
Economics 45
Electronics and Computer Engineering 49
Environmental Engineering 51
Electrical and Electronics Engineering 52
English 58
Finance 59
French 61
General Studies 61
Humanities and Social Sciences 63
Humanities 68
Instrumentation 68
Information Systems 71
Internet Technology & e-Business 72
Japanese 72
Mathematics 72
Master of Business Administration 76
MBA in Business Analytics 81
Mechanical Engineering 84
Microelectronics 89
Manufacturing Engineering 90
Management 93
Public Health 94
Manufacturing Systems Engineering 95
Materials Science and Technology 95
Music 96
Pharmacy 97
Physics 102
M.E. Sanitation Science, Technology and Management 106
Sanskrit 106
Russian 107
Skill Area 107
Software Systems 107

This part gives a detailed description of all the courses.

Offering of courses: The academic calendar consists of two regular semesters. The summer term is not part of the academic calendar except where specifically stated. The offering of courses shall always depend on the normal unfolding of these courses for regular students who should be able to negotiate all the courses required as compulsory or electives as they proceed within the stated number of years in the programme. Very often any departure from this practice is subject to the overall facilities available. It will be invariably taxing of facilities to help the largest number of students when possible. For instance, same course is offered in both the semesters where only one is necessary, in the pattern described above. Depending upon the need and the facilities, Dean, AUGSD/AGSRD decides the courses that will be offered in any particular semester and this information will be made available through a course-wise timetable at the beginning of every semester.

It will be clear from the above discussion that a student who wishes to exercise his choice of electives can do so only through courses available in the timetable and not courses which are mentioned in the bulletin. Nonetheless, students can easily guess, on the basis of previous timetables, which courses are likely to be offered in what semester and make an advance planning to the extent it is possible. Similarly, a student who has backlog will find that he is already out of phase with the pattern that has been described earlier and therefore has to work out a strategy for himself by which he reduces fouling up as much as it is possible for him to do so.

While registration in a particular course or set of courses is governed by Academic Regulations, for easy reference the following general guidelines together with specific points are listed.

1. The Dean, AUGSD/AGSRD may introduce or withdraw courses in categories which are taken on the basis of electives or options.
2. Registration in any course can be made only with the prior permission of the Dean, AUGSD/AGSRD.
3. Although the detailed break-up of the units in terms of hours for lecture and practical classes are presented without designating tutorial hours, every student will be required to attend these tutorial classes as and when required by the Dean, AUGSD/AGSRD.
4. In the structure of a programme a block of courses follow in a particular sequence semester after semester. The mere fact that no specific restriction has been put does not permit unwarranted jumbling of this sequence. This sequence is presented in semesterwise pattern for each programme.
5. The lists of courses to be followed invariably have numbers attached to each course. These numbers generally determine the level at which the course is to be normally registered. However on the same plane there are courses which are specially designed for group C programmes and are not available to students of groups A&B programmes. Appropriate sections of the Bulletin may be consulted.
6. Sometimes a particular course has a prerequisite condition which has to be fulfilled before one can register in that course, or has to be waived with the consent of the Dean, AUGSD/AGSRD.
7. For registration in certain specific courses like Specialized Discipline Courses, Higher Degree Courses, apart from the prerequisite, there will also be requirement of prior preparation. Academic regulations must be consulted for this.
8. For students registered in courses of Off-Campus Work Integrated Learning and Collaborative Programmes corresponding instructions have been detailed in PART V.

Note: The items mentioned above are not exhaustive. For precise rules reference should be made to Academic Regulations.

Course Description for all On-campus Programmes

Aeronautics

AN F311 Principles of Aerodynamics **3 0 3**

Introduction to Airfoils, forces and coefficients, fundamental principles, inviscid incompressible flow, incompressible flow over Airfoils and Finite Wings, Compressible Flow, Subsonic Compressible Flow, Transonic and Supersonic Flow, Hypersonic Flow, Viscous Flow, Exposure to Software tools for Geometry Modelling and Flow field simulation.

Pre-requisite: CE F231 OR CHE F212 OR ME F212 Fluid Mechanics OR MF 218 Transport Phenomena in Manufacturing

AN F312 Aircraft Propulsion **3 0 3**

Air breathing engines, Jet engines, Performance parameters of jet engines, Ramjet and pulsejet engines, Thermodynamic and performance analysis of turbojet, turbofan and turboprop engines, Intake, Combustion and Exhaust systems in propulsion engines, Advanced propulsion engines. Exposure to Software Tools for Nozzle Flow and Propulsion Performance Simulations

Pre-requisite: CE F231 OR CHE F212 OR ME F212 Fluid Mechanics OR MF 218 Transport Phenomena in Manufacturing

AN F313 Flight Mechanics and Controls **3 0 3**

Introduction to Airplane Flight Mechanics, Equation of Motion (3DOF), Atmosphere and Propulsion, Aerodynamics forces, Cruise and Climb, Take-Off and Landing, Acceleration and Turns, Equation of Motion (6DOF), Static Stability and Control, Dynamic Stability and Control, Feedback Stability Augmentation, Exposure to Software Tools for Flight Path Simulation and Control.

AN F314 Introduction to Flight **3 0 3**

Fundamentals and historical developments in Aviation, Standard Atmosphere Properties, Basic Aerodynamics, Airfoils and Wings, Forces, Supersonic Flight, Airplane Performance, Stability and Control, Types of powerplants for aerospace vehicles, Introduction to Structures and Materials, Supersonic and Hypersonic Vehicles, Exposure to Software tools for Wing Geometry Modelling and Force Calculations.

AN F315 Aircraft Structures **3 0 3**

Basic elasticity and 2D problems, Virtual work and energy method, Bending of thin plates, Structural components of aircraft, Airworthiness and airframe loads, Bending, Shear and Torsion of Thin-Walled Beams, Stress analysis of aircraft components including Wing spars and box beams, Fuselage, Wings, Fuselage frame and wing ribs, Laminated composite structures, Aeroelasticity, Computational Modelling of various Aircraft Components under Service Loads.

Pre-requisite: ME F211 OR CE F211 Mechanics of Solids

Biological Sciences

BIO F110 Biology laboratory **0 2 1**

An introductory level course where students would perform selected experiments of biology in the laboratory so that they appreciate the concepts learnt in theory course. Experiments related to Microscopy and micrometry, quantification of biological macromolecules, chlorophyll estimation, measurement of solvent potential of plant tissue, measurement of parameters related to cell cycle, Experiments related to hematology, DNA quantification from the plant organs; Water analysis.

BIO F111 General Biology **3 0 3**

Living systems and their properties; major biological compounds; basic physiological processes; introduction to genetics; environment and evolution.

BIO F201 Introductory Biology **3 1 4**

Living systems and their properties; classification of organisms; biochemical pathways operative in organisms; introductory genetics, Introductory recombinant DNA technology, ecology and environmental scienes and related basic labs.

BIO F211 Biological Chemistry **3 0 3**

The molecular process of life presents us with a seemingly never ending succession of chemical mechanisms of almost incredible fascination. This course is introduced at the cellular and molecular level and focus upon bio -macromolecules, biosynthesis of macromolecules, energy yielding and requiring processes, genetic information etc. This would help going for higher level activities, appreciation of biochemical problems, evaluation and problem solving. It also includes theory of techniques used in biochemistry and related experiments.

BIO F212 Microbiology **3 1 4**

Introduction and classification of microbes; structure, physiology and genetics of microbial cell; isolation, cultivation, physiological and biochemical characterization of microbes; host parasite relationship; microbiology of soil, water and food; physical chemical methods of controlling microbes; antimicrobial drugs; clinical microbiology; and related lab components.

BIO F213 Cell Biology **3 0 3**

Types and properties of cells; microscopy; membrane structure, function and transport; endomembrane system and its functions; nuclear organization and functions; ribosomes and protein synthesis; cytoskeleton; cell communication; cell cycle, cell growth and cancer; apoptosis; techniques, related experiments and applications of cell biology.

BIO F214 Integrated Biology **3 0 3**

The Integrative Biology course is a course which bridges as well as opens new vistas to a student taking up bioogy. The course covers two tracks, essentially. The first track introduces the student to the ordering that helps biologists to actually study the vast diversity of the living world. This track would encompass questions related to the origin and evolutionary pathways followed in Nature, as well as the methods followed by biologists to systematically categorize and document them. The second track highlights the uses and applications of biology in everyday life – whether in the economic or in the social realms. Together, the course projects the subject in a way from which the student can choose and implement his biological knowledge vis-à-vis his/her interests.

BIO F215 Biophysics **3 0 3**

A study of molecules and their interaction forces; bio-energetics and physical techniques as applied to biological phenomena and related labs.

BIO F216 Water,Sanitation and Solid Waste Management **3 0 3**

Municipal Solid Waste Management in Developing Countries, Planning and Design of Sanitation Systems and Technologies, Introduction to Household Water Treatment and Safe Storage, Introduction to Faecal sludge management.

BIO F217 Laboratory for Water,Sanitation and Solid waste Management **1 2 3**

Chemical oxygen and Biological oxygen demand of wastewater, Total organic carbon analysis, Phosphorus analysis, Kjeldahl Nitrogen analysis – for waste water, estimation of total solids and volatile solids in organic waste, biochemical methane potential of organic waste, struvite precipitation from wastewater and analysis by XRD Microbial fuel cell for wastewater treatment, detection of methanogens by fluorescence microscopy, atomic absorption spectrophotometric analysis of arsenic in water composting of faecal sludge.

BIO F231 Biology Project Laboratory **3**

The course includes projects involving laboratory investigation

or laboratory development in Biology. The course is normally available to students of second or higher level. The course must coterminate with a project report.

BIO F241 Ecology and Environmental Sciences 3 0 3

Biotic and abiotic components of environment; limiting factors; regional ecology; ecosystem productivity and trophism; population and community ecology; succession and evolution; pollution; environmental biotechnology; Indian environmental movement. Associated with related labs.

BIO F242 Introduction to Bioinformatics 3 0 3

Introduction to genomic & Proteomics, Biological databases and data mining, sequence similarity search and sequence alignment algorithms, Phylogenetic tree construction algorithms, Protein structure predication and structure analysis, use of software package in Bioinformatics; Related lab components.

BIO F243 Genetics 3 0 3

Facts and theories of heredity, their relation to the present state of biological theory in general; elements of population genetics; genetics and species concept and related labs.

BIO F244 Instrumental Methods of Analysis 1 3 4

Principles, configuration, applications of instruments like mass spectrophotometer, NMR,UV, IR, X-ray apparatus, atomic spectrophotometer, Fluorescence Spectroscopy, gas chromatography, liquid scintillation spectrophotometer, laser device, high voltage electrophoresis, ultracentrifuge, DTA,TGA, Thermo Cycler-PCR, SDS-PAGE, ELISA etc. The course is specially designed for students in the first degree majoring in experimental sciences and would require groups of students to work with the above instruments in order to appreciate the potentiality of such modern instrumental methods of analysis.

BIO F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

BIO F311 Recombinant DNA Technology 3 0 3

The course deals with theoretical aspects and lab exposure to selected experiments of recombinant DNA manipulation. Emphasis will be placed on procedures to create chimeric molecules using examples from actual experimental work. Vector designing, PCR, qPCR, DNA sequencing, in-vitro mutagenesis, cloning in prokaryotic and eukaryotic systems and whole genome approaches will be covered with related lab components.

BIO F312 Plant Physiology 3 0 3

Basic functional processes in plants; Plant tissue system, Plant-water relations, Gaseous exchange, Stomatal regulations, Mineral nutrition and absorption, Transport of material, Growth and development, Hormones and PGRs, Photoperiodism, Vernalization, Plant defense mechanisms, Stress Physiology and related lab components.

BIO F313 Animal Physiology 3 0 3

Principles and concepts underlying the function of tissues and organ systems in animals, with emphasis on mammalian systems and integration of systems at the level of the whole organism. Several biological systems are considered, including respiratory, circulatory, nervous, endocrine, immune, excretory, muscles, skeletal and reproductive systems. Laboratory session will help to study function of any organ system; Related lab components.

BIO F314 Conservation Biology 2 1 3

Biological diversity: its measurement, value and crisis; conservation at ecosystem, population and species levels; protection, management and res-toration of ecosystems; sustainable development and community-based conservation; conservation legislation. Course practicum will be effected through classroom and field activities.

BIO F315 Applied Nutrition and Nutraceuticals 3 0 3

This course will provide a broad framework for understanding the significance of food and nutrition to human health and well-being. Beginning with basic concepts in nutritional biochemistry & microbiology, this course will expand into applied nutrition themes — malnutrition – under-nutrition *versus* over-nutrition, nutrigenomics, clinical nutrition, functional foods & nutraceuticals, food safety and security. The course will also include themes such as industrial development of functional and genotype-specific foods and beverages (example, infant-food formulations), fortified foods, phytochemicals, nutritional databases & personalized nutritional plan, using suitable case-studies

BIO F341 Developmental Biology 3 0 3

Scope and problems in developmental biology; major model organisms (vertebrates, invertebrates and plants) and their life cycles; patterning and axis formation; morphogenesis; organogenesis; nervous system; germ cells and sex; cell differentiation and stem cells; growth, ageing and regeneration; applications of developmental biology. The course will emphasize universal principles that govern the process of development; Related lab components.

BIO F342 Immunology 3 0 3

Introduction to immune system, cell mediated and humoral immunity, immune system in health and disease immunity to infectious diseases, immune mechanisms involved in cancer, immunodeficiency and autoimmunity. Vaccination and transplantation Immunology; Related lab components.

BIO F352 Cell and Tissue Culture Technology 3 1 4

Theories and practices on *in vitro* techniques for plants and animals, development of normal and tumor cell lines, somatic hybridization, monoclonal antibody production, hairy root cultures, secondary metabolite production, scale-up strategies for large scale production of biomass.

BIO F366 Lab Project 3

BIO F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BIO F376 Design Project 3

BIO F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BIO F411 Laboratory 0 9 3

Specially designed for M.Sc. Biological Sciences; cannot be taken by others under any circumstances.

This laboratory course is designed only for M.Sc. Biological Sciences students and aims to expose the students to and build competence in selected techniques of modern biology.

BIO F413 Molecular Biology of Cell 3 0 3

Introduction of eukaryotic cell cycle, genetic regulation of cell cycle and differential gene expression during developmental process. In addition, the postulated functions of hitherto accepted non-essential DNA and the functioning of higher eukaryotic genes with unexpected structures in eukaryotic genomes would also be covered.

BIO F417 Biomolecular Modelling 3 0 3

Biomolecular Conformation, Structural genomics and proteomics, protein folding, Forecefield, Simulation, Conformational analysis, ab initio structure prediction, comparative modeling,

lattice models, usage of modeling packages.

BIO F418 Genetic Engineering Techniques 1 3 4

Experiments on the common molecular biology techniques used in gene manipulation in bacteria and plants; gene cloning procedure in bacteria – from isolation of plasmids to screening of recombinant clones; polymerase chain reaction (PCR) and its applications; gene and protein expression analysis; DNA sequencing; Agrobacterium-mediated gene transfer in plants and introduction to plant cell culture techniques; Use of software for molecular biology.

BIO F419 Molecular Evolution 3 0 3

Introduction of evolution of macromolecules, reconstruction of evolutionary history of genes and organisms, evolutionary adaptation to temperature, water solute adaptation, dynamics of genes in populations, rates and pattern of nucleotide substitution, evolution of gene duplication and domain shuffling, concreted evolution of multigene family, genome organization and evolution, roles of mutation and selection in molecular evolution.

BIO F421 Enzymology 3 0 3

Enzyme nomenclature and classification; isolation and purification; structures; kinetics; regulation of enzymatic reactions; evaluation of enzymes and other proteins.

BIO F431 Reproductive Physiology 3 0 3

Study of sexual cycles; biochemistry of fertilisation; control of ovarian functions; gonadotropins; pheromones and mammalian reproduction.

BIO F441 Biochemical Engineering 3 0 3

Principles of Chemical Engineering applied to Bioprocesses; Kinetic Models for growth, substrate utilization and product formation; Biological reaction kinetics and applied enzyme catalysis; immobilized biocatalysts; Bioreactor Design and Operation; Fermentation, Upstream & Downstream processing; Novel Bioreactor Configurations; Transport phenomena in Bioprocesses; Instrumentation and control; Bioprocess Optimization and Scale up; Industrial Protein Purification Techniques; Commercial Enzymes & Biopharmaceuticals; Bioprocess Patenting, Economics & Feasibility Studies.

BIO F451 Bioprocess Technology 3 0 3

Bioprocess Principles; Kinetics of Biomass production, substrate utilization and product formation; Kinetics of enzyme catalyzed reactions and applied enzyme catalysis; Fermentation process parameters and controls, Upstream & Downstream processing; Bioreactor Design & Operation; Transport processes in Bioreactors; Novel Bioreactor Configurations; Immobilized biocatalysts; Bioconversion; Protein Purification; Industrial applications of Bioprocesses; Bioprocess Patenting & Economics.

BIO F491 Special Project 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

BIO G510 Application of Computers and Statistics in Biology 5

to data classification, analysis and probability; statistical inference – estimation and hypothesis testing; linear regression and correlation; design of experiments; analysis of variance; non parametric procedures & tests; statistical quality control; experimental design in clinical trials and validation; basic techniques in optimization. Introduction to computer and its components; operating systems; principles and use of standard software packages having application in drug design, development, analysis, etc.; principles of software creation; processing concepts, flow charting and algorithms, programming constructs, programming languages, program development sequence; information systems: need, significance concepts, their analysis, design and implementation; software life cycle with special reference to software planning and maintenance.

BIO G511 Population and Quantitative Genetics 5

Gene pool, allele frequency, genotype frequency, Hardy-Weinberg equilibrium & its complications, non-random breeding, genetic drift, genetic load, gene flow, selection, intensity of selection pressure, inbreeding & artificial selection, natural selection & polymorphism, neutral theory & evolution speciation.

BIO G512 Molecular Mechanism of Gene Expression 3 2 5

Prokaryotic and eukaryotic genomes and their topology: DNA - protein interactions; RNA transcription and transcriptional control; DNA replication; transcription in yeast; RNA processing; translation; mechanism of gene expression in pro and eukaryotes.

BIO G513 Microbial and Fermentation Technology 3 2 5

Metabolic Stoichiometry- energetics, fundamentals of microbes and their morphology, Stoichiometry of cell growth and product formation, fermentation kinetics, phases of growth in batch culture, continuous culture and fed-batch cultures, kinetics of cell growth, product formation and substrate utilization-substrate and product inhibition kinetics, enzyme technology. Industrial Biotechnology- strain selection and improvement, media formulation and sterilization strategies, industrial applications, fermentation and product recovery, preparation of alcohols, antibiotics, organic acids, enzymes, bakery and dairy products, biopharmaceuticals, vaccine production.

BIO G514 Molecular Immunology 3 2 5

This course will deal extensively with topics like molecular basis of T and B cell antigen recognition and activation. Immunity to microbes and diseases caused by humoral and cell mediated immune responses will be covered and emphasis placed on congenital and acquired immunodeficiencies. Advanced topics like antibody engineering will be discussed with the help of review articles.

BIO G515 Stem Cell and Regenerative Biology 3 1 4

Introduction to stem cells and regenerative biology; embryonic stem cells, adult stem cells, manipulation of stem cells for replacing cells in diseased tissues; transplantation of embryonic and adult stem cells, replacing congenitally defective organs and damaged organs, tissue engineering, biodegradable and biocompatible materials, nano-devices, and regulatory perspectives.

BIO G516 Fermentation Processes (5*)

Introduction to Fermentation, fermentation processes, microbial organisms in fermentation, strain isolation, improvement and preservation, media formulation, sterilization, metabolic pathways and engineering, metabolite overproduction, detailed case studies on food fermentation including cheese, dairy products, bakery foods, wine, brandy, beer, and food related fermentation including single cell protein, baker's yeast, enzymes, organic acids, antibiotics, amino acids, bio-fuel, industrial alcohol. Preparation of vaccine, insecticides, alkaloids. Microbial transformation, Bioleaching, Fermentation economics.

BIO G517 Recombinant DNA Technology 3*

The course deals with theoretical aspects of recombinant DNA manipulation. Emphasis will be placed on procedures to create chemeric molecules using examples from actual experimental work. Vector designing, polymerase chain reaction, invitro mutagenesis and cloning in prokaryotic and eukaryotic vectors will be covered.

BIO G522 Interferon Technology 3 1 4

Characterization, Functional activity, broad pleiotropic agents, antiviral, anti-angiogenic, antitumor, anti-proliferative, immunomodulatory effect, specific receptor binding, mechanisms, sequencing, classification, Dosage formulation Therapeutic study, side effects, molecular manipulation and activity profile.

BIO G523 Advanced and Applied Microbiology 3 2 5

Molecular taxonomy, Systematic Microbiology; Study of molecular diversity of microorganisms, clinical microbiology, human-microbe interaction, molecular plant-microbe interaction, applied microbiology and synthetic microbiology.

BIO G524 Animal Cell Technology 3 2 5

Animal cell and tissue culture from various organisms, types of cell lines, development and maintenance of cell lines, manipulation and applications of cell culture technology for Biotechnological research and therapeutics implication.

BIO G525 Environmental Biotechnology and Waste Management 3 2 5

Applications of biotechnology to the management of environmental problems, role of biotechnology in increasing plant and animal production through biological insecticides, herbicide resistance, mineral cycling, conservation of genetic resources and biological nitrogen-fixation. Use of biotechnological processes in pollution control, bioremediation of toxicants, treatment of domestic and industrial waste will be emphasized. Ethical issues related with the release of genetically modified organisms would also be covered.

BIO G526 Cancer Biology 3 2 5

Basic concepts and molecular basis of cancer, Growth, Regulation and Metastasis, Cancer Immune system Interaction, Cancer therapy, Cancer and Environment, Cancer and society.

BIO G532 Biostatistics and Biomodelling 3 1 4

Probability analysis variables in biology; standard deviation and standard errors; correlation and correlation coefficient; regression analysis; significance test; chi-square and goodness of fit; applications of computers in statistics; handling of software on enzyme kinetics and protein sequence analysis; computer analysis of nucleic acid structure.

BIO G541 Neural Network Analysis 5

Basic concepts, Characteristics of nerve cells and neurons, Definition of artificial neurons, Algorithms, network topology and functions, Neural network application for learning, expert systems, knowledge representation, speech recognitions and synthesis, visual perception and pattern recognition and language processing: Emphasis will be on a comparative study with biological systems.

BIO G542 Advanced Cell and Molecular Biology 5

Eukaryotic cell cycle: restriction point, G1 phase progression, role of cyclins, cancer cell cycles; growth factors and their interaction with receptors: PDGF, EGF, VEGF, FGF, TGF; stress responses: mechanisms molecular biology with special reference to hypoxia; extracelular matrix and adhesion molecules; cytokines: sources, molecular structure, targets and mechanisms of action; apoptosis, caspases and necrosis.

BIO G544 Bioremediation and Bio-metallurgy 5

Applications of microbial metabolism for removal of toxic material from environmental sample and recovery of metals from low grade ore; metal- microbe interaction, comparison of conventional and microbe based processes of treating toxic waste material; steps in bioremediation processes such as preparation of biomass through genetic manipulations, immobilization, batch or continuous processes;applications of microbes in bioleaching process and recovery of copper, gold and nickel with case studies.

BIO G545 Molecular Parasitology & Vector Biology 5

Biology of parasitic diseases and their transmission in human and animal population by vectors/carriers. molecular aspects of parasite and vector biology, modes of infection, life cycles of parasite and vector, host - parasite interactions, infectivity pattern, mechanisms of drug resistance and immune evasion, methods of diagnosis, prophylaxis, treatments to parasitic diseases and vector control measures.

BIO G551 Membrane Biology 5

Concepts of biological membrane, Membrane constituents phospholipids, glycolipids and cholesterol; Membrane bilayers, amphipathic molecules, Self-assembly process; Membrane proteins, lateral and transverse diffusion, fluid mosaic model, Membrane permeability; Organization and dynamics of membrane, Signal transduction, role of carbohydrate components of membrane, Red-cell membrane proteins, Tools and techniques in membrane study: electron microscope, X-ray study, autoradiography and spectrometry. Immune response, Surface properties, Kinetics of membrane-bound processes.

BIO G561 Advances in Recombinant DNA Technology 3 2 5

Recent advances in high---throughput genomics, proteomics and large---scale mutagenesis; genomics techniques like transcriptome arrays and arrays for whole genome analysis; proteomics analysis techniques like 2D PAGE and MS; understanding genome and protein structures and protein interactions through yeast/bacterial two---hybrid systems; large scale mutagenesis and interference.

BIO G570 Recent Developments in Biology 1 0 1

The students will be exposed to recent advances / research in the area including but not restricted to animal, plants or microbial systems. There will be emphasis placed on understanding the applications and benefits of the in silico and/or wet lab approaches to the selected topics.

BIO G612 Human Genetics 3 2 5

Epigenetic and Chromosomal Control of Gene Expression: DNA methylation, Genomic imprinting and mammalian development. DNA damage & repair: Damage control during replication and mitosis, Genome stability and checkpoint control, Disorders related to aberrant DNA repair. Molecular genetics of inherited disorders. Cancer genetics: Genetic analysis of various cancers, tumor suppressor genes, metabolic polymorphisms and cancer susceptibility. Genomics & Proteomics: Human genome project and its applications in Gene therapy, novel drug design approaches.

BIO G631 Membrane and Liposome Tech. 3 1 4

Membrane structure and biogenesis: techniques for the study of membrane structure and properties; model of membranes; molecular transport mechanisms; techniques of artificial membrane productions; liposomes - structure and characteristics; carrier mechanisms for targeting therapeutic agents; industrial applications of liposomes.

BIO G632 Transgenic Technology 3 2 5

Transgenic techniques as replacements of traditional breeding practices; understanding faulty gene pool; development of commercial and economically viable tissue culture and their genetic improvement through r-DNA strategies; development of recombinant transplants for improved genomic system.

BIO G641 Cell & Tissue Culture Technology 2 2 4

Plant and animal cell culture from various organism; types of cell lines; development and maintenance of cell lines; tissue culture for viral growth, hybridization and gene manipulation; hybridoma technology and protoplast fusion.

BIO G642 Experimental Techniques 4

Specially designed laboratory course which aims to impart training in selected range of techniques such as, salt fractionation, dialysis, PAGE with discontinuous buffer solution, Western Blotting, Ion-exchange chromatography and Gel filtration, Genomic DNA extraction from Human Blood, bacteria, purification of DNA and analysis, polymerase chain reaction, single, double and partial restriction digestion, construction of genomic DNA library, Southern Blotting, Karyotyping, short term lymphocyte culture,

RNA extraction and quantification.

BIO G643 Plant Biotechnology 3 2 5

Plant cell and tissue culture, media constituents, micro propagation and other culture techniques, their applications and limitations, germplasm storage, secondary metabolite production, therapeutic protein and antibody production through plants, promoter designing and inducible promoters, molecular markers and their applications, approaches to influence metabolite partitioning and quality and quantity of plant storage products.

BIO G651 Protein and Enzyme Bioengineering 3 2 5

Sources, isolation, purification and storage of protein and/or enzymes; kinetics of enzyme catalyzed reactions; biocatalyst reaction engineering; techniques of production and recovery of enzymes; protein and enzyme modification; clinical and industrial applications of free and immobilized enzymes.

BIO G661 Gene Toxicology 3 1 4

Origin and fundamentals of Gene Toxicity; genotoxic effects in plants and mammalian systems; screening and measurements of genetoxicants; techniques in gene toxicology and their application to human, agricultural and environmental monitoring.

BIO G671 Bioconversion Technology 3 2 5

Waste and by-product utilization; downstream processing; biogas production; principles of biodegradation process parameters; bioreactor design and operation; exploitation of waste streams enzyme-based bioconversions of high value products.

Biotechnology

BIOT F211 Biological Chemistry 3 0 3

Chemistry and functions of constituents of cells and tissues; introduction to enzymes; metabolism of carbohydrates, lipids, aminoacids; nucleic acids and protein synthesis; vitamins and hormones.

BIOT F212 Microbiology 3 1 4

Introduction and classification of microbes; structure and physiology of microbial cell; infection and immunity; host parasite relationship; microbiology of milk, air, water and food; physical and chemical methods of controlling microbes; experiments for isolation, cultivation, physiological and biochemical characterization of microbes.

BIOT F213 Cell Biology 3 0 3

Fundamental processes of life at cellular and sub-cellular levels, cell environments, membrane transport, cell movements, division and control mechanisms.

BIOT F215 Biophysics 3 0 3

A study of molecules and their interaction forces; bioenergetics and physical techniques as applied to biological phenomena.

BIOT F241 Genetic Engineering Techniques 1 3 4

Experiments on the common molecular biology techniques used in gene manipulation in bacteria and plants; gene cloning procedure in bacteria – from isolation of plasmids to screening of recombinant clones; polymerase chain reaction (PCR) and its applications; gene and protein expression analysis; DNA sequencing; Agrobacterium-mediated gene transfer in plants and introduction to plant cell culture techniques; Use of software for molecular biology.

BIOT F242 Introduction to Bioinformatics 3 0 3

Introduction to genomics and proteomics, human genome and other sequencing projects, biological databases and data mining, sequence similarity search and sequence alignment, protein structure prediction and structure analysis, use of software packages in Bioinformatics.

BIOT F243 Genetics 3 0 3

Facts and theories of heredity, their relation to the present state of biological theory in general; elements of population genetics; genetics and species concept.

BIOT F244 Instrumental Methods of Analysis 1 3 4

Principles, configuration, applications of instruments like mass spectrophotometer, NMR, UV, IR, X-ray apparatus, atomic spectrophotometer, gas chromatography, liquid scintillation spectrophotometer, laser device, high voltage electrophoresis, ultracentrifuge, DTA, TGA, etc.

BIOT F245 Introduction to Environmental Biotechnology 3 0 3

Industrial processes, incorporating design and monitoring of waste treatment technologies; microbial removal and degradation of organics pollutants, phytoremediation of soil and water contaminated with toxic metals and radionuclides, wetlands as treatment processes, biofilms, biofilters for vapor-phase wastes, and composting; biosensors in environmental analysis, molecular biology applications in environmental engineering and genetic engineering of organisms for bioremediation.

BIOT F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

BIOT F311 Recombinant DNA Technology 3 0 3

The course deals with theoretical aspects of recombinant DNA manipulation. Emphasis will be placed on procedures to create chemeric molecules using examples from actual experimental work. Vector designing, polymerase chain reaction, invitro mutagenesis and cloning in prokaryotic and eukaryotic vectors will be covered.

BIOT F314 Industrial Microbiology and Bio process Engineering 2 2 4

Principles and application of fermentation technology with respect to production of value added biotechnological products and strategies of improving production; development of biological processes associated with raw materials preparation to product recovery, relevant to industries as diverse as medical, food and environmental protection.

BIOT F342 Immunology 3 0 3

Introduction to immune system, cell mediated and humoral immunity, allergy, mechanisms of hypersensitivity reactions, immunity to infectious diseases, immune mechanisms involved in cancer and transplantation immunology.

BIOT F343 Experiments in Biotechnology 0 3 3

Advanced molecular biology techniques such as genomic DNA isolation, plasmid DNA, single, double & partial digestion, construction of genomic DNA library, PCR, polymorphism in studies, southern blotting, RNA isolation, Real Time PCR, protein expression and analysis and immuno-histochemical techniques.

BIOT F344 Downstream Processing 2 1 3

Recovery and purification of biologically – produced products including biomass itself, extracellular and intracellular components; Strategies to recover and purify products, separation of insoluble products, cell disruption, separation of soluble products, finishing steps for purification, integration of reaction and separation.

BIOT F345 Proteomics 3 0 3

This course deals with the introduction to proteome, significance and analysis of post-translational modification of proteins, protein-protein interaction. Functions of all protein will be discussed in light of the standard prokaryotic and eukaryotic models. Emphasis will be given on methods of proteomic research, proteome analysis, resolution and identification of proteins.

BIOT F346 Genomics 3 0 3

This course provides an introduction to the field of genomics. It also covers the structure of the human genome, and the strategies that were used to map and sequence the genome, and details how genomic sequence information is utilized for pharmacogenomics, drug discovery and diagnostics. The course also introduces post-genomics technologies such as bioinformatics, functional genomics and comparative genomics.

BIOT F347 Immunotechnology 3 0 3

Immunotechnology is a specialised course, which deals with biotechnological aspects of immunological mechanisms Hybridoma technology and production of monoclonal antibodies, antibody engineering using genetic manipulations, alternatives to hybridoma technology for monoclonal antibodies, designing and building of mAb genes, primary and secondary libraries for antibody genes. Emphasis will be given on the production of humanized and human antibodies. Uses of monoclonal antibodies in diagnosis, therapy of allergic diseases, vaccine production, abzyme, purification, quantification and cytogenetic analysis.

BIOT F352 Cell and Tissue Culture Technology 3 0 3

This course will provide an introduction to theory and application of tissue culture technologies. The details of animal and plant tissue culture will be covered including design of media and large scale production of the animal and plant cells. The course also covers the various techniques of preserving the animal cell lines.

BIOT F366 Lab Project 3

BIOT F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BIOT F376 Design Project 3

BIOT F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BIOT F413 Molecular Biology of the Cell 3 0 3

This course is designed to impart knowledge of molecular biology of the cell. Students will understand the various concepts related to cell structure and function at molecular level. : Molecular biology and nucleus, ultrastructure and cytochemical studies, membrane structure and function. Organelle involved in intracellular transport and cell signaling , cell sorting Cell junctions and adhesion molecules, Cell division and the Cell Cycle.

BIOT F416 Introduction to Pharmaceutical Biotechnology 3 0 3

The course is designed to provide advances in drug development, drug delivery systems and pharmaceutical specialties including polypeptides, proteins, viruses, DNA and antibiotics. It covers relevant aspects for the development of new bi technology based drugs, target identification, downstream processing and formulation. Special emphasis is given on understanding the mechanisms and process involved in diseases.

BIOT F417 Biomolecular Modeling 3 0 3

The course is designed to provide students the first hand experience of potential utility of biomolecular modeling especially in concurrent pharmaceutical research, and in cell and structural biology. It describes the functionality, advantages, and limitations of standard computing strategies for the simulation of biomolecules. Biomolecular Conformation, Structural genomics and Proteomics, Protein folding, Forecefield, simulation, Conformational analysis ,abinitio structure predictioncomparative modeling, lattice models, usage of modeling packages.

BIOT F420 Introduction to Plant Biotechnology 3 0 3

Introduction to plant tissue culture, Micropropagation, Somaclonal variation, meristem culture, Anther culture, Cell suspension culture, Secondary metabolite production, Protoplast isolation and Fusion, cryopreservation, Techniques for Plant Transformation – Agrobacterium and Biolistics, Transgenics in crop Improvement.

BIOT F422 Nanobiotechnology 3 0 3

The course deals with the principles and application of nano- and micro-fabrication methods to build tools for exploring the biological systems. The course includes interdisciplinary aspects of biology and nanotechnology on the principles of microfabrication techniques with a focus on nanoparticles, drug delivery systems, and interations with molecular and cellular level for biomedical and biological research applications.

BIOT F423 Drug design and delivery 3 0 3

The objective of this course is to give insight into the principles of drug discovery and molecular mechanism of drug action. The course is designed for applications in the pharmaceutical and biotechnology related to identifying and optimizing a drug candidate for clinical development. Special emphasis is given on rational and systematic approaches to the development of novel classes of drugs against diseases and effective treatment.

BIOT F424 Food Biotechnology 3 0 3

The course gives an overview on presence of microorganisms, their activity and control in food. It explores the scientific methods for measuring microorganisms and their products. Preservation techniques of foods, food safety, quality controls and food borne diseases are also discussed. The course also covers food fermentation and use of various microorganisms in preparation of fermented foods at industrial level.

BIOT F491 Special Project 3

Course description is same as “BIO F491”

BITS

BITS F111 Thermodynamics 3 0 3

Concepts and laws of thermodynamics; macroscopic thermodynamic properties; application to closed and open system; microscopic approach to entropy; equations of state; thermodynamics of nonreacting mixtures.

BITS F112 Technical Report Writing 2 0 2

Overview of communication, elements of effective writing, formal reports, types of reports, preparatory steps for writing reports, methods and sources of data, use of illustrations, oral presentation.

BITS F113 General Mathematics I 3 0 3

I. Review of coordinate geometry, Theory of equations, Progression and series, permutations and combinations, Binomial theorem, Functions: Trigonometric (with identities), Transcendental.

II. One Dimensional Calculus: Limit and continuity, Differentiation, Integration. Applications of derivatives and definite integration.

BITS F114 General Mathematics II 3 0 3

I. Polar coordinates, Function of several variables, Multiple integrals, Vector valued functions.

II. Complex functions and their analyticity.

III. First order and second order ordinary differential equations, Laplace transformations and its applications to ordinary differential equations.

BITS F201 Material Science and Engineering 3 0 3

Introduction on materials for engineering, structures of metals, ceramics and polymers; crystalline structure imperfections; amorphous and semi-crystalline materials (includes glasses, introduction to polymers); Correlation of structure to properties and engineering functions (mechanical, chemical, electrical, magnetic and optical); phase diagrams; Improving properties by controlled solidification, diffusion or heat treatment; Failure analysis and non-destructive testing; Types of materials (includes synthesis, Fabrication and processing of materials): Polymers and composites, Environmental degradation of materials (corrosion); Evolution of materials (functional materials, Biomimetic materials, energy saving materials etc); Criteria for material selection.

BITS F211 Introduction to IPR 1

Importance & relevance of IPR’s in the globalised era; legislation covering IPR’s in India; patents, copyrights, trademarks, industrial designs, trade secrets, geographical indications; procedures for filing IPR’s in India, WTO, TRIPS agreement and their relevance to agriculture, industry education and service sector

and others.

BITS F212 Introduction to Human Rights 1

Relevance of human rights education in India: evolution of human rights and duties, human rights: international norms, human rights and duties in India, redressal mechanisms for human rights violations, deprivation of human rights: core issues; women and human rights and duties, good governance, science and technology and human rights.

BITS F213 Introduction to Environmental Studies 1

Ecosystems, evolution and biodiversity; impact of population and economic growth on the environment; sustainable development and use of resources such as water, food, and energy; environmental quality – waste management, air and water pollution, hazards such as global warming, ozone layer depletion, acid rain, and nuclear accidents; sustaining environmental quality- economic, social, political and ethical issues.

BITS F214 Science, Technology and Modernity 3 0 3

Interrelationship between science, technology and modern society; forms in which beliefs and values of a modern society shape sciences and technologies; forms in which scientific discoveries and technological developments influence and shape modern societies. Scientific Revolution and the emergence of modernity as a social condition; Enlightenment promise of progress within the economic system of capitalism. Some critiques of the received view; recent phase of capitalism and the role of technology in globalization.

BITS F215 Applications of Bio-Medical Instrumentation Techniques in Healthcare 2 0 2

Introduction to biomechanics, neuro-prosthetics based on function- sensory, motor, neuro prosthetics; based on regulation-person, auto regulated as adjuncts or alternates to therapy, implants, prosthetics for vision, audition, pain relief, pharmakokinetic studies, brain-machine interface –methods, rapid prototyping technique in developing artificial bones, tissues, tendons, cartilages, and various applications of these techniques in improvement of health-care.

BITS F217 Environment, Development and Climate Change 3 0 3

Specific topics on environment, development and climate change; regional, national and international climate debates; review of international climate negotiations such as Kyoto, Copenhagen and other declarations; environment problems: causes, sustainability and policies; population, resources and sustainability; population dynamics, capacity and conservation; food security, poverty, impact and global solutions; energy resources: renewable, wind, oil, natural gas, nuclear energy; growth, technology and greenhouse gas emissions, carbon credit; regional impacts of climate change and adaptation strategies; techniques in modeling; water resources and pollution: monsoon, drought, rainwater harvesting, traditional practices in water conservation; case studies.

BITS F218 General Mathematics III 3 0 3

Linear equations and matrices, Determinants, Basis of R^n, Eigen Value, Eigen Vector, Linear transformations on R^n.

Linear Programming: Geometric Solutions, Simplex Method, Duality, Post optimal Analysis, Transportation and Assignment Problem. Nonlinear Programming (Unconstrained optimization).

BITS F219 Process Engineering 2 1 3

Basic concepts related to heat transfer, mass transfer and flow of fluid, processes and equipment involved in extraction and filtration; mixing and granulation; size reduction and classification, evaporation and distillation, drying and crystallization, humidification and dehumidification. Materials of construction. Theory of compression and consolidation of solids.

BITS F221 Practice School I 5

BITS F225 Environmental Studies 3 3 0 3

Environment, human population, and industrialization; natural resources and the impact of man-made activities on them; structure and function of ecosystem, population ecology, biodiversity and its conservation, overview of natural resources, environmental pollution, social issues and the environment, and environmental impact assessment.

BITS F226 Soft Skills for Professionals 3 0 3

Social Skills: Personality development, Emotionalintelligence, Etiquette. Study Skills: CommunicationSkills, Academic writing Presentations and PublicSpeaking, Interviews, Group Discussion. CareerPlanning Skills: Creative thinking, Ethical Values,Capacity Building: Learn Unlearn & Relearn/Domainknowledge, Leadership and Team Management,Decision making/ Negotiation, Time and StressManagement.

BITS F231 Practice School I 5

All the above courses are run during the summer term only. The operation of all these three courses will be identical in nature. However, BITS F221 will be a required course for all integrated First Degree students with Practice School option. This course is also a prerequisite for BITS F412 Practice School II. BITS F231 may be available only to those students who have successfully cleared BITS F221 and BITS F241 may be available only to those students who have successfully cleared BITS F231. Thus BITS F231 and BITS F241 can be taken by highly motivated students if facilities are available after satisfying the needs of students who have to compulsorily register in BITS F221.

BITS F232 Foundations of Data Structures and Algorithms 3 1 4

Algorithm Analysis – Mathematical preliminaries, Sorting Algorithms, Search Algorithms, Linear Structures, Non-Linear Structures, Hashing, Non-Linear Structures, Graphs and Algorithms.

(Open elective for non-B.E. Computer Science students)

BITS F233 Essentials of Start-up 3*

Problem Identification and Opportunity Discovery through Design Thinking; Deep understanding of Customer and Markets; Market size estimation; Create a Compelling Value Proposition; Competitive Advantage; Build your minimum viable product (MVP); Lean principles in Startup; Build the Product Roadmap; Financial Feasibility; Go-to-Market Strategy; Managing growth and Targeting Scale; Funding Strategy.

BITS F234 Introduction to Engineering Design 4*

Introduction to Engineering Design is a significant contributor in teaching students how to transform a concept into a tangible reality, in order to test - with confidence - tangible realities by simulating real-world conditions. In this course, students will develop fundamental CAD skills in both the 2D realm (e.g. building plans or circuit design) and the 3D realm (e.g. using fully manipulable animated models that are invaluable tools for visualising complex mechanisms). They will also improve their skills and knowledge in drawing techniques, learn to use specific tools, and learn about the design process. They will also learn how Indian and Australian standards define the common language of graphic communication. These graphically presented virtual realities will also extend into the realm of augmented reality, in which simulations and the real world combine for a totally immersive design experience.

Equivalent: OENG1250 Introduction to Engineering Design offered at RMIT.

BITS F235 Digital Fundamentals 4*

This course is focused on digital literacies for engineers and will equip students with the ability to apply a problem-solving methodology to common engineering problems. Using a problem-based approach, students will develop the skills to design, write, test and debug programmes that improve the world we live in. They will be presented with various types of engineering problems which they will then work through from problem identification and algorithm design through to the implementation phase. As part of this course, they will also be introduced to the syntax and development environment of the engineering software tool MATLAB/Simulink. This course establishes a foundation for engineering programmes that require advanced programming and problem-solving skills such as Electrical & Electronic, Computer & Network, Mechatronic and Automotive Engineering.

Equivalent: OENG1206 Digital Fundamentals offered at RMIT

offered at RMIT.

BITS F236 Foundations of Artificial Intelligence for STEM **4***

This course introduces the foundations of Artificial Intelligence (AI) tailored to students from a range of health, science, technology, engineering, and math disciplines. AI is a branch of computer science devoted to developing intelligent hardware and software systems. Applications of AI are now widespread in the world of work. It is therefore increasingly important for all health, science, technology, engineering, and math disciplines graduates to have an understanding of the foundations and applications of the field of AI relevant to their own discipline. This course will also challenge the students to consider the impact and ethics of AI on their future profession and society.

Equivalent: COSC2960 Foundations of Artificial Intelligence for STEM.

BITS F237 STEM for Sustainable Development **4***

This course provides students with an introduction, understanding and appreciation of sustainability as applied in contemporary Health and Science, Technology, Engineering and Mathematics (STEM) (including holistic, integrative and interdisciplinary consideration of the sustainable development goals, priorities and future sustainability trends in relation to STEM and health. The course will explore the nexus between topics such as environmental sustainability, climate change, biodiversity, health, food and nutrition and energy and transport and the application of sustainable sciences and technologies such as low carbon technologies, circular and digital economies and advanced manufacturing. Sharing and communication of diverse viewpoints and expertise from across the STEM and health disciplines will be facilitated to enable collaborative action to address real world sustainability problems. This course will also explore how diversity, inclusion, reconciliation and equity act as driving forces within sustainability and promote and enable diverse voices to be heard and activated to co-create sustainable futures for society and the environment. Ultimately, the course will encourage and enable the students to bring a sustainability focus, approach and agency into their future studies and resulting careers.

Equivalent: ONPS2702 STEM for Sustainable Development offered at RMIT.

BITS F311 Image Processing **3 0 3**

Introduction to Image Processing and Imaging systems, Image sampling, Transforms, Enhancement and Restoration, Coding and Communications, Image Compression, Image understanding, Neural network and PR Approaches.

BITS F312 Neural Networks and Fuzzy Logic **3 0 3**

Introduction to neural networks, neural dynamics; activations and signals; activation models; unsupervised and supervised learning rules and their domain of applications; architectures of neural systems; Fuzzy sets, fuzzy binary relations; fuzzy logic, fuzzy reasoning; applications in decision making, control theory, adaptive fuzzy and neural control systems and their comparison; Concepts in control systems : stability, state variable, controllability, regression and optimization; mathematical models in control; conventional controllers : design, tuning; Relations, design of fuzzy control systems; control using ANN; Hybrid control, Neuro-fuzzy, GA and bio-inspired optimized control; Case studies on applications of neural, fuzzy and hybrid techniques.

BITS F313 Multicriterion Decision Making in Engineering and Management **3 0 3**

Introduction, Single Objective Optimization, Estimation of weights, Multiobjective optimization, Classification Methods, Discrete Multicriterion Decision Making, Fuzzy Logic based discrete MCDM, Correlation coefficients and group decision making, Advanced topics of decision making, Case studies.

BITS F314 Game Theory and Its Applications **3 0 3**

Strategic thinking, Rational choice, Dominance, Rationalizability, Nash equilibrium, Best response functions, Duopoly models and Nash equilibrium therein, Electoral competition, Pure strategy, Mixed strategy, Extensive forms, Sub-game perfect Nash equilibrium, Bayesian Nash equilibrium, Select Applications of Game Theory.

BITS F315 Introduction to Cognitive Neuroscience **3 0 3**

Introduction, Methods of Cognitive Neuroscience, Sensation and Perception, Attention & Action, Memory, Emotions, Psycholinguistics, Network Neuroscience, Consumer Neuroscience, Social Cognition and Metacognition.

BITS F316 Nonlinear Dynamics and Chaos **3 0 3**

Chaos – definitions, characteristics, and measures; Examples of chaotic systems; Nonlinear dynamics and chaos – state space, Poincare sections, Iterated maps, Period-doubling; Quasi-periodicity, Intermittency, fractals; computer simulations of chaotic systems; Selected topics and applications of chaos theory; Examples will be drawn from different disciplines in science, engineering, and social sciences.

BITS F317 Theoretical Neuroscience **3 3 0 3**

Introduction to nervous system: Neurons; central and peripheral nervous systems; nerves; ganglions; brain areas; Neural circuits – few examples; Single neuron modelling: Electrical properties of a neuron; Action potential; Integrate and fire models;Conductance based models - Hodgkin-Huxley model, Morris-Lecar model; Cable equation; Multicompartment models for dendrites; Models for synapses; FitzHugh-Nagumo model; Networks of neurons: Feed forward network; Recurrent networks; Excitatory-Inhibitory networks; Stochastic networks; Encoding and decoding:Firing rate; Spike-train statistics; Receptive fields;Reverse correlation methods; Static nonlinearities;Discrimination; Population decoding; Spike-train decoding; Shannon entropy; Mutual information;Entropy maximization and information; Current trends in theoretical neuroscience.

BITS F319 Negotiation Skills and Techniques **2 0 2**

Overview, Negotiation styles, Negotiation process, Tactics in Negotiation, Handling conflicts in negotiation, Best Alternative to a Negotiated Agreement, Communication - Key to Effective Negotiating, Non-verbal communication in Negotiations, Emotions: dealing with others and ourselves, International negotiations, Cross Cultural Issues in Negotiations, Power in negotiation, Workplace Negotiations, Turning Negotiation into a Corporate Capability, Do's and Don'ts of Negotiations, Negotiating over the telephone/ Electronic media, Ethics in negotiation, Negotiation-Exercise.

BITS F319 Negotiation Skills and Techniques **2 0 2**

Overview, Negotiation styles, Negotiation process, Tactics in Negotiation, Handling conflicts in negotiation, Best Alternative to a Negotiated Agreement, Communication - Key to Effective Negotiating, Non-verbal communication in Negotiations, Emotions: dealing with others and ourselves, International negotiations, Cross Cultural Issues in Negotiations, Power in negotiation, Workplace Negotiations, Turning Negotiation into a Corporate Capability, Do's and Don'ts of Negotiations, Negotiating over the telephone/ Electronic media, Ethics in negotiation, Negotiation-Exercise.

BITS F320 Managerial Skills **2***

The role of manager, team building and goal setting, basics of supervision, leadership, decision making, negotiation skills and techniques, how managers communicate, how to interview, process of induction, training and development, delegation, how to appraise employees, how to manage time, use of committees, how to handle meetings, how to handle complaints.

BITS F321 Legal and Economic Environment of Business **4***

Indian contracts act, sale of goods act, negotiable instruments act, companies act, corporate tax laws, consumer protection and unfair trade practices act, FEMA, Industrial policy, macroeconomic environment, fiscal and monetary policy, overview of Indian economy, economic indicators.

BITS F322 Venture Team Development and Organization **3 0 3**

Building and managing high performance teams; Multidisciplinary teams; Virtual teams; Homogeneity and diversity in teams; Team building – inspiration , interdependence, interaction and

integrity; Leadership; Motivation; Compensation and ESOPs; Negotiation Skills and techniques; Interpersonal skills; Communication skills; Conflict Management; Decision making; SMART goals; Perception and bias; Cultural and emotional intelligence; Permanent and contingent workforce; Causes and remedies of dysfunctional teams.

BITS F323 Venture Finance 3 0 3

Developing Financial Projections, Alternate forms of Financing, Venture Financing Decisions, Business Valuation and Equity Financing; Angel and Venture Capital Funds; Financing for Growth, IPO and Exit.

BITS F324 Strategy for Entrepreneurs 3 0 3

Developing vision, mission, goals, objectives for an enterprise; Internal and external business environment; Formulating a business model; New entry strategy; Assessing market segments and competition; Blue ocean strategy and red ocean strategy; Investor profile; Porter's generic strategies and five forces model; Boston Consulting Group (BCG) matrix; SWOT analysis; General Electrical Matrix; Core competency; Growth strategies; Stability strategies; Renewal strategies; Indirect assault strategies; Competitor growth limiting strategies; Functional strategies; Strategic myopia.

BITS F325 New Product and Service Design 3 0 3

New product and service design: standardization, mass customization, delayed differentiation, modular design, and robust design. Defining requirements and specifications. Technical, business and financial feasibility of design. Prototyping, manufacturing and testing. Product and Service lifecycle. Customer satisfaction and sustainability. Reliability. Legal and Ethical considerations.

BITS F326 Design Thinking for Innovation & Entrepreneurship 3 0 3

Design thinking and innovation mind-set; Creative confidence; Design thinking process; Design thinking – need finding and empathy; Idea generation; Prototyping and experimentation; Human centred design ethos; Innovation through brainstorming; Innovation through prototyping; Innovation by design; Case studies for innovation in all spheres: product, service, business, finance/investments, marketing; Designing a startup; Designing in teams; Designing to use; Design thinking in innovation to handle the unexpected; Innovating within the framework of entrepreneurship.

BITS F327 Artificial Intelligence for Robotics 2 1 3

Introduction to AI, Application of AI in Robotics. Introduction to Robot Operating Systems (ROS), Python and programming with application of Raspberry-Pi and Arduino. Practical Robot Design Process, implementation of pick and place process. Basic robot sensing techniques (Vision and Listening), Beam Models of Range Finders, sensor models. Object Recognition Using Neural Networks and Supervised Learning. Robot learning process, Reinforcement learning and Genetic Algorithms. Basic concepts of speech recognition and natural language. Path planning, SLAM, decision trees, classification techniques, wave front, the A* (A star) and D* (D star) algorithms, and node-based planners. Non-deterministic simulation technique and Monte Carlo modeling, the Robot Emotion Engine, the Human Emotion Model.

BITS F328 Innovation Ecosystem and the Future of Work 4*

This course deals with the concepts of innovator in study, work and life. This course will broaden and strengthen student's innovation effectiveness. Students will discover how technology, society, governments, and global trends drive change in the future of work over the span of their career. Students will gain a holistic view of innovation - of self, others, and the task. Understand how bringing people and project together in innovation ecosystems brings new ideas to life, strategically delivering an innovation's true value into the hands of adopters. The course is richly illustrated with fast-paced interactive learning activities and topics. Concepts will be brought to life through stories from alumni students, STEM industry leaders both locally and international. The engaging workshops, serious games and assessment will bring the topics together and provide them with the opportunity to apply their discipline insight as they build their skills and knowledge.

Whether students are a collaborator or leader in innovation, both the skills and an innovators mindset are highly valued by industry. Yet, student's may find that it is of more significant personal value as a strategy for a resilient, vibrant, and fulfilling career in a future of accelerating change.

Equivalent: OENG1235 Innovation Ecosystem and the Future of Work offered at RMIT.

BITS F329 Social and Environmental Applications of Data Science 3*

The course will provide a platform for students to apply data science principles, techniques, and tools to solve problems related to climate and health. The course will expose students to real life problems. The course will also allow students to correlate climate change to health. The applications will be inherently inter-disciplinary in nature, and could involve co-supervision by BITS Pilani faculty in departments other than CSIS.

This is a projects-based course for imparting hands-on experience of Data Science for Climate and Health. Students will work in groups and undertake 2 projects: one focused on Data Science either for Climate or Health (termed DS(C) or DS(H)); and a second project focused on Data Science for Climate and Health (termed DS(CH)).

BITS F331 Quantum Computation and nformation I 3 0 3

History and scope, introduction to quantum information, quantum bits (qubits), quantum parallelism, teleportation etc; Basic ideas of quantum systems - two-state systems, evolution of states, superposition, entanglement, quantum measurement, decoherence; Basic ideas of computation theories and models : computational resources, complexity; Quantum Gates - single qubit and multiple qubit gates, controlled gates, universal gates, measurement; Quantum algorithms - Deutsch', Shor's and Grover's Algorithms; quantum circuits, quantum Fourier Transform and applications, quantum search algorithm; Physical Implementation of quantum computation Compression and transmission of quantum information, quantum noise, error-correction, coding and cryptography, complexity, fault-tolerant computation.

BITS F333 Project on Organisational Aspects 3

These courses involve projects related to thrust areas where students are expected to get involved with planning, organisation and execution of new ideas and concepts. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BITS F334 Project on Organisational Aspects 3

These courses involve projects related to thrust areas where students are expected to get involved with planning, organisation and execution of new ideas and concepts. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BITS F343 Fuzzy Logic and Applications 3 0 3

Fuzzy sets, fuzzy binary relations; fuzzy logic, fuzzy reasoning; applications in decision making, control theory, expert systems, artificial intelligence etc.

BITS F345 Information Law and Cyber Law 3 0 3

Information related crimes and Cyber-crimes and methods to contain them; National and International laws and IT acts. Economic considerations related to the use and management of digital data; Legal and policy issues, rights, responsibilities, and potential liabilities of parties in information exchange and digital transactions; Cyber laws; Introduction to intellectual property, IPR, legal and technical aspects; Digital rights management: Tools, Standards and Techniques.

BITS F351 Nonlinear Dynamics and Chaos 3 0 3

Dissipative systems; Bifurcations in maps & differential equations (1-d, 2-d, 3-d) – saddle node, transcritical, pitchfork, Hopf, etc.; Application of bifurcation analysis to various systems in natural & engineering sciences; Chaos; Routes to chaos; Quasiperiodicity; Intermittency; Fractals & strange attractors; Con-

servative systems.

BITS F364 Human Computer Interaction 3 0 3

Principles of human-computer interaction; Evaluation of user interfaces; Usability engineering; Task analysis, user-centered design, and prototyping; Conceptual models and metaphors; Software design rationale; Design of windows, menus, and commands. Voice and natural language I/O; Response time and feedback; Color, icons, and sound; Internationalization and localization; User interface architectures and APIs.

BITS F372 Data Communications and Networks 3 0 3

Communication Concepts; Data and Voice Communications; Hardware Systems and Configurations; Network Topologies and Design Aspects; Protocols; Networking Software; Local Area Networks; Network Security and Management; Emerging Trends in Communications.

BITS F381 TIC Projects 3

These courses provide an avenue for first degree students who are normally in third year or in a higher class, to earn a letter grade credit for doing projects under the Technology Innovation Centre. These projects are sponsored by the industries which come to the Institute under the scheme for participating in Technology Innovation Centre. The projects are also supervised and monitored by the personnel from industry who visit as Associate Faculty. These courses are unstructured and would require all the rigor which the industry would demand.

BITS F382 Reading Course 3

BITS F383 TIC Projects 3

These courses provide an avenue for first degree students who are normally in third year or in a higher class, to earn a letter grade credit for doing projects under the Technology Innovation Centre. These projects are sponsored by the industries which come to the Institute under the scheme for participating in Technology Innovation Centre. The projects are also supervised and monitored by the personnel from industry who visit as Associate Faculty. These courses are unstructured and would require all the rigor which the industry would demand.

BITS F385 Introduction to Gender Studies 3 0 3

Introduction to gender studies, Sociological theories about gender, Women's access to education, interest, access and role in science and technology from gender perspective, Gender bias, work place, women and employment opportunities, Women and Politics, women in *Panchayati Raj* Institutions, women and family, women and violence, dowry, women and law, women's movements, feminism, women and human rights, women and media, gender equity-policy issues, women and development.

BITS F386 Quantum Information and Computation 3 0 3

History and scope, introduction to quantum information, quantum bits (qubits), quantum parallelism, teleportation etc. Basic ideas of quantum systems, two-state systems, evolution of states, superposition, entanglement, quantum measurement, decoherence. Basic ideas of computation theories and models, computational resources, complexity. Quantum Gates: single qubit, multiple qubit gates, controlled gates, universal gates, measurement. Quantum algorithms, Deutsch', Shor's and Grover's Algorithms, quantum circuits. Quantum Fourier Transform and applications, Quantum Search Algorithm. Physical Implementation of quantum computation. Compression and transmission of quantum information, quantum noise, error-correction, coding and cryptography, complexity, fault-tolerant computation.

BITS F398 Creative Multimedia 2 2 3

Imaginative and creative communication skills, interactive multimedia applications incorporating various aspects of rich media; digital screen design, typography, non linear editing, animation techniques, sound design and editing, testing and managing multimedia products, post production techniques.

BITS F399 Humanistic Theories of Science and Technology 3 0 3

Ways of considering the interrelationship among three of the major dimensions of our culture: its science, its technology and its humanistic orientation. Alternative ways of thinking about science and technology, diverse approaches of humanistic scholarship to studying science and technology, along with their historical sources. Approaches by social scientists to analyze technical fields of science and technology.

BITS F407 Selected Readings 2 0 3

The course is intended to nurture the students critical thinking and to enhance their skills at information gathering and expressing. Selected readings from books in the areas of History, Science & Technology, Culture, Literature, Art, Philosophy, Psychology, Religion, Development Concepts and Trends etc. will be assigned to the students. A set of books will be identified in at least two broad areas for study and analysis.

BITS F412 Practice School II 20

BITS F413 Practice School II 20

The above two courses will be operated identically with stipulated prior preparation conditions as per the Academic Regulations. BITS F412 is a required course for all students with Practice School option either for a single degree or for one of the degrees under dual degree scheme. BITS C413 has been created as a required course if a dual degree student is permitted a Practice School option for a second degree after he has completed Thesis option for one degree.

BITS F414 Introduction to Bioinformatics 3 0 3

Introduction to genomics and proteomics, Human genome and other sequencing projects; Biological database and data mining; Similarity search and sequence alignment; Protein structure prediction and structure analysis; Use of software package in bioinformatics.

BITS F415 Introduction to MEMS 3 1 4

Overview, history and industry perspective; working principles; mechanics and dynamics, thermofluid engineering; scaling law; microactuators, microsensors and microelectromechanical systems; microsystem design, modeling and simulation; materials; packaging; microfabrication: bulk, surface, LIGA etc; micromanufacturing; microfluidics; microrobotics; case studies.

BITS F416 Introduction to Nanoscience 3 0 3

Introduction; nanoscience in nature; fundamental science behind nanomaterials; synthesis and properties of nanomaterials; tools to study the properties, size and shape determinations, application of nanomaterials in science, engineering and biomedical field; future trends.

BITS F417 Microfluidics and Its Application 4*

Introduction to microfluidics, scaling in microfluidics, theoretical microfluidics, Philosophy of Computational Fluid Dynamics, Concepts of discretization, fabrication techniques for microfluidic devices, microvalves, micropumps, microflow sensors, microfluidics for life sciences: micromixers, microneedles, microfilters, microseparators, microreactors, modeling and simulation on CAD tool.

BITS F418 Introduction to Biomedical Engineering 3 1 4

Introduction; Engineering principals applied for physiological phenomena; Bio implant materials:Metallic, ceramics; Polymeric materials for bio applications; Protein-biomaterial surface Interactions;Modification of surface of the biomaterials; Tissue engineering;Drug delivery systems, principals,and applications; Biomedical sensors; Modeling and simulation.

BITS F419 Management of Cross-cultural Engineering Teams 3 0 3

Characteristics of open technological innovation in competitive global market. The dynamic interaction between technological innovation and market competition – the S-curves. Standard battles to shape the dominant design of a new technology – Cross-the-Chasm and timing of entry. Competitive strategy of companies in different market segments – the Segment-Zero Principle.Commoditization of technology and product on global market – out-sourcing and off-shoring. Blueocean strategy to innovate new breakthrough products.

BITS F421T Thesis 16

BITS F422T Thesis 16

The above two courses will be operated identically with stipulat-

ed prior preparation conditions as per the Academic Regulations. BITS F421 is a required course for all students with Thesis option either for a single degree or for one of the degrees under dual degree scheme. BITS F421 and BITS F422 have been created as required courses if a dual degree student is permitted Thesis option for a second degree after he has completed Thesis option for one degree.

BITS F423T Thesis 9

BITS F424T Thesis 9

Course description of the above two courses is same as given under BITS F421T/BITS F422T. However Thesis with this course number will be available with concurrent coursework for at most 9 Units over a full semester duration.

BITS F427 Digital Marketing 3 0 3

Fundamentals of e-Business and Internet Marketing, e-Business Models and Frameworks, Digital Marketing Strategy, Online Public Relations, Search Engine Optimization and Marketing, Content Marketing, E-Mail Marketing, Social Media Marketing, Mobile Marketing, Optimizing Customer and User Experience, Web Analytics.

BITS F428 Essentials of Strategic Management 3 0 3

Difference between Strategy and Organizational effectiveness; Tools for internal and external strategic analyses; Environmental Scanning and Industry Analysis; Market opportunities and internal sources of competitive advantage; Value chain analysis; Corporate level, Business level and Functional strategies; Strategy implementation.

BITS F429 Nanotechnology for Renewable Energy and Environment 3 1 4

Basics of nano physics, macro vs. nano. Solar cells: Organic solar cell, quantum dot solar cell, dye sensitized solar cell. Self cleaning in solar panel. Fuel cell: Nano electrode and catalysts. Batteries: Nano electrode based batteries. Catalysts: H2 production and H2 storage. Carbon nano tube for energy. wind energy: Nanocomposites, nanocoating, and nanolubricants. Nanotechnology as tool for sustainability. Environmental fate & transport of nanomaterials. Nanomaterials for ground water remediation. Nanomaterials as adsorbents. Toxicity of nanomaterials, Ecotoxicological impacts of nanomaterials, Societal implications of nanotechnology.

Pre-requisites

BITS F201: Material Science and Engineering (Pre-requisite) OR CHEM F333: Chemistry of Materials (Pre-requisite) OR PHY F414: Physics of Advanced Materials (Pre-requisite) OR CHE F243: Material Science and Engineering (Pre-requisite) OR ME F213: Materials Science and Engineering (Pre-requisite) OR MF F213: Materials Science and Engineering (Pre-requisite).

BITS F430 Renewable Energy Laboratory 0 2 2

Experiments on generation of photovoltaic power, wind energy, geothermal energy, fuel cell energy, piezoelectric energy harvesting, smart grid, micro grid, etc.

BITS F431 Flexible Manufacturing Systems 3 2 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

BITS F433 Supply Chain Analytics 3 1 4

Introduction to supply chain analytics, Data understanding and data preparation, Supply chain performance , Descriptive analytics, Predictive analytics and setting up the problem, Supply chain forecasting, studying holt, winter and ARIMA models, Supply chain Network Planning, Multi echelon network optimization, Supply chain sales and operations planning, Supply chain segmentation, Vehicle routing problems, Supervised and Unsupervised learning, Use of Bayesian networks in supply chain, Simulation and SC models, Supply chain risk management.

BITS F437 Technical Communication 3 0 3

Overview of technical communication, verbal and non-verbal communication, elements of effective writing, technical report, technical proposal, research paper, dissertation, thesis, presentations and group discussions.

BITS F441 Robotics 3

The objective of this course is to make the students familiar with Robotics, the main components of kinematics, sensors, transmission and drives, control systems, intelligence and vision, geometric modelling and reasoning, assembly planning, grasping, collision avoidance, mobile robots, force strategies, uncertainty analysis, and representation of visual world.

BITS F442 Remote Sensing and Image Processing 3

Introduction to remote sensing; types of sensors; earth resource sensors; Landsat; IRS; SPOT; microwave remote sensing; SAR; SLAR; thermal infrared remote sensing; data analysis; image processing; smoothing; filtering; image averaging;enhancement techniques; transforms; FFT; PCA; segmentation; gradient operators; pattern recognition; ML classifier; minimum distance classifier; other classifiers; ISODATA clustering; feature selection; divergence; canonical analysis; recent develoopments in remote sensing; LIDAR; imaging spectroscopy etc.

BITS F444 Artificial Intelligence 3

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving.

BITS F445Neural Networks and Applications 3 0 3

Introduction to neural networks and fuzzy systems' neural dynamics; activations and signals; activation models; unsupervised and suprvised learning rules and their domain of applications; architectures of neural systems; adaptive fuzzy and neural control systems and their comparison; case studies on fuzzy and neural control systems.

BITS F446 Pattern Recognition 3

The object of this course is to study the principles and available techniques for the analysis and design of pattern recognition system, introduction to pattern classification by distance functions, and likelihood functions, trainable pattern classifiers: deterministic and statistical approach.

BITS F447 Multimedia Computing 3 0 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codecs, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

BITS F448 Retail Management Systems 3 0 3

Retailing history and theories, basic retail management process, retail industry in Indian and abroad, shopper behavior in retailing, retailing formats and location related issues, category management, supply chain management in retail, retail buying, store layout and design, point of purchase communication, retail pricing strategy, building store loyalty and technology in retailing. Case studies and projects in retailing, specially focusing on Indian scenarios.

BITS F449 Financial Engineering 3 0 3

Introduction; Review of Markets, Players, and Conventions; Cash Flow Engineering with Forward Contracts; Engineering Simple Interest Rate Derivatives; Swap Engineering; Report Market Strategies; Dynamic Replication Methods and Synthetics; Mechanics of Options; Options Engineering with Applications; Pricing Tools; Applications of Fundamental Theorem of Finance; Fixed Income Engineering; Tools for Volatility Engineering: Volatility Swaps and Volatility Trading; Engineering of Equity Instruments: Pricing and Replication, computational

methods such as Monte Carlo Simulation.

BITS F451 Autonomous Mobile Robotics 3 0 3

Kinematics, Dynamics and Control of Mobile Robots, Path planning, Roadmaps, Cell decomposition, Sensors for mobile robots, Sensor fusion algorithms, Autonomous navigation algorithms.

BITS F452 Blockchain Technology 3 0 3

Blockchain Technology, and its applications, Cryptocurrencies, Distributed Ledger Technology, Decimalized Systems, Blockchain Data Structure, Cryptography for Blockchain, Decentralized Identity Management, Consensus Mechanism, Smart contracts, Ethereum, Ethereum Virtual Machine, Distributed App development, Consortium Blockchain, Hyperledger, Case studies/Enabling Technologies and applications

BITS F453 Computational Learning Theory 3 0 3

Empirical Risk Minimization, Structural Risk Minimization, PAC learning, The Rademacher Complexity, Error Decomposition, VC dimension, Convexity, Lipschitz Learning, Regularization and Stability, Stochastic Learning, Subgradients

BITS F454 Bio-Inspired Intelligence: Algorithms and Applications 3 0 3

Concepts of Nature and Social Systems; Principles of Swarm Intelligence; Particle Swarm Optimization - Convergence, Variations and Comparisons, Applications in Engineering; Ant Colony Optimization Algorithms, ACO for NP-Hard Problems; Bio-inspired Models (Bat, Fish, Cuckoo, Bee, Wolf) - Algorithms, Applications, Algorithm Analysis; Study on Search Spaces and Test Functions

BITS F455 Analytics For Supply Chain 3*

Supply chain performance, Descriptive analytics, Supply chain forecasting, studying holt, winter and ARIMA models, Supply chain segmentation. Single period and multi-period inventory modeling, Multi-echelon inventory models, Network flow models, Distribution planning, Sales, & Operations planning, Vehicle routing problems, Simulation in supply chain risk assessment.

Equivalent: MPBA G520: Analytics For Supply Chain

BITS F456 Capstone Project I 4*

This course is the first half of a research and development (R&D) project that comprises two sequential courses (Part A and Part B) and is the capstone for all engineering programmes offered under BITS RMIT Academy. In this culminating academic experience student will apply their technical knowledge and further develop their research, design and professional engineering skills. The authentic project maybe industry based and focuses on producing well-managed practical and pertinent solutions to either discipline specific, or cross disciplinary engineering problems, through robust research and established engineering design processes. The Capstone Project I focuses on: articulation of the project requirements, challenge, need, problem or feasibility; establishment of design criteria and constraints; project planning; the critical appraisal of all the relevant published material by way of a comprehensive literature search and review; benchmarking of all related and relevant solutions; and hence well-informed consideration of possible solutions. After successfully passing this course, students will undertake the required companion course “Capstone Project II” which will result in the fulfilment of the final project deliverable.

Equivalent: OENG1167 Engineering Capstone Project Part A offered at RMIT.

BITS F457 Capstone Project II 4*

This course includes a work integrated learning experience in which student’s knowledge and skills will be applied and assessed in a real or simulated workplace context, and where feedback from industry and/ or community is integral to their experience. This second half of the Capstone engineering research and development (R&D) project concludes a culminating experience that applies student’s technical knowledge, research, design and professional engineering skills. It maybe industry based and aims to produce a well-managed practical and pertinent solution to either discipline specific, or cross disciplinary engineering problems, through robust research and established engineering design processes. This second part of the project (Part B) focuses on: Summarising the outcomes from student’s ‘Capstone Project I’; Clearly articulating a plan, including milestones and responsibilities; The application of a methodical design process for the systemic optimisation and embodiment of an engineered solution; The manufacture of a tangible deliverable (wherever appropriate); The test and verification of the solution; and a comprehensive suite of relevant project documentation.

Prerequisite: BITS F456 Capstone Project I

Equivalent: OENG1168 Engineering Capstone Project Part B offered at RMIT.

BITS F461 Software Engineering 3

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

BITS F462 Renewable Energy 3 0 3

Introduction of renewable energy, advantages, potential, status of development, broad details of different renewable energy systems such as solar, wind, biomass, microhydel, geothermal etc; Renewable energy development policy, Renewable energy industries, international co-operation, HRD and career growth opportunities, consultancy areas and future thrust areas in renewable energy development.

BITS F463 Cryptography 3 0 3

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

BITS F464 Machine Learning 3 0 3

Neural networks; neuro-computing theory and applications, knowledge representation; computational learning theory; statistical/probabilistic methods, genetic algorithms; in ductive/analytic/reinforcement learning and bayesian networks; selected topics such as alpha-beta pruning in game trees, computer models of mathematical reasoning, natural language understanding and philosophical implications.

BITS F465 Enterprise Computing 3 1 4

Overview of enterprise applications and their architecture-Building distributed multi tier applications using enterprise java–Packaging and deploying enterprise applications into application servers- Development of web applications using java servlets - java server pages and java server faces - Usage of JDBC for database driven enterprise applications -Enterprise java support for building soap and Rest enabled web services-Enterprise application integration using software components -Enterprise java beans-Message based communication between enterprise application components using JMS-Need for handling data persistence in database driven applications in an object-oriented manner –Usage of java persistence API for handling data persistence-Need for security of enterprise applications-Securing enterprise java applications using java based Glassfish application server-Configuring glassfish server for SSL security-Working with Realms, Users, Groups, and Role for client authentication-Overview of dot net framework for building distributed enterprise applications-Dot net framework: windows presentation foundation windows communication foundation-asp.net and ado.net

BITS F466 Service Oriented Computing 3 1 4

Introduction to Web Services: Distributed computing using software component technologies like DCOM and EJBs-overview about Service Oriented Architecture- RPC and Document centric SOAP enabled web services-Describing information using XML -SAX and DOM based XML parsers-XSLT-XPath. SOAP Protocol for web services- Describing Web Services using WSDL-Publishing and Finding web services using UDDI Registry-UDDI SOAP APIs-Inquiry APIs-Publisher APIs. Web Services security –Need for secured web service-confidentiality of

web service invocation using XML encryption and its advantages over SSL security -Integrity of soap message using xml digital signing-Maintaining confidentiality and integration together for soap messages -Authentication mechanisms for Web service client – Security Assertion Markup Language- Incorporating saml assertions for web service client authentication- IP layer security for web service- Need for work flow of web services-Usage of Business Process Execution Language for describing workflow of web services-Rest web service, its protocol and usage-Usage of Ajax in invoking Rest web service-Role played by web services in cloud computing.

BITS F467 Bioethics and Biosafety 3 0 3

Introduction to the need and issues governing biosafety, legal, ethical and social implications of human gene manipulation, guidelines for research in transgenic organisms and plants, socio-economic impacts of biotechnological experiments, GLP and MGP and CPCSEA guidelines, patent processing, ethics in stem cell research, animal cloning and organ transplants, environmental pollution-hazards and control, public education and participation in biosafety.

BITS F468 New Venture Creation 3 0 3

Entrepreneurship as career option, idea to opportunity – market analysis and segmentation, presenting a pitch deck, building the startup team, competition analysis, lean startups, product development, intellectual property, sales and marketing, business models, financing, launching a business, growth and exit strategy, social entrepreneurship, business plan presentation skills.

BITS F469 Financing Infrastructure Projects 3 0 3

Investment decisions in infrastructural projects: benefit cost analysis, measurement problems, indirect estimation methods of benefits; Cost of capital: private and public money, different schools of thought on social capital- cases; Multiple projects and constraints: linear and integer programming models, goal programming formulation; Financing infrastructure projects: venture capital, sources of capital–private and public participation, modes of cooperation such as BOOT and BOT national and international sources, international agencies, borrowing terms and conditionalities; Public policy issues, leasing and mortgaging, evaluation issues, infrastructural mutual funds, valuation aspects; Real options, value of option for delay, abandonment and vacant land – judgmental assessment of options; post review and administrative issues in project management, international (cross country) projects, implementation issues.

BITS F482 Creating and Leading Entrepreneurial Or- 3 0 3 ganizations

Fundamentals of entrepreneurship; elements of leadership; identifying business opportunities; market study and research; business plans; finance, issues in raising finance; venture capitalist evaluation of business plans, technical aspects for the project, corporate strategies for growth; legal aspect to entrepreneurship, people skills, marketing and branding; creativity and communication.

BITS F488 Services Management Systems 3 0 3

Understanding Services, the Service Sector today, Designing the Service Enterprise, Technological Issues, Structuring Service Operations, Processes Management, Staffing for Services, Functions of Services Management System, Client Relationships, Measuring and Reporting Services.

BITS F489 Enterprise Resource Planning 3 0 3

Introduction to ERP; Re-engineering and ERP systems; ERP planning, design, and implementation; ERP systems – sales and marketing; ERP systems – accounting and finance; ERP systems – production and materials management; ERP systems – human resources; Managing and ERP project; Supply chain management and e-Market place.

BITS F493 Business Analysis and Valuation 3 0 3

Theory of finance, value maximization, stakeholder theory, and corporate objective function: value creation – ways and means, business analysis: The techniques of strategy and competitive analysis, value chain analysis for competitive advantages, business valuation – approaches and methods, the dark side of valuation: strategic investment decisions.

BITS F494 Environmental Impact Assessment 3 1 4

Environment and global problems; Framing Environmental issues; effects of infrastructure development on environment; prediction and assessment of environmental impacts of infrastructure projects: technical and procedural aspects, guidelines and legal aspects of environmental protection, impacts on air, water, soil and noise environment, valuation, strategic assessment, mathematical modeling for environmental processes; social impact assessment (SIA), dislocation/disruption impact of Infrastructure projects; Life Cycle Assessments (LCA) and risk analysis methodologies; mitigation of environmental impacts; case studies; environmental management plan (EMP), national and international certification and guidelines including ISO.

BITS G501 Biostatistics 5

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like mean, median, mode, standard deviation, kurtosis, correlation coefficient; probability distributions; sampling and estimation of parameters; tests of hypothesis; data analysis. Introduction to data classification, analysis and probability; statistical inference – estimation and hypothesis testing; linear regression and correlation; design of experiments; analysis of variance; non parametric procedures & tests; experimental design in clinical trials and validation; basic techniques in optimization.

BITS G511 Advanced Project 5

This course is designed to permit treatment of an advanced area in a discipline or interdisciplinary pursuit to meet the objectives of acquisition of additional competence by the student and also development of new areas of study or lab. The course will be characterized by minimum formal contact and maximum self-study under immediate supervision by the teacher.

BITS G512 Object Oriented Programming 2 2 4

Basics of object oriented programming: objects, classes, instances; inheritance; polymorphism; operator overloading; static and dynamic binding; small talk, C++, cases from other object oriented languages like Ada, Loop, Flavors, Objective-C, etc.; object oriented software engineering.

BITS G513 Study in Advanced Topics 5

In this course students will be assigned study work in advanced areas of professional interest. Each student will work under the overall supervision and guidance of a faculty member and will in the end submit a project report encompassing critical review of the material studied.

The organisation and evaluation of the course would be achieved through seminars, group discussions, project report etc. The course will be conducted by the team of teachers who provide guidance for study work.

BITS G514 Environmental Health 3 0 3

Environmental Health and its importance, water pollution, air pollution, automobile pollution, pollution due to chemicals used in agricultural sector, handling and disposal of domestic and industrial refuse, incineration of waste materials, techniques for studying, monitoring and controlling pollution, effect on health, vector control, effect of high frequency electromagnetic radiation, nuclear radiation, hazardous wastes, occupational health.

BITS G515 Management Principles and Practices 4*

Management concepts and functions; Decision process; Marketing variables, analysis and research; Services marketing; Financial transactions and statements; Financial planning and control; Manpower planning and development; Personnel appraisal, General administration.

BITS G516 Introduction to Business Sustainabiligy 3 0 3

Evolution of the Concept of sustainable development, Dimensions of sustainable development, Issues and Trends in business sustainability, Business Sustainability, Sustainable Consumption and Production, Industrial Environment Management, Finance of sustainability, Setting Goals and Measuring Progress towards sustainability

BITS G517 Cross Cultural Management 3 0 3

The Critical Role of Culture in Management, The Various Dimensions of Culture, The Impact of Culture On Management Functions Like Communication, Negotiation, Motivation, Leadership and Human Resource Management, Formulating and Implementing Strategy for International and Global Operations, Managing Global Teams, International Assignment and Expatriate Management, Skills and Competencies for Global Managers, International Business Etiquette and Uniqueness of Indian Culture and Management.

BITS G518 Writing Seminar 3 2 5

Understanding claims structures; multiple rhetoricalcontexts and diverse persuasion strategies in classical,Rogerian and the Toulminian framework; Analyzingarguments rhetorically; Analyzing visual arguments,overview of anthology of arguments, re-evaluatingsources and presenting new operational definitions;Project

BITS G521 Fourth Generation Languages and Applications 1 3 4

Nature of 4GLs; application generators; RDBMS and 4GLs; SQL based 4GLs; 4GLs and development of information systems and decision support systems; other types of 4GLs; case studies.

BITS G522 Software Development Standards 1 3 4

Standards and their role in software development; Institutions involved in formulating and promoting standards; operating environment standards; POSIX; software design standards; diagramming standards; coding standards; language design, code generation and usage standards; software portability and standards; standards in software development tools; standards in compilers and interpreters; open systems; OSI; user interface standards.

BITS G524 Health Economics and Policy I 5*

Introduction to health economics; utility and health; how to think about health and health care; the production of health; health through the life cycle; a model of consumption and health; the demand for medical care: conceptual framework; empirical studies of medical care demand and applications; the physician and the physician-firm; physicians in the marketplace; the hospital as a supplier of medical care; hospitals in the marketplace; the demand for health insurance; government provision of health insurance; externalities in health and medical care; managing the market: regulation, quality certification, and technical change; universal insurance issues and international comparisons of health care systems

BITS G525 Health Economics and Policy II 5*

Health care provision; health in low and middle income countries; health system issues in low and middle income countries; introduction to economic evaluation; making decisions in health care; measuring and valuing effects: health gain; measuring and valuing effects: consumption benefits of health care; cost analysis; using clinical studies as vehicles for economic evaluation; economic evaluation using decision-analytic modelling; characterizing, reporting, and interpreting uncertainty; ethical and social implications of economic evaluations of health policies

BITS G526 Data Sciences I 5*

Different types of data, methods for data collection, organizing, summarizing, and interpretation of data, introducing descriptive statistics (measures of central centenaries, measures of variation), introducing random variables, probability distributions, discrete and continuous probability distributions, sampling, sampling distributions, theory of estimation, estimation of parameters (point and interval estimates), tests of hypothesis, types of errors, determinations of sample size for a study, tests of hypothesis using parametric (t-test, ANOVA) and various nonparametric tests, understand the correlations and regression analysis. An introduction to epidemiologic studies and survival analysis.

BITS G529 Research Project I 6

BITS G539 Research Project II 6

This is a package of two courses dealing with an advanced pursuit in terms of a study project or a lab project in assigned areas of professional interest. Each student will work under the overall supervision and guidance of an assigned teacher. The second course may be a continuation of the task engaged in the first course; or the two courses may be independent of each other. Each course must end with a well-defined project report outlining all the investigative efforts and conclusions.

BITS G540 Research Practice 4*

This course is designed to train the students towards acquiring competence in research methodologies. The course will be conducted in terms of actual participation in Research and Development Work. Each student will be assigned to a faculty member to work on specified projects. The student will be required to present a number of seminars in his research area in a structured manner.

BITS G541 User Interfaces 1 3 4

Emerging importance of user interfaces; user interface management systems; designing UIMS toolkits; hardware and OS aids in user interface development; human & psychological factors in user interface design; theories, principles and guidelines; emerging interaction styles; menu selection systems, command languages, direct manipulation; interaction device; hypertext; standards in user interface design and implementation; case studies from Domain Dialog; Apple's user interface; Open Look; OSF/Motif.

BITS G553 Real Time Systems 3 1 4

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

BITS G554 Data Compression 3 1 4

Introduction: the need for data compression. Information theory and data compression; Entropy, Relative entropy and mutual information. Fano’s inquality. Types of information sources, and source extension. Asymptotic equipartition property and data compression. Entropy rates of stochastic processes. Kraft inequality, Prefix codes, Huffman codes and Arithmetic coding. Quantization and Rate distortion theory. Lossy image compression techniques based on DCT, VQ and Fractals. Introduction to wavelets: continuous and discrete wavelet transforms. Filter banks and wavelets. Frames and tight frames. Wavelet packets. Wavelet based signal processing. Joint source and channel coding.

BITS G560 Practice School 20

BITS G561T Dissertation 25 (Max)

BITS G565T Dissertation 5

BITS G612 Methods and Techniques of Systems Engineering 2 3 5

This course would cover various systems engineering methods and techniques in the context of their application to the design, implementation and operation of large, humanly-contrived soft systems. The techniques would be chosen from amongst linear programming, integer programming, queuing theory, inventory control, simulation, maintenance models sampling techniques, forecasting techniques, decision models, network scheduling methods etc. These would be applied in the context of resource planning, facility location, manpower planning, financial management, decision-making, maintenance issues, construction and operation scheduling; planning research issues; social assessment of technology; issues of technology-economy nexus etc.

BITS G613 Systems Analysis for Large Systems 2 3 5

System thinking and approach; concepts of systems with special reference to large, humanly-contrived soft systems; review of mathematical techniques and principles of economics and management required for systems engineering of such systems; modelling and systems engineering methodology for large soft systems.

BITS G619 Professional Practice 4

This course will aim to achieve a professional development of the student in the context of the overall goal of his/her programme. Depending upon the profession, this course will be conducted in terms of actual participation in professional activities such as teaching, laboratory organization, course development, organizational development, R&D work, design, production, data organization, data preparation or management of institutions/ hospitals/voluntary organizations, etc. The course will also deal with communication aspects such as teaching a course, presenting a paper in the seminar/conference, articulating ideas and concepts to professional audience/customers, etc. This course will also deal with the laws and ethics concerned with the profession of an individual.

BITS G620 Professional Practice I 3

BITS G621 Professional Practice II 3

These two courses, to be offered in two consecutive semesters, are designed to train the students towards acquiring competence in teaching as well as in research methodologies. The course will be conducted in terms of actual participation in professional activities such as teaching, laboratory organization, course development, R & D work, etc. Each student will be assigned under a faculty member to work on specified projects, and to assist the faculty in teaching and research activities. The student will be required to present a number of seminars in a group in a structured manner.

BITS G624 Computer Based Simulation and Modeling 2 3 5

Discrete event simulation on computers; Systems simulation & simulation languages; GASP & GPSS; Continuous simulation - languages and modelling techniques; Forrester's models; case studies.

BITS G629T Dissertation 25 (Max)

This is a required component for all higher degree students except for those who opt and are selected for practice school programme. The unit requirements will vary from 12 to 25 units. It may be registered for one full semester (12 to 25 units) after completing all courses or may be registered for varied units (4 to 10 units) along with other courses.

BITS G630T Dissertation 25 (Max)

This is a required component for all higher degree students except for those who opt and are selected for practice school programme. The unit requirements will vary from 12 to 25 units. It may be registered for one full semester (12 to 25 units) after completing all courses or may be registered for varied units (4 to 10 units) along with other courses.

BITS G639 Practice School 20

A higher degree student if permitted can register in this course in lieu of Dissertation only after the completion of all course work. Concurrent registration of other courses with this course is not permitted. All clauses of Academic Regulations applicable to First Degree Practice School courses will govern the operation of this course.

BITS G640 Practice School 20

A higher degree student if permitted can register in this course in lieu of Dissertation only after the completion of all course work. Concurrent registration of other courses with this course is not permitted. All clauses of Academic Regulations applicable to First Degree Practice School courses will govern the operation of this course.

BITS G641 Management Information and Decision Support Systems 2 3 5

Data & information; characteristics of information; components of management information systems; information flows; design and maintenance of management information systems; decision support systems.

BITS G644 Development and Use of Computer Software 5

Concepts and operations of processors; concept, capabilities and types of software; review and case studies of computer applications. Principles and use of standard software packages. Principles of software creation: processing concepts, flowcharting and algorithms, programming constructs, programming languages, program development sequence. Concepts of data and information: files and databases, logical data storage structures. Information Systems: need, significance, concepts, their Analysis, Design and Implementation. Software Engineering: software life cycle, with special reference to software planning, software requirements and software maintenance. The course would terminate with a term paper on a specialised area of the development and use of computer software.

BITS G649 Reading Course 5

BITS G651 Project Formulation and Preparation 2 3 5

This course is designed to inculcate principles of technical documentation as required within S&T organizations. Through this course, students are expected to acquire familiarity with several of the following: Proposals, feasibility reports, formal project reports, short reports, memos, negotiations, contracts, etc. In the process principles of project formulation and evaluation, such as technical considerations; performance specifications; preliminary block diagrams, types and analysis of contracts; cost estimation concepts, work breakdown structure; project data preparation, scheduling facilities etc., would be introduced. The course would invariably include the preparation of a detailed report embodying as many of the above concepts as appropriate.

BITS G654 Advanced Instrumentation Tecniques 5

Generalized approach to measuring systems; performance characteristics of instruments; primary sensing elements and transducers; analog and digital signal conditioning operations; microprocessors in instrumentation; applied process control instrumentation; General purpose and analytical instruments covering spectroscopic, separation, atomic absorption instruments UV-VIS-IR,GLC, HPLC, etc; Instrumentation practices in typical R&D laboratories; instrumentation case studies covering selection, quality assurance, system design, etc; Hands on experience in operation of sophisticated instrumentation systems.

BITS G659 Technical Communication 3 1 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; précis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

BITS N101T Physical Fitness, Health and Wellness 1

Basic Exercise - warm-up and warm-down exercise, Calisthenics and its importance, Cardio-respiratory or endurance exercises - various forms of endurance exercise, exercise with intensity and duration for physical wellness; strength training exercise; various strength exercises and their importance, free hand weight training; flexibility exercise and wellness and relaxation exercise including stretching & yoga. This course can be taken only on audit.

BITS N301T Personality Integration Leadership Orientation and Teamwork 3*

Concept of personality and its role in personal and career growth : self-assessment of strengths and weakness, visioning and goal setting, development of action plans for personal growth; Effective communication, collaboration and conflict management: understanding the process and importance of communication and feedback, assessment of individual conflict management styles, importance of nonverbal communication, creating effective presentations and resume; Leadership and emotional intelligence: understanding individual leadership style, understanding the needs of followers, leveraging the power of EI for relationship building and leading; Team work and networking: building effective teams, decision making and leadership in teams, developing effective networks.

(This course will be offered as an Audit Type course for both First-Degree & Higher-Degree Students)

Civil Engineering

CE F211 Mechanics of Solids 3 0 3

Introduction to mechanics of rigid bodies and deformable bodies, Thermal stresses, Equilibrium of forces, Bending moment and shear force diagrams for determinate beams and frames, Analysis of statically determinate trusses; Flexural and shear Stresses in beams, Combined stresses, Stresses and strains on inclined planes, Introduction to torsion, Torsion in shafts, Slope and deflection in beams due to bending, Introduction to Energy Methods, Stresses in thin cylindrical shells, Suspension cables, Failure theories, Buckling of columns using Euler's Theory.

CE F212 Transport Phenomena 3 0 3

Concepts and definitions, Fluid pressure and measurement, Hydrostatics, Buoyancy, Fundamentals of fluid flow and Kinematics of Fluid in Motion, Flow Analysis using Control Volume Approach and its applications in conservation of mass, momentum and energy, Analysis of flow through pipes, Differential forms of the fundamental laws, Viscous fluid flow Analysis, Navier-Stokes Equations, Study of Flow pattern through Orifices and Mouthpieces, Notches and Weirs and Dimensional analysis and similitude.

CE F213 Surveying 3 1 4

Overview of Traditional Surveying Techniques like Chain surveying, Compass surveying and Plane Table Surveying, Traverse Computations and Adjustments, Levelling, Contouring, Curve Setting: Different methods of setting Simple Circular Curve, Compound Curve, Reverse Curve, Trigonometric Levelling, Tachometric Surveying, Surveying with GPS / DGPS and Total Stations and Electronic Distance Measurement, Introduction to aerial photogrammetry.

CE F214 Construction Materials 3 0 3

Different types of cements, chemical composition, properties and tests, coarse and fine aggregate for concrete, tests on aggregates, grading of aggregates and its effect on concrete properties, chemical and mineral admixtures, properties and tests on fresh and hardened concrete; transportation and placing of concrete, nondestructive testing of concrete, durability of concrete, quality control and acceptance criteria of concrete, Factors in the choice of mix proportions, Proportioning of concrete mixes by various methods – BIS method of mix design.; Special Concretes such as fibre reinforced concrete, high performance concrete, self consolidating concrete etc., Manufacturing/ sources, classification, applications, properties and testing of bricks, blocks, tiles, stones, aggregates, puzzolanas, flyash, lime, wood, timber, paints, tar, bitumen, cutback, emulsion, modified bitumen, steel, non-ferrous metals, polymeric material, geosynthetics, etc. Low cost and waste material in construction. Latest, BIS, IRC & ASTM specifications and guidelines of all above mentioned material, Construction equipments, classification, selection and economics.

CE F230 Civil Engineering Materials 3 2 4

Different types of cements, chemical composition, properties and tests, coarse and fine aggregate for concrete, tests on aggregates, grading of aggregates and its effect on concrete properties, chemical and mineral admixtures, properties and tests on fresh and hardened concrete; transportation and placing of concrete, non-destructive testing of concrete, durability of concrete, quality control and acceptance criteria of concrete, Factors in the choice of mix proportions, Proportioning of concrete mixes by various methods – BIS method of mix design; Introduction to special concretes. Manufacturing/sources, classification, applications, properties and testing of bricks, blocks, tiles, aggregates, lime, timber, paints, glass, bitumen, cutback, emulsion, modified bitumen, steel, non-ferrous metals, polymeric materials, geo-synthetics, etc. Low cost and waste material in construction. Latest, BIS, IRC & ASTM specifications and guidelines of all above mentioned material, and construction equipment.

CE F231 Fluid Mechanics 3 0 3

Concepts and definitions; compressibility of fluids, Fluid pressure and measurement, Fluid statics, Buoyancy, Rigid body motion, Fluid Kinematics, Conservation laws: Control Volume approach, Differential analysis of fluid flow, Study of flow pattern through Orifices and mouthpieces, Notches and weirs, Analysis of flow through pipes, Viscous fluid flow analysis: Analysis of flow through pipes, Dimensional analysis and similitude.

CE F241 Analysis of Structures 3 0 3

Static and kinematic Indeterminacy, Energy principles; Force Methods of analysis: strain energy method, consistent deformation method, Displacement Methods of analysis: Slope-deflection method, Moment distribution method; Introduction to Matrix Methods of structural analysis: Flexibility and Stiffness Methods, Influence Line Diagrams; Analysis of Moving/Rolling loads (for determinate structures), Introduction to approximate analysis of frames and trusses, Analysis of Three-hinged, two-hinged and fixed Arches, Analysis of indeterminate trusses. Exposure to relevant software.

CE F242 Construction Planning and Technology 3 0 3

Principal components of a building system and their interrelationships, functional planning and requirements of a building and its components using relevant codes, building processes, types and construction of foundation systems, masonry, walls, floors, roofs, vertical transportation, doors, windows, building finishes, plumbing services, damp proofing, temporary supporting structures; introduction to planning and scheduling of projects, construction project network analysis, Introduction to quantity estimation, costing and valuation, contracts, tenders, engineering economy and cost benefit analysis of a project, introduction to building information modeling, computer applications in construction management. Exposure to relevant software.

CE F243 Soil Mechanics 3 1 4

Introduction, Origin and classification of soils, index properties of soil, Compaction characteristics of different soils, lab and field compaction, quality control, Effective stress principle, capillarity, Darcy's law, permeability, Seepage through soils: piping, quicksand condition, flow nets, flow through dams, filters, Stress in soils due to applied loads, Boussinesq equatin, Newmark's Influence Chart, Approximate Method, Compressibility and consolidation characteristics, Consolidation Settlement, Shear Strength and Mohr-Coulomb strength criterion, direct, UCS and triaxial shear tests, strength of loose and dense sands, pore pressures, Skempton's coefficients. Site investigations, methods of drilling, sampling, in situ test - SPT, CPT, plate load and geophysical tests, immediate settlement based on elastic theories and in-situ tests. Exposure to relevant software.

CE F244 Highway Engineering 3 1 4

Overview of basic characteristics of Transportation systems, social factors and strategic consideration, Road development plans, Highway development projects in India, Road Development organizations, Stages in highway alignment and Detailed project Report preparation, Introduction to transportation planning, Geometric design Standards: Cross section elements, sight distances, horizontal and vertical alignments, Pavement Material Characterization: Aggregate testing and blending, Bitumen and Bituminous Concrete testing and mixture design protocols, introduction to Superpave Mixture Design protocols, IRC methods for the design of flexible and rigid highway pavements, Overview of different stages in flexible and rigid highway construction, Overview of Highway Evaluations and Maintenance, Traffic Engineering: Traffic Characteristics, Highway capacity and level of service concepts, Traffic measurement and analysis, Traffic signals, parking studies and analysis, traffic accidents, Introduction to Intelligent Transportation Systems. Exposure to relevant software.

CE F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

CE F311 Design of Concrete Structures 3 1 4

Engineering properties of different concreting materials; Design Philosophies; Concepts of Limit State Method; Limit State Design for flexure of Singly and doubly reinforced rectangular and flanged section beams, one-way and two-way slabs; Design for Bond, anchorage and development length; Design of beams with rectangular and Flanged sections for Shear; Limit state of

serviceability for beams and slabs; Limit State Design for collapse of columns subjected to axial, axial plus uni-axial bending and axial and bi-axial bending; Design of Footings; Design of Stair Cases.

CE F312 Hydraulics Engineering 3 1 4

Behaviour of real fluids: boundary layer theory, turbulent flow through conduits; analysis of closed-conduit hydraulic systems including pipes, valves, fittings, and pumps, water hammer in pipes, pipe networks analysis: Hardy cross method and linear graph method; Open channel hydraulics: uniform and non-uniform flow; flow past immersed bodies: drag and lift; Analysis of Impact of jets; Introduction to fluid machinery.

CE F313 Foundation Engineering 3 0 3

Earth Pressure theories, Retaining structures, design and checks for stability, General requirement for satisfactory performance of shallow foundations, general, local and punching shear failures, bearing capacity, settlement, tilt and rotation of foundations, proportioning of Shallow Foundations, footings on layered soils and slopes, Deep foundations, capacity of single and group Piles, laterally loaded pile, Stability of slopes, Introduction to Ground Improvement Techniques and geosynthetics with applications, Introduction to machine foundations for different type of machines, Introduction to geotechnical earthquake engineering and liquefaction of soils, computer applications in foundation design.

CE F320 Design of Reinforced Concrete Structures 3 0 3

Design Philosophies: Concepts of working stress in comparison with limit state method; Limit state design for flexure of Singly and doubly reinforced rectangular and flanged section beams; one-way and two-way slabs; Design for bond, anchorage and development length; Design of beams for shear; Limit state of serviceability for beams and slabs; Limit state design for collapse of columns subjected to axial, uni-axial and bi-axial bending; Design of simple footings; Design of simple stair cases.

CE F321 Engineering Hydrology 3 0 3

Introduction to hydrometeorology; Precipitation measurement and analysis; Hydrologic abstractions; Stream flow measurement; Runoff and hydrographs; Floods; flood routing; Ground water hydrology; Sediment transport; Introduction to irrigation engineering, Introduction to dams, spillways, diversion headworks and distribution systems.

CE F323 Introduction to Environmental Engineering 3 0 3

Introduction to environmental systems; Material (conservative and non-conservative systems) and energy balances; Risk Assessment; Water pollution and management; Air pollution and management; Essentials of Solid waste management; environmental noise pollution and its control; radioactive waste management; Modelling of Environmental systems; Introduction to Environmental impact assessment ; Legislations

CE F324 Numerical Analysis 3 0 3

Solution of Linear Algebraic System of Equations, Storage Schemes and techniques to a System of Large number of Equation, Numerical Solutions by Interpolation, Integration of Functions containing Singularities, Finite Element Method, Solutions of Initial and Boundary Value Problems, Boundary Integral Element Method, Solution of Non Linear System of Equations.

CE F325 Fundamentals of Rock Mechanics 3 0 3

Internal structure of Earth; Types of rocks andgeological features; Intact rock and rock mass; Shearstrength; Rock mass classification systems; Rock slopefailure mechanisms; Convergence ConfinementMethod, Ground and Support Reaction Curves,Longitudinal Deformation Profile, Construction ofMetro Tunnels, Cut and Cover Method, Tunnel BoringMachine; Stresses in rocks, Rock burst, Squeezingground conditions; Methods for improvement of rockmass response.

CE F326 Impact of Climate Change on Water 2 1 3

Introduction to hydrology, climate change, Overview of global climate models (GCM) and Regional Climate Models (RCMs), performance indicators, weights estimation, ranking of GCMs, Ensembling of GCMs; Importance of downscaling, bias correction of data; Role of cluster analysis, fuzzy cluster analysis, Kohonen Neural Networks in the classification of GCMs; Role of Hydrological models; Effect of climate change on the water including urban floods, health and its impacts on society etc.; mitigation and adaptation strategies; Case studies for demonstrating the replicating ability of the employed techniques, limitations, and challenges

CE F341 Hydrology & Water Resources Engineering 3 0 3

Hydrological Cycle and Budget; Precipitation Measurement and Analysis; Hydrologic Abstractions; Stream Flow analysis and concepts of hydrograph; Hydrologic measurements; Statistical analysis in hydrology; Ground Water hydrology; Flood Routing; Water withdrawals and uses, Introduction to dams, spillways, diversion head-works and distribution systems, River basin management, Reservoir planning and multi-purpose reservoirs, hydropower engineering, Systems analysis techniques in planning and practical applications.

CE F342 Water & Waste Water Treatment 3 1 4

Water supply and waste water systems; capacity requirements; analysis of water and waste water; treatment requirements; unit operations and processes of treatment, design of treatment units; disposal of waste water and sludge; design of sewers and water distribution networks; rural sanitation; effluent repurification and reuse.

CE F343 Design of Steel Structures 3 0 3

Introduction to Limit State Design and Plastic design, Limit state design of bolted and welded connections, Eccentric connection, Design of Tension Members, Design of Compression Members, Design of Beams, Design of plate girders, Column bases. Exposure to relevant software.

CE F345 Computational Geomechanics 3 3 0 3

General Theory of Elasticity; Analysis of Stress and Strain, Spherical and Deviatoric Stress Tensors, General state of stress in three-dimensions in cylindrical coordinate system, Three-dimensional Mohr's stress Circle, Strain Transformation, Octahedral Strains, Mohr's Circle for Strain, Equations of Compatibility for Strain; Pore pressure and stress-strain response of soil due to undrained loading, Volume Change Behaviour, Peak State and Dilatancy, Rowe's Dilatancy Theory; Critical State Parameters, Failure line in p´-q space and e-p´ space, Soil Yielding, Strain Hardening and Strain Softening; Introduction to failure theories of soils, their relative merits and demerits and applicability for different types of soil; Computer Applications; Suitability of the failure models in real-time geotechnical problems.

CE F366 Lab Project 3

CE F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CE F376 Design Project 3

CE F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CE F411 Operation Research for Engineers 3 0 3

Linear programming, Simplex method, Duality and sensitivity analysis, Transportation model and its variants, Integer linear programming, Nonlinear programming, Introduction to Multi-objective optimization and case study, Game theory, Evolutionary computation, Inventory models, Queuing system, Decision making under certainty, risk, and uncertainty.

CE F412 Disaster Management 3 0 3

Definitions, types of hazards, natural and man-made disasters, impact, causes and effects, damages, coping mechanism and relief assistance, disaster continuum, preparedness, prevention, mitigation, warning and management, vulnerability assessment, rehabilitation and reconstruction after disasters, pre disaster planning for earthquakes, cyclones, floods, draught and famine, disaster resistant constructions, non-structural and structural

mitigation measures, guiding principles of mitigation, education and training for disasters, disaster case studies, computer use in disaster scenario development.

CE F413 Advanced Structural Design 3 0 3

Design of concrete chimneys, water tanks, retaining walls, bunkers and silos, Design of steel tanks, towers, Roof trusses and Gantry Girder design, Design of plate girders, Design of Beam-Columns.

CE F414 Introduction to Environmental Engineering 3 0 3

Environmental pollution; essentials of solid waste management; environmental noise pollution and its control; water quality significance; air quality management; industrial site selection criteria environmental impact assessment-case studies-computer applications.

CE F415 Design of Prestressed Concrete Structure 3 0 3

Introduction to basic concepts of prestressing; load balancing technique prestressing systems; analysis of prestress; losses in prestress; deflection; design of anchorage zone, design of prestressed concrete girders.

CE F416 Computer Applications in Civil Engineering 3 1 4

The basics and use of recent Civil Engineering Software related to Hydraulics, Structures, Transportation, Geo-technology and Construction Planning and Management etc., Practical assignments on industry related problems using the above software.

CE F417 Applications of Artificial Intelligence in Civil Engineering 3 0 3

Introduction to Artificial Intelligence and soft computing; Neural networks: Introduction, models, and its application in civil engineering, fuzzy logic and its application in decision making, Clustering; Genetic algorithms; Expert systems; Introduction to machine learning (Support Vector Machine), case studies.

CE F419 Geotechnical Earthquake Engineering and Machine Foundation 3 0 3

Seismic hazard, Engineering seismology, Wave propagation, Dynamic Soil Properties, Dynamic bearing capacity, Seismic design of foundation, Seismic slope stability, Dynamic earth pressure, Seismic design of retaining structure, Liquefaction, Design of machine foundation, Soil improvement techniques, Seismic design codes.

CE F420 Introduction to Bridge Engineering 3 0 3

Investigations for bridges, types of bridges and loading standards, selection of bridge type, analysis of culverts and girder bridges, pier and abutments, different types of bridge foundations.

CE F421 Analysis and Design of FRP Reinforced Concrete Structures 3 0 3

Course description is to be developed.

CE F422 Urban Hydrology 2 1 3

Urban hydrology, Hydrological and planning models, Urban flooding: Planning, forecasting and mitigation strategies, General circulation models and downscaling approaches, Management of Syphonic rainwater systems and detention facilities, sustainable urban drainage systems, Impact of anthropogenic activities, case studies.

CE F423 Green Buildings and Energy Conservation 3 0 3

Climate zones and sun path diagram, thermal comfort, heat flow through building materials, energy efficient building design factors like site planning, plan form and orientation, construction techniques, materials and finishes, natural day lighting and ventilation strategies, thermal performance of building elements, Efficient water management in buildings, Green building rating system, Vernacular architecture and its use in contemporary design, Case studies of contemporary green buildings.

CE F425 Airport, Railways and Waterways 3 0 3

Airports: Characteristics of aircrafts related to airport design; runway orientation, length, capacity, configuration and number, taxiway layout, high-speed exit taxiway, terminal building functional areas, visual aids; grading and drainage; Railways: component of railway tracks, train resistance and tractive power, curves and super elevation, switches and crossing, signalling and interlocking, high speed tracks, track stresses. Tunnelling: necessity of tunnels, ventilation, lighting and drainage; Water transportation: nature of water transportation, classes of harbours, desirable features of harbour site, planning and design of port faculties; Pipeline transportation systems: need and planning.

CE F426 Geosynthetics and Reinforced Soil Structure 3 0 3

Geo-synthetics: classification, functions, applications, properties & testing, Applications and advantages of reinforced soil structure. Principles, concepts and mechanism of reinforced soil. Soil-reinforcement interface friction. Behaviour of Reinforced earth walls, basis of wall design, internal and external stability condition, Codal provisions; Seismic design consideration. Bearing capacity improvement and design of foundations resting on reinforced soil; embankments on soft soils; Design of reinforced soil slopes, Indian experiences. Use of geosynthetics for separations, drainage and filtration. Use of geosynthetics in roads, airports and railways, India Road Congress, AASHTO and other relevant guidelines; randomly distributed fiber reinforced soil. Soil nailing. Geocell, PVD, Geosynthetics in Environmental Control: Liners for ponds and canals; covers and liners for landfills – material aspects and stability considerations; Use of jute, coir, natural Geotextiles, waste products such as scrap tire, LDPE and HDPE strips, as reinforcing material.

CE F427 System Modeling and Analysis 3 0 3

Systems and system's approach, Modelling of physical system and non-physical system, Continuous and discrete systems, Time domain analysis, Frequency response, Steady-space analysis.

CE F428 Earthquake Resistant Design and Construction 3 0 3

Earthquake resistant design philosophy. Ground motion characterization, response spectra and design spectra. Free and forced vibration analysis of single and multiple degree of freedom system. Seismic analysis and design of buildings and other structures as per relevant codes. Seismic design of foundations and liquefaction of soil, Earthquake resistant construction and detailing for masonry & concrete structure as per relevant codes.

CE F429 Design of Foundation Systems 3 0 3

Evaluation and interpretation of soil properties, dynamic properties of soil, geophysical and seismic methods, Stress in soil mass due to applied load, various methods of settlement analysis, static and dynamic bearing capacity of footings, bearing capacity of footings resting on layered soils and footing on or near slopes, tilt, rotation and horizontal displacement of foundations subjected to eccentric-inclined loads, foundations on rocks, seismic design of shallow foundations, analysis of raft foundations, circular and annular rafts, structural design of shallow foundations, pile foundations load capacity and settlements, various methods of analysis of laterally loaded Pile Foundations, uplift capacity, piles subjected to dynamic loads, seismic design of pile foundations, structural design of pile foundations, static and dynamic earth pressure theories, stability analysis of retaining walls, reinforced earth wall design, machine foundations for reciprocating machines, impact type, rotary machines such as turbines, turbogenerator, IS code provisions on foundations, codal provisions on structural and earthquake resistant design of foundations.

CE F430 Design of Advanced Concrete Structures 3 0 3

Design of footings and stair cases, Determination of deflection and crack width in beams and slabs, Design of flat slabs, Design of beam column joints, Design of circular Slabs, Design of Retaining walls, Design of beams curved in plan.

CE F431 Principles of Geographical Information Systems 3 1 4

Introduction to Geographical Information Systems(GIS), Spatial data models, Coordinate systems and geo-referencing, Map projections, Databases and database management systems, Spatial databases, Interpolation methods: Deterministic and Statistical. Digital elevation models and their applications, Network analysis, GNSS, Strategies for development, implementa-

tion and management of GIS, Next generation GIS, Case studies on use of GIS from various fields such as water and land resources, environment, transportation; Introduction to remote sensing & Image processing.

CE F432 Structural Dynamics 3 0 3

Free and forced vibrations, single and multi-degree systems, continuous systems, response of various systems to different excitations, damping; numerical evaluation of dynamic response, frequency domain analysis, mode superposition, direct integration for dynamic response.

CE F433 Remote Sensing and Image Processing 3 1 4

Overview, Fundamental concepts of remote sensing, Air photo Interpretation, Multispectral, Thermal and hyper spectral Scanning, Microwave remote sensing, Photographic Systems, Photogrammetry, Digital Image Processing, Image File format, Pre-Processing of Data, Enhancement techniques, Image Transformations, Image classification, Spatial Filtering, Applications.

CE F434 Environmental Impact Assessment 3 0 3

Environment and global problems; Framing Environmental issues; effects of infrastructure development on environment; prediction and assessment of environmental impacts of infrastructure projects: technical and procedural aspects, guidelines and legal aspects of environmental protection, impacts on air, water, soil and noise environment, valuation, strategic assessment, mathematical modeling for environmental processes; social impact assessment (SIA), dislocation/disruption impact of Infrastructure projects; Life Cycle Assessments (LCA) and risk analysis methodologies; mitigation of environmental impacts; case studies; environmental management plan (EMP), national and international certification and guidelines including ISO.

CE F435 Introduction to Finite Element Methods 3 0 3

Element properties, Isoparametric formulations, analysis of framed structures, plane stress, plane strain, and axisymmetric problems, analysis of plate bending, FEM Software applications in Civil Engineering, Introduction to FEM programming. Exposure to relevant software.

CE F491 Special Project 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

CE G511 Matrix Methods in Civil Engineering 3 2 5

Matrix techniques; basic equations of solid mechanics; variational methods; finite difference and finite element methods; applications to structural mechanics, soil and rock mechanics, fluid mechanics, and hydraulic structures.

CE G512 Topics in Environmental Engineering 3 1 4

Collection and disposal of solid wastes; air pollution and control; stream sanitation; rural water supply and sanitation.

CE G513 Advanced Computational Techniques 3 1 4

Interpolation, Polynomial Interpolation, Lagrange, Newton's Interpolation, Numerical integration, Wilson θ Method, Newmark's Method, Gauss and Hermitian Quadrature, Quadrature rules for multiple integrals, Large system of linear simultaneous equations, Direct and iterative algorithms based on Gauss elimination, Gauss Seidel method and symmetric banded equations, storage schemes – skyline, band solver, frontal solver, Cholesky decomposition, Non-linear system of equations, Eigen value problems, Forward iteration, Inverse iteration, Jacobi, Given's method, Transformation of generalized Eigen value problem to standard form, Vector iteration method, Initial and boundary value problems, Solution of first and second order differential equations using Euler, modified Euler, and Runge-Kutta methods, Finite difference operators.

CE G514 Structural Optimization 3 1 4

Introduction, Engineering Optimization Problems, Optimal problem formulation, Single-variable optimization algorithms, Bracketing methods, Region Elimination methods, Gradient-based methods, Multivariable optimization algorithms, Evolutionary optimization methods, Simplex Search method, Hooke-Jeeves pattern search method, Powell's conjugate direction method, Cauchy's method, Newton's method, Conjugate Gradient method, Constrained Optimization algorithms, Kuhun-Tucker conditions, Transformation methods, Direct search for constrained minimization, Feasible Direction Method, Specialized algorithms, Integer Programming, Geometric Programming, Nontraditional optimization Algorithms, Genetic algorithms, Simulated Annealing, Structural Optimization, Methods of optimal design of structural elements, minimum weight design of truss members, optimum reinforced design of R.C. C. Slabs and beams, Optimization to the design of structures such as multi-storey buildings, water tank, shell roofs, folded plates.

CE G515 Fundamentals of Systems Engineering 3 1 4

Linear Programming, Queuing Theory, Inventory Control, Simulation, Maintenance models sampling techniques, Forecasting techniques, Decision models, Network scheduling, application to Resources planning, financial Management, facility location, decision making Maintenance issues, construction & operational issues for Civil Engg. System

CE G516 Multicriteria Analysis in Engineering 3 1 4

Introduction, Conventional optimization, Multi-objective Optimization, Fuzzy logic and its extensions, in multi-objective optimization, Multicriterion Decision Making, Deterministic analysis, Stochastic analysis, Fuzzy analysis, Classification problems, Hybrid approaches in Decision Making, Genetic Algorithms, Artificial Intelligence, Artifical Neural networks, Practical applications in Engineering.

CE G517 Waste Management Systems 3 1 4

Introduction, Wastewater and Solid Wastes, Collection and Transportation, Waste Disposal Systems, Land Treatment, Wastewater Management Methods, Wetland and Aquatic Treatment, Landfilling, Incineration, Energy from Wastes, Recycling, Composting, Reduction, Reuse and Recovery, Risk management, Case studies.

CE G518 Pavement Analysis and Design 3 1 4

Basic concepts in transportation planning, accessibility and mobility, land use interaction, government role in transportation planning. characteristics of travel and transport problems, transportation survey and data collection: planning, design and implementation, travel analysis zone (TAZ) development, traditional four-step modelling process, analysis of travel behaviour and demand: studying travel behaviour, analysing urban travel markets; innovations in transportation modelling: travel behaviour model, activity-based models. econometric modelling using r-studio, modelling travel demand with CUBE. Transportation Demand Management (TDM), Transportation System Management (TSM), Smart City Transportation Planning: Transit-Oriented Development (TOD), Pedestrian-Oriented Development, liveable street planning, multimodal transportation planning, shared mobility concepts, integrated transportation management and planning. transportation & energy, climate change, fuel choice and green mobility.

CE G520 Infrastructure Planning and Management 3 1 4

The goals and perspectives of planning; forecasting and design of alternatives; plan testing: economic, financial and environmental evaluation; the challenges of managing infrastructure; Information management and decision support system; Concepts of total quality management; Economics: life-cycle analysis and maintenance, Rehabilitation and Reconstruction (M.R & R) programming; Infrastructure management system (IMS) development and implementation; Rural Infrastructure Planning.

CE G521 Topics in Structural Engineering 3 2 5

Introduction to structural optimization, application to simple structures such as trusses, and simple frames; Theory of plates and its applications in Civil Engineering; folded plate design; theory and design of shell structures specifically with application in structures covering large area.

CE G522 Pavement Design, Maintenance and Man- 3 2 5 agement

Materials for road construction: specifications and tests on binder, aggregate and soil; Asphalt mix design; Pavement structure; Stresses in flexible and rigid pavements; Design of flexible and rigid pavements; Pavement Management System (PMS) implementation and operation; Data base requirements; Road condition surveys; Data management; Pavement condition analysis; Determination of maintenance and rehabilitation needs at network level; Panel inspection; Prioritization and optimization; Budgets, programmes and plans of action.

CE G523 Transportation Systems Planning and Man- 3 1 4 agement

System and environment; sequential transportation systems planning: trip generation, trip distribution, modal split and traffic assignment. Transportation Systems Management (TSM) actions: traffic management techniques for improving vehicular flow, preferential treatment for high occupancy modes, demand management technique for reduced traffic demand, staggered hours, vehicle restrictions; planning for pedestrians, parking planning; Methods of accident data collection and analysis.

CE G524 Urban Mass Transit Planning, Operations 3 1 4 and Management

Modes of public transportation and application pf each to urban travel needs; Comparison of transit modes and selection of technology and transit service; Estimating demand in transit planning studies and functional design of transit routes; Terminal design; Management and operation of transit systems, Model for operational management; Fleet and crew management; Terminal management; Fiscal management.

CE G525 Water Resources Planning and Management 3 1 4

Introduction; Quantitative and qualitative assessment of water resources; Engineering principles applied to the management of water resources; Hydrographic and project surveys; Watershed management; Measurement techniques in water resources engineering; Gains of water resources planning to the society; Water economics; Computer utilization areas; Project discussions; Laboratory experiments.

CE G526 Systems Approach to Water Resources 3 1 4 Modeling

Introduction to system analysis; Water management models: types and significance; Fundamentals of model development; Model solution techniques (computational methods) such as computer aided optimization, simulation, statistical analysis and reliability considerations; Model calibration and verification; Modeling of water quality subsystems and water quantity subsystems in various water bodies and its methods of analysis.

CE G527 Construction Management 3 1 4

Industry profile, parties involved, contracts, bonds, bidding, changes, pre-planning, construction management approach and partnering; Planning and scheduling, net-work based scheduling systems (CPM), Resource management, Network acceleration, PERT probabilistic approach.

CE G528 Selection of Construction Equipment and 3 1 4 Modeling

Selection and application of construction and earth moving equipment; Productivity analysis of equipment operations; mathematical models for construction operations; Quality issues in construction process modeling.

CE G529 Construction Project Control Systems 3 1 4

Concepts, planning and organization; bar charts and schedule networks; CPM computer software, Resource management; Optimal project duration; Project estimates; Budgeting and cash flow; Project control; PERT and line of balance; Project simulation; Materials management and information systems; Claims; Corrective actions; Total quality management; Equipment economics; Nature of design projects: (1) design of project scheduling networks, (2) design of construction operations, (3) development of project breakdown structure, and (4) development of project cash flow design.

CE G530 Design of Construction Operations 3 1 4

Techniques for the design and analysis of construction operations to maximize productivity and minimize resource idleness; Queuing theory, line of balance, simulation, probabilistic and statistical methods applied to construction; An actual construction operation will be modeled and analyzed as part of the course in the context of a term project.

CE G531 Environmental Conservation 3 1 4

Environmental management; impact of development schemes; essentials of an environmental policy and an environmental act; environmental issues and priorities, ecological effects of current development process; energy resources and water resources planning; Economics of pollution control; National conservation strategy; Organisations dealing with environmental conservations.

CE G532 Advanced Soil Mechanics 3 1 4

Modern concept of soil structure and its application in explaining its behaviour; effects of seepage on equilibrium of ideal soil; mechanics of drainage; theories of elastic subgrade reaction; theories of semi infinite elastic soils; vibration problems.

CE G533 Advanced Composite Materials for Struc- 3 1 4 tures

Introduction and History of FRP, Overview of Composite materials, Physical and Mechanical Properties and Test methods, Design of RC Structures reinforced with FRP Bars, Flexural Strengthening of RC Beams, Shear Strengthening of Beams, Flexural Strengthening of Slabs, Strengthening of Axially and Eccentrically Loaded Columns, Seismic Retrofit of Columns.

CE G534 Pavement Material Characterization 3 1 4

Field and Laboratory tests on soil, stabilization techniques. Geosynthetics testing and specifications. Tests on aggregates including the quarrying, crushing, stacking and gradation. Tests on bitumen and importance of viscosity grading, tests on bitumen emulsions and application, tests on modified bitumen. Performance grading of bitumen and the rheology test as per ASTM standards. Bituminous mixture design using Marshall's and Super-Pave methods. Performance tests on bituminous mixtures such as resilient modulus, dynamic modulus, creep tests, 4-point bending fatigue test and Hamburg wheel tracking rutting test. Pavement Quality Concrete (PQC) mixture design and tests on joint filler and sealant materials. Admixtures for bituminous and cement concrete. Alternate materials such as Reclaimed Asphalt Pavement (RAP) material, fly-ash, slags and other marginal materials.

CE G535 Highway Geometric Design 3 1 4

Highway functional classification; route layout and selection, design controls and criteria: turning paths, driver performance, traffic characteristics; highway capacity; access control; safety; environment; Elements of design: sight distance, horizontal alignment, transition curves, super elevation and side friction; vertical alignment: - grades, crest and sag curves; highway cross-sectional elements and their design; at-grade Intersections – sight distance consideration and principles of design, canalization, mini roundabouts, layout of roundabouts, interchanges: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design; parking layout and design; terminal layout and design.

CE G536 Traffic Engineering and Safety 3 1 4

Road users and their characteristics; traffic studies- volume, speed, origin-destination (O-D) and delay studies; analysis and interpretations of traffic studies; traffic forecasting; capacity and level of service analysis; traffic characteristics at un-signalized and signalized intersections; design of signalized intersections, capacity and LOS of signalized intersections, actuated signal control, signal coordination; traffic controls: signs, markings, street furniture; traffic regulations; parking studies; nature of traffic problems and their solutions; traffic safety: accidents- da-

ta collection and analysis; causes and prevention.

CE G537 Transportation Economics and Finance 3 1 4

Need for economic evaluation; concept of total transport cost; fixed and variable costs, elasticity of demand, marginal costs; value of travel time, accident costs; methods of economic evaluation; taxation in road transport, user charges: fees and tolls; highway legislation; investment policies and pricing, issues in financing and subsidy policy, public private partnership (PPP) options in transport sector: BOT, BOOT, BOLT; feasibility studies, identification and sharing of risks in PPP projects, operation and management agreements.

CE G538 Project Planning and Management 3 1 4

Foundations of project management: project life cycle, environment, selection, proposal, scope, ToR standardization; work break down structure; network scheduling: critical path method (CPM), programme evaluation and review technique (PERT), planning and scheduling of activity networks; resource planning: allocation, schedule compression, precedence diagram, generalized activity network; estimation of project cost, earned value analysis, monitoring project progress; quality assurance; contract administration and management; mechanization and advanced process control; quality audit; milestones, bonus and penalties; dispute resolution; capacity building and skill development.

CE G539 Introduction to Discrete Choice Theory 4*

Introduction, element of choice process, individual preferences, behavioral choice rule, utility based choice theory; data collection techniques, stated preference (SP) survey, revealed preference (RP) survey, paradigms of choice data; discrete choice models, property of discrete choice models, Multinomial logit model; overview and structure, Nested logit model formulation; discriminant analysis, Naive Bayes classification, classification trees, classification using nearest neighbors; application of fuzzy logic and artificial neural network in discrete choice modeling.

CE G542 Water Resources and Management 3 1 4

Water resources system for different utilization; theory and analytical methods for minimum cost and optimum development; analysis and design of multi-purpose water resources system; engineering and economic principles applied to the management of water resources.

CE G543 Traffic Flow Theory 3 1 4

Traffic flow elements: speed, volume and density and their relationships; time-space diagrams, controlled access concept, freeway concept, system performances, measures of effectiveness; mathematical modeling; probabilistic & stochastic models of traffic flow process, discrete and continuous modeling: headways, gaps and gap acceptance; macroscopic models; car-following model; queuing models; fundamentals & development of queuing processes; traffic simulation; intelligent transportation systems (ITS).

CE G544 Fracture Mechanics of Concrete Structures 3 1 4

Types of failure, Types of fracture, Modes of fracture, Fracture criteria, Energy release rate, Stress intensity factor (SIF), SIF of more complex cases, , Elastic plastic analysis through J-integral, Crack tip opening displacement, Test methods, Fatigue failure, Fracture mechanics of concrete: Need for fracture in concrete, Linear Elastic fracture models, Elasto-plastic fracture models, Nonlinear fracture models, RILEM fracture energy, softening of concrete, fracture process zone, size effect, Interface fracture, Fracture behaviour of special concretes, Numerical analysis.

CE G545 Airport Planning and Design 3 1 4

Air Transport structure and organization; forecasting air travel demand, trend forecasts and analytical methods; air freight demand; airport system; characteristics of the aircraft; airport capacity and configuration; airport master planning: site selection, layout plan, orientation and length of runway as per ICAO specifications; geometric design of runway taxiway and aprons; structural design of runway and taxiway pavements; airfield pavement drainage; airport runway structural evaluation using Heavy Falling Weight Deflectometer (HFWD), overlay design. Passenger terminal function, passenger and baggage flow, analysis of flow through terminals, parking configurations and apron facilities; air cargo facilities-flow through cargo terminals, airport lighting; airport access problem; environmental impact of airports.

CE G546 Highway Construction Practices 3 1 4

Road planning and reconnaissance; right of way selection; fixing of alignment; road construction techniques: construction staking, clearing and grubbing of the road construction area; subgrade construction: excavation and filling, compaction, preparation of sub grade, quality control tests as per MORTH specifications; granular subbase and base course construction: gravel courses, WBM, WMM, stabilized soil subbases, use of geo-textiles and geo-grids; construction of bituminous layers; concrete pavement construction; field quality control ; road making machinery.

CE G547 Pavement Failures, Evaluation and Rehabilitation 3 1 4

Pavement deterioration, distress and different types of failures, pavement surface condition deterioration such as slipperiness, unevenness, rutting, cracking; pot holes, etc., causes, effects, methods of measurement and treatment, use of modern equipment for pavement surface condition measurements, Analysis of data, interpretation. Structural deterioration of pavements: causes, effects, methods of treatment. Structural evaluation of flexible pavements by rebound deflection method, analysis of data, design of overlay, use of FWD and other methods for evaluation of flexible and rigid pavements and their application. Evaluation of new pavement materials, model studies, pavement testing under controlled conditions, accelerated testing and evaluation methods, Test track studies. Instrumentation for pavement testing.

CE G548 Pavement Management Systems 3 1 4

omponents of pavement management systems, pavement maintenance measures; pavement performance evaluation: general concepts, serviceability, pavement distress survey systems, performance evaluation and data collection using different equipment; evaluation of pavement distress modeling and safety; pavement performance prediction: concepts, modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM-IV models, comparison of different deterioration models, functional and structural condition deterioration models; ranking and optimization methodologies: Recent developments, economic optimization of pavement maintenance and rehabilitation.

CE G549 Rural Road Technology 3 1 4

Network planning, accessibility and mobility; road alignment and survey; geometric design: cross-sectional elements, sight distance, horizontal and vertical alignments; road materials and use of marginal materials; pavement design, drainage, culverts and small bridges; construction and specifications; quality control in construction; pavement failures; maintenance; preparation of detailed project report (DPR); community participation in planning, design, construction and management.

CE G551 Dynamics of structures 3 1 4

Free and forced Vibration Analysis of SDOF system, Response to general dynamic loadings, Numerical evaluation of dynamic response, Effect of damping; Free and forced vibration of undamped and damped multi degree of freedom systems; Modeling for multi degree of freedom systems; Equation of motions, Evaluation of natural frequencies and mode shapes, orthogonality conditions, Modal analysis and modal combination rules, Numerical evaluation of dynamic response for multi degree of freedom, time history analysis; support excited vibration, analysis of non-linear systems, Free and forced vibration analysis of continuous systems, Random vibrations, Stochastic response; Vibration isolation, vibration absorber and tuned mass damper; Evaluation of wind, blast, wave loading and other dynamic forces on structure; Modeling and dynamic analysis of buildings, bridges, water tank, liquid storage tanks, stack like structure, machine foundations etc.

CE G552 Advanced Structural Mechanics and 3 1 4

Stability

Analysis of stress and strain in three dimension domain, deviatoric stress and strain; stress and strain invariants, compatibility conditions, equilibrium equations; stress-strain relations for anisotropic, orthotropic and isotropic elastic materials; yield criterion; plastic potential and flow rules. Problems on plane stress and plain strain conditions, Airy stress function; Axi-symmetric problems; torsion of prismatic bars, circular and non-circular sections; thin-walled sections, membrane and sand-heap analogies, concept of stability of structures and examples of instability. Stability of structures with one and two degree of freedom, buckling of columns; beam-columns and simple frames, lateral torsion buckling of beams; and introduction to postbuckling of plates.

CE G553 Theory of Plates and Shells 3 1 4

Analysis procedure and the basic theory of plates and shells; Different kinds of plates such as rectangular, circular, and elliptical; Different kinds of shell structures such as shell of revolution: spherical shells, cylindrical shells and special shell structures; Principles and applications of bending of plates, membrane theory, bending of shells, and stability of plates and shells; Kirchoff theory, Reissner-Mindlin-Naghadi type theories, rectangular plates-solution by double Fourier series, membrane theory of shells, and case study on plates and shells using numerical tools.

CE G554 Advanced Structural Design 3 1 4

Practical design problems on analysis and design of multistoried and industrial buildings, chimney, retaining wall, water tank, towers, etc using both the steel and concrete materials. Modeling of structures subjected to various load (DL, LL, WL, EQ etc.) combinations, structural analysis, design, and detailing of specific advanced concrete and steel structures.

CE G555 Remote Sensing and GIS in Water Resources 4*

Basic concepts of Remote Sensing (RS) and image processing; photogrammetry; global positioning system and its application in water resources; fundamentals of GIS; map projection; spatial data modeling and analysis; integration of hydrologic models and RS & GIS with relevance to surface and ground water resources. advanced aspects of RS & GIS; case studies.

CE G556 Advanced Computational Hydraulics 4*

Ordinary and partial differential equations; finite difference schemes and their variations, finite element methods and their variations; implicit and explicit types; accuracy, convergence and stability; applications to steady and unsteady flows in various fields in hydraulics; one-, two- and three-dimensional flows; Case Studies.

CE G557 Stochastic Hydrology 4*

Basics of statistics in hydrology, discrete and continuous distributions and their applications to hydrological variables; parameter estimation; hypothesis testing; regression analysis; classification and characteristics of time series; autocorrelation analysis; univariate and multivariate stochastic models; spectral analysis; case studies.

CE G558 Advanced Groundwater Hydrology 4*

Aquifers - hydraulic characteristics of aquifers (confined and unconfined). Basic principles of ground water flow; Techniques of artificial recharge; Well design; groundwater recharge basins and injection wells; flow into aquifer with different boundaries and special cases; ground water models (digital and analog models): groundwater pollution, contaminant transport, remediation and legislation.

CE G559 Soft Computing in Water Resources 4*

Introduction and role of soft computing techniques such as fuzzy logic, expert systems, evolutionary algorithms in water resources engineering; classical sets and fuzzy sets; membership functions; defuzzification; basics of expert systems and relevant terminology; Procedure for development of knowledge base and handling of uncertainty; fundamentals of evolutionary algorithms; case Studies.

CE G560 Hydrologic Simulation Laboratory 4*

Role of simulation and optimization modeling in water resources; data mining techniques in hydrology; database management; applicability of hydraulic and hydrologic related simulation models and softwares; applicability of optimization based models and softwares.

CE G561 Impact of Climate Change on Water Resources Systems 4

Introduction to anthropogenic climate change; impact of climate change on hydrology and water resources; global climate teleconnections; various modeling approaches including general circulation models and downscaling approaches; selection criteria; climate predictability and forecasting; limitations and uncertainties; adaptability to climate change; Case Studies.

CE G562 Advanced Concrete Technology 4

Components of concrete; chemical properties of cement & cementitious paste; heat of hydration; microstructure of cementitious paste; properties of aggregates; chemistry of mineral admixtures;chemistry of chemical admixtures; characterization of powdered and solid block concrete; effect of concrete composition on properties of fresh concrete; rheology of concrete; effect of concrete composition on properties of hardened concrete; shrinkage and creep; correlation between micro- and specimen level properties, interfacial transition zone (ITZ); durability of concrete; prediction of concrete service life; techniques for non-destructive evaluations (NDE) of concrete; green concrete; concrete with alkali activated binders (AAB); difference between alkali –activated binders and blended cements.

CE G563 Stochastic Methods in Civil Engineering 3 1 4

Uncertainty, Discrete and Continuous distributions, Hypothesis testing, Classification and characteristics of time series, Autocorrelation analysis, Multivariate data analysis by logistic regression, discriminant analysis, cluster analysis, factor analysis, queuing theory, Reliability analysis, Statistical quality control, Introduction to univariate and multivariate stochastic models, markov chain and their properties, introduction to Transition probability, case studies.

CE G564 Structural Health Assessment and Rehabilitation 3 1 4

Introduction, Overview of present repair, retrofitting, and strengthening practices, Distress identification, Repair management, Causes of deterioration and durability aspects, Holistic models of Deterioration of RCC, Durability Aspects, Intrinsic and extrinsic causes an stage of Distress, Condition survey and Non-destructive Evaluation, Classes of Damages and Repair Classification, Structural Analysis and Design, Reserve Strength, Evaluation of Building Configuration, Repair materials and their selection, Rehabilitation and Retrofitting Methods, Analysis and Design of Externally FRP and ECC Strengthened Structures , Retrofitting using External Unbonded Post-tensioning and Near Surface Mounted FRP Rebars, Durability Based Design of FRP Reinforced/Strengthened Bridge Girders, Case Study Problems.

CE G565 Transportation Planning 3 1 4

Basic concepts in transportation planning, accessibility and mobility, land use interaction, government role in transportation planning, characteristics of travel and transport problems; transportation survey and data collection: planning, design and implementation, travel analysis zone (TAZ) development, traditional four-step modelling process; analysis of travel behaviour and demand: studying travel behaviour, analysing urban travel markets; innovations in transportation modelling: travel behaviour model, activity-based models, econometric modelling using r-studio, modelling travel demand with cube, transportation demand management (TDM), transportation system management (TSM), smart city transportation planning: transit-oriented development (TOD),pedestrian-oriented development, liveable street planning, multimodal transportation planning, shared mobility concepts, integrated transportation management and planning, transportation and energy, climate change, fuel choice and green mobility.

CE G566 Public Transportation 3 1 4

Modes of public transportation, history and classification, transit

right of way, qualitative swot analysis. role of public and private sectors in mass transit. transit planning and data collection. ridership prediction, route determination, stopping policy, stop spacing determination, transit network design: capacity, way headway, station headway, safety regime, dwell time, frequency. vehicle capacity, transit operation scheduling: development of time-table and determination of fleet size; and, crew scheduling process, demand-based transit planning. fare structure and collection technology. dynamic responsive transit planning. transit system performance measures and benchmarking. innovation in transit system technology

CE G567 Highway Design **3 1 4**

Highway functional classification; design controls and criteria: turning paths, traffic characteristics, highway capacity aspects, access control, safety, environment; sight distances; horizontal and vertical alignments; geometric design for expressways, at-grade intersections rotaries and mini roundabouts, importance of channelization and design of channelizing islands, intersection layouts; grade separated interchanges: types, layouts, suitability, advantages and limitations of different types of interchanges, performance based design, geometric design consistency; pedestrian-oriented development, liveable streets, bicycle and pedestrian planning; on street and off street parking layouts and design; layouts of truck terminals and bus bays; introduction to geometric design software. plan and profile preparation using drafting and visualization software such as AutoCAD, Micro-station. Alignment design using MXROAD, AutoCAD Civil 3D, open road; checking swept path of turning vehicles: AutoTrack, AutoTurn; Highway design manuals.

CE G568 Traffic Systems Analysis **3 1 4**

Characteristics of traffic stream: Traffic flow, speed and density, Traffic data collection. Modeling uninterrupted traffic flow: Microscopic and macroscopic modeling, Car-Following theory. Capacity and level-of-service analysis: Concepts of capacity and level-of-service (LOS) of highways, expressway, highway, multi-lane highway and multi-modal LOS as per latest Highway Capacity Manual (HCM). Traffic flow at Toll-Plazas: Queuing theory, delay and queue length analysis of traffic at Toll-Plazas. Traffic flow at un-signalized intersections: Gap acceptance theory and capacity estimation of traffic at un-signalized intersections. Traffic flow at signalized intersections: Delay and queue length analysis of traffic at signalized intersections, design of signals and concept of Co-ordinated signals. Adaptive signal concepts., Advanced Intelligent Transport Systems (ITS). Introduction to latest Traffic simulation packages, Exposure to relevant codes of practice.

CE G569 Transportation Economics **3 1 4**

Introduction to engineering economics. Transportation Demand and Supply. Transportation Cost concept. Conceptual aspects of Elasticity, Demand forecasting methods, factors influencing transport demand, direct and cross-price elasticities of demand, factors that cause shifts in demand function. Investment and financing of transport: Revenue sources; expenditure sources; traditional project delivery methods and innovation in financing. Congestion pricing. Transport project evaluation: economic appraisal; discount rate and time value of money; net present value; cost-benefit analysis and life cycle cost analysis as per IRC:SP:30. Road User Cost Study (RUCS). Feasibility and evaluation, cost, evaluation of alternatives, analysis techniques, measures of land value and consumer benefits from transportation projects, prioritization of projects.

CE G570 Highway Construction Technology **3 1 4**

Road planning and reconnaissance; right of way selection; fixing of alignment; road construction techniques: construction staking, clearing and grubbing; subgrade construction: excavation and filling, compaction, preparation of sub grade, quality control tests as per MoRT&H specifications; granular subbase and base course construction: gravel courses, WBM, WMM, stabilized soil subbases, use of geo-textiles and geo-grids; construction of bituminous layers; concrete pavement construction. Hot mix asphalt plants, road construction equipment, material placement and compaction methods, shoulders, highway drainage and roadside requirements; State of the art construction management techniques, construction standards, quality control and quality assurance including contract documents and arbitration.

CE G571 Road Asset Management **3 1 4**

Need for Road inventory data, purpose and types. Characterization of pavement performance including the concept of pavement condition index. Application of road roughness data including the calibration for universal roughness standard. The non-destructive measurement of structural condition of the pavement at network and project level. Database Management with automated survey methods for distress prediction. Pavement deterioration models, pavement maintenance and rehabilitation techniques. Life cycle cost analysis using HDM4. Prioritization of pavement maintenance strategies. Developing asset management plans: financial plan, asset valuation, resource allocation. Economic evaluation of alternative pavement design strategy and selection of an optimal maintenance strategy.

CE G572 Transportation Data Analytics **3 1 4**

Research Design Concepts in transportation, Data collection and analysis techniques. Probability Distributions, Sampling and Measurement, Interval Estimation, Hypothesis Testing, Analysis of Variance. Simple, Multiple and Time-series Regression, Dynamic Regression Models, Structural Equation Models, Count Data Models. Supervised Learning Methods: Tree-based Methods and Support Vector Machines. Clustering Methods: Dimensionality Reduction (Principal Component Analysis, Independent Component Analysis), Clustering Methods: Hierarchical clustering, K-Means Clustering, Mean Shift Clustering, Density-based Clustering. Data analysis and modelling using R-Studio. Case Studies –Traffic Operations, Pavement Materials and Quality Control, Transportation Planning, Public Transit and Road safety and Highway Geometric Design.

CE G573 Road Safety and Accident Analysis **3 1 4**

Road safety, accident statistics and investigation, collision and condition diagrams, accident data collection. Reactive and proactive measures of road safety, safe systems approach, black-spot identification and mitigation measures, development of safety performance functions, road safety audit (RSA), identification and treatment of crash locations, economic analysis of road safety measures, Application of intelligent transportation system in road safety management, Accident investigation, Introduction to Road safety manuals including IRC SP 88, PIARC Documents, AUSTROADS Documents, International Road Assessment Program (I-RAP), Network-based safety analysis, Road signs and markings and related codes, Accident Reconstruction.

CE G574 Pavement Maintenance **3 1 4**

Importance of highway maintenance works and timely rectification of defects in flexible pavements. Routine maintenance, preventive maintenance, periodic maintenance, special maintenance, emergency repairs, patching of potholes, strengthening and rehabilitation of road pavements and drainages. Causes of distress in flexible and rigid pavements, failure of surface and subsurface drainage systems. Maintenance of rural roads: Gravel roads, bituminous roads, cell filled pavements, roller compacted concrete pavement, interconnected block pavement. Maintenance of urban roads: Flexible pavements, thin and ultrathin white topping, cobble roads, interconnected block pavement, side drains and subsurface drainage layer, utility service lines. Retrofitting of dowel bars in rigid pavement.

CE G575 Freight Transportation **3 1 4**

Introduction to Freight System, Overview of three-layer structure of freight: Global, Regional and Local, Freight Transport Industry Structure: Maritime freight Transport, Air freight Transport, Road freight Transport, Rail Freight Transport. Factors affecting freight demand, Freight generation, Freight trip generation, Modelling Inter-Regional Freight Demand Models. Use of GPS and Bluetooth Data for Freight Analysis, International best practices of freight models. Freight Distribution Structures, Logistics Network Planning, Distribution centers, urban freight consolidation centers and warehouses: location, design and operation, Warehouse management and information, Material Management and Inventory Theory, Economic Order Quantity, Demand forecasting for inventory replenishment systems. Off-hour freight delivery (OHD) schemes, Freight emission modelling, Humanitarian Logistics. Relief Network Models for Efficient Disaster Management.

CE G576 Advanced Computational Modelling **3 1 4**

Introduction to computational modelling and simulations for large material deformation or flows; Theoretical basis and programming of grid-based methods and mesh-free/ particle-based methods; XFEM/ SPH/ Peridynamics/ Phase Field approaches etc.; Constitutive modelling; Equation of states; Modelling of real-life problems in structural, soil, rock and fluid mechanics; Techniques for management and visualization of large data.

Pre-requisite: CE F435 **OR** CE G619 **OR** ME G512

CE G610 Computer Aided Analysis and Design in Civil Engineering **3 2 5**

Computer languages; CAD, graphics; database management system; knowledge base expert system; development of preprocessor and post processor with graphic interface; analysis and design, optimization techniques, genetic algorithms, software development for analysis and design, interfacing.

CE G611 Computer Aided Analysis and Design **3 2 5**

The course aims at developing complete self reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

CE G612 Advanced steel Structures **3 1 4**

Steel properties; high strength steels, structural behaviour, analysis and design; loads and environmental effects; load and resistant factor design (LRFD); column and beams; connections; member under combined loads; bracing requirements; composite members; plastic analysis and design; tall steel buildings, detailing in steel structures.

CE G613 Advanced concrete Structures **3 1 4**

Materials; high strength concrete, flexure analysis and design; shear and diagonal tension; bond and anchorage; serviceability; torsion; columns; joints; indeterminate beams and frames; yield line analysis; strip method for slabs; composite construction; footing and foundations; concrete building system; concrete tall buildings, detailing in concrete structures.

CE G614 Prestressed Concrete Structures **3 1 4**

Effect of prestressing; source of prestress, prestressing steel; concrete for construction; elastic flexure analysis, flexural strength; partial prestressing; flexural design based on concrete stress limits; tension profile; flexural design based on load balancing; losses due to prestress; shear diagonal tension and web reinforcement; bond stress, transfer and development length, anchorage zone design, deflections.

CE G615 Earthquake Engineering **3 1 4**

Single and multi degree freedom system; seismic risk, causes and effects of earthquakes; seismicity, determination of site characteristics; design earthquakes; earthquake resistant design philosophy; seismic response; earthquake resistant design of structures; detailing for earthquake resistance in concrete and steel structures.

CE G616 Bridge Engineering **3 1 4**

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

CE G617 Advanced Structural Analysis **3 1 4**

Flexibility Method; stiffness method; beam curved in plan; two dimensional and three dimensional analysis of structures; shear deformations, shear wall analysis; interactive software development for analysis of structures.

CE G618 Design of Multi-Storey Structures **3 1 4**

Loads and stresses; building frames; framing systems, bracing of multistorey building frames; diaphragms; shear walls and cover; tube structure, approximate analysis and preliminary design; frame analysis; design loading, wind effects and response, earthquake response of structures.

CE G619 Finite element analysis **3 2 5**

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

CE G620 Advanced Foundation Engineering **3 1 4**

Types of foundations, capacity and settlement of foundations, soil properties, design considerations, discrete method for analysis, design of shallow and deep foundations, failure in foundations, remedial measures, case studies of foundations.

CE G621 Fluid Dynamics **3 2 5**

Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory;flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

CE G622 Soil-Structure-Interaction **3 1 4**

Importance of soil-structure interaction, basic theories, types of interaction problems, numerical modelling, experimental and field investigations, prediction of failure mechanism, economic considerations.

CE G623 Ground Improvement Techniques **3 1 4**

Requirements for ground improvement, various techniques of improvement, water table lowering, ground freezing, electro-osmosis, compaction, tamping, use of explosives, vibratory probes, thermal treatment, addition of lime, cement and bitumen, gravel and sand columns, preloading techniques, reinforced earth, soil replacement techniques.

CE G631 Selected Topics in Soil Mechanics and Geotechnical Engineering **3 1 4**

Formation of soil & soil deposits, subsurface exploration, collapsible soils identification treatment & design consideration, review of casting expansion models in soil, treatment of weak soil, numerical modelling, fracture propagation & fracture energy, fluid infiltered materials, modern trends.

CE G632 Design of Foundations for Dynamic Loads **3 1 4**

Evaluation and interpretation of geotechnical reports, selecting foundation design parameters from laboratory and field tests, Selection of foundation, Analysis and design of strip, isolated & combined footing, circular and ring foundation, Design of raft foundation using conventional rigid method, Coefficient of subgrade reaction, Winkler model for footings and mat on elastic foundations, Proportioning and structural design of footings subjected to combined vertical, moment and horizontal loads, Seismic design of shallow foundations, ductile detailing, Analysis and design of different type of pile foundations, piles subjected lateral load, moment and uplift, piles subjected to dynamic loads, design of pile group and pile cap, Seismic design of pile foundations and ductile detailing, Analysis and design of retaining walls, reinforced earth wall design, seismic design of retaining structure, Analysis and design of machine foundations for reciprocating machines, impact type, rotary machines such as turbines, turbo-generator, Computing static and dynamic stiffness of foundations, soil-structure interaction, Optimization and computer aided design of foundation, BIS, IRC, ACI, ASCE, AASTHO and Euro code provisions on structural and earthquake resistant design of foundations.

CE G641 Theory of Elasticity and Plasticity **3 2 5**

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.

Chemical Engineering

CHE F211 Chemical Process Calculations **3 0 3**

Historical overview of Chemical Engineering, Principles of balancing with examples to illustrate differential and integral bal-

ances lumped and distributed balances, Material balances in simple systems involving physical changes and chemical reactions, Systems involving recycle, purge and bypass, Properties of substances: single component & multicomponent, single and multiphase systems. Ideal liquid and gaseous mixtures, Energy balance calculations in simple systems, Introduction to Computer aided calculations-steady state material and energy balances for chemical plants

CHE F212 Fluid Mechanics 3 0 3

Dimensions and Units, Velocity and Stress Fields, Viscosity and surface tension, Non-Newtonian flow, Introduction to Fluid Statics, Dimensional Analysis (Buckingham PI theorem), Types of flows, Fluid Statics, Bernoulli equation, Differential and Integral analysis methods of analysis, Navier Stokes equation, Potential flows, Stream functions and velocity potential, Boundary Layer Theory, Flow measurement, Pipe flow analysis, Flow past immersed objects, Packed beds, Fluidized beds, Sedimentation, Pumps and compressors Agitation and Mixing, (Power consumption, mixing times, scale up), Introduction to Turbulent Flows (Reynolds equations), Compressible flows.

CHE F213 Chemical Engineering Thermodynamics 3 0 3

Review of work, heat, reversible and irreversible processes, First Law applications to closed and open systems, Second law, Entropy, and applications related to power and refrigeration, Heat effects, Availability and Exergy analyses Equations of state and generalized correlations for PVT behaviour, Maxwell relations and fluid properties estimation; Residual and excess properties, Partial molar quantities; Gibbs-Duhem Equation, Fugacity and Activity Coefficient models, Vapour-liquid equilibria, Chemical Reaction Equilibrium.

CHE F214 Engineering Chemistry 3 0 3

Organic chemistry – Important functional groups, their reactions and named reactions, Physical chemistry – thermo-physical and thermodynamic properties determination, phase rule, Adsorption equilibria, Electrochemistry, Chemical methods of analysis, Instrumental methods of analysis, Water and waste water chemistry and analysis, Corrosion, Engineering materials and inorganic chemicals, Metals and alloys, Polymers, Fuels and fuel analysis.

CHE F241 Heat Transfer 3 0 3

Steady state and unsteady state conduction, Fourier's law, Concepts of resistance to heat transfer and the heat transfer coefficient. Heat transfer in Cartesian, cylindrical and spherical coordinate systems, Insulation, critical radius, Convective heat transfer in laminar and turbulent boundary layers, Theories of heat transfer and analogy between momentum and heat transfer, Heat transfer by natural convection, Boiling and condensation, Radiation, Heat exchangers: LMTD, epsilon-NTU method, Co-current counter-current and cross flows, NTU – epsilon method for exchanger evaluation.

CHE F242 Numerical Methods for Chemical Engineers 3 0 3

Introduction to mathematical modelling and engineering problem solving, Use of software packages and programming, Errors and approximations including error propagation and Numerical error, Roots of equations: Linear algebraic equations, 1-D and multi-dimensional unconstrained optimization including gradient methods, Linear programming, Non-linear constrained Optimization, Optimization with packages, Least Squares Regression including quantification of error, Polynomial regression, Lagrange, inverse and spline interpolation and Fourier approximation, Engineering applications, Numerical differentiation and integration, Ordinary differential equations, Partial differential equations, Engineering applications

CHE F243 Material Science and Engineering 3 0 3

Introduction on materials for engineering, structures of metals, ceramics and polymers; crystalline structure imperfections; amorphous and semi-crystalline materials (includes glasses, introduction to polymers); Correlation of structure to properties and engineering functions (mechanical, chemical, electrical, magnetic and optical); phase diagrams; Improving properties by controlled solidification, diffusion or heat treatment; Failure analysis and non-destructive testing; Types of materials (includes synthesis, Fabrication and processing of materials): Polymers and composites, Environmental degradation of materials (corrosion); Evolution of materials (functional materials, Biomimetic materials, energy saving materials etc); Criteria for material selection.

CHE F244 Separation Processes I 3 0 3

Molecular diffusion in fluids, Interphase mass transfer, mass transfer coefficient, Theories for interphase mass transfer, overall mass transfer coefficient and correlations, mass transfer with chemical reaction, analogy between momentum, heat and mass transfer, Absorption, Distillation including azeotropic and extractive distillation, Liquid-Liquid extraction, Leaching, Equipment for absorption, distillation, extraction and leaching.

CHE F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

CHE F311 Kinetics and Reactor Design 3 0 3

Kinetics Reaction rate, order, rate constant; Batch reactors Design + basics; Kinetic constants from batch reactor data; Ideal flow reactors Mass and Energy balances; Isothermal, adiabatic and non-isothermal operation; Catalysts, Catalytic rates, Reaction mechanisms; Internal/External transport in catalysts; Non-catalytic solid-gas reactions; Reactor design for ideal flow reactors; Kinetics of Solid Catalyzed Reactions; Yield and Selectivity; Concept of RTD; Segregation and Maximum Mixedness models.

CHE F312 Chemical Engineering Lab I 0 3 3

This course aims to help students gain practical experience using laboratory-scale experiments to supplement theory courses taught in classroom with major focus on chosen experiments from Fluid Mechanics, Engineering Chemistry, Heat transfer and Separation Processes – 1. Students will collect and analyze experimental data using theoretical principles related to relevant courses already covered in previous Semesters.

CHE F313 Separation Processes II 3 0 3

Special equilibrium based separations like humidification and water cooling, Drying of wet solids, adsorption, crystallization etc., Mechanical separations like filtration, centrifugation, froth floatation etc., Solid separations based on size reduction including sieving operations and related equipment like crushers, mills, pulverizers etc., special separation processes like ion-exchange, membranes, chromatography etc.

CHE F314 Process Design Principles I 3 0 3

Process invention using heuristics and analysis (The Design process, Process creation and heuristics for process synthesis, Molecular structure design, Role of process simulators Like Aspen, Chemcad, Hysys etc. in process creation), Detailed process synthesis using algorithmic methods with emphasis on reactor networks, separation trains, batch processes, heat integration etc.

CHE F315 Machine Learning for Chemical Engineers 3 0 3

Introduction to machine learning and relevance in Chemical Engineering, Univariate and multivariate techniques of data processing; Dimensionality reduction; Machine learning techniques for process modelling; Supervised algorithms (Regression, Artificial Neural Network, Bayes technique, Support Vector Machine etc.); Unsupervised algorithms (Principal component analysis, k-Means Clustering, Hierarchical Clustering, Hidden Markov models etc.); Application to Chemical engineering Problems (reactors, distillation, pumps, heat exchangers etc.) using suitable computational platforms.

Pre-requisite: CHE F242: Numerical Methods for Chemical Engineers **OR** MATH F313: Numerical Analysis

CHE F341 Chemical Engineering Laboratory II 0 3 3

This course aims to help students gain practical experience using laboratory-scale experiments to supplement theory courses taught in classroom with major focus on chosen experiments from Kinetics and Reactor Design, Process Dynamics and Control and Separation Processes – 2. Students will collect and analyze experimental data using theoretical principles related to relevant courses already covered in previous Semesters.

CHE F342 Process Dynamics and Control 3 0 3

Introduction to process control, Theoretical models of chemical process, Laplace Transforms, Transfer functions and state space models, Dynamic response of first and second order processes, Effect of dead time, Dynamics response of more complicated systems, Development of empirical models from empirical data, Feedback control, Control system instrumentation, Overview of Control system design, Dynamic behavior and stability of closed loop system using root locus, frequency response using Bode and Nyquist plots, PID controller design and tuning, Control system design based on frequency response analysis, Feed forward, cascade and ratio control, Introduction to multivariable control system, identification of interaction, design of controllers in interactions, elimination of interactions, Control strategies for common industrial processes such distillation, heat exchangers, etc. Control strategies for Batch processes.

CHE F343 Process Design Principles II 3 0 3

Review of process synthesis, Design and sizing of equipment of heat exchangers, separation towers, pumps etc. Cost accounting and capital cost estimation, Annual costs, earnings and profitability analysis, optimization of process flow sheets, Steps involved in designing configured industrial systems like solar desalinators, fuel cells, hand warmers etc.

CHE F366 Lab Project 3

CHE F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CHE F376 Design Project 3

CHE F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CHE F411 Environmental Pollution Control 3 0 3

Air & water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies; associated laboratory.

CHE F412 Process Equipment Design 3 0 3

Application of principles of Chem. Engg. to the selection and design of equipment for Chemical industries; design, cost estimation and selection of process equipment; piping, pressure vessels, heat exchangers, distillation columns etc. Use of computer software packages in the design; plant safety practices; use of codes.

CHE F413 Process Plant Safety 3 0 3

Role of safety in society. Engineering aspects of process plant safety. Chemical hazards and worker safety. Hazardous properties of chemicals. Safety aspects in site selection and plant layout. Design and inspection of pressure vessels. Storage, handling and transportation of hazardous chemicals. Risk assessment methods. Toxic release, fire and explosions. Boiling liquid expanding vapor explosions. Safety audit. Emergency planning and disaster management. Case studies.

CHE F414 Transport Phenomena 3 0 3

Analogy for momentum, heat and mass transport; shell balance approach for analysis of individual and simultaneous momentum, heat and mass transport; hydrodynamic and thermal boundary layers; velocity, temperature and concentration distributions in turbulent flow; interphase transport for isothermal and non-isothermal systems.

CHE F415 Molecular and Statistical Thermodynamics 3 0 3

Fundamental of Statistical Mechanics, Quantum Mechanics, Postulates, Concept of Ensembles, Intermolecular Potential Energy functions; Distribution functions: Radial Distribution Function (RDF); Applications of Statistical Mechanics: Thermophysical property calculations in ensembles; Cooperative Phenomenon: Phase Equilibria: Ising model, Gibbs Ensemble (VLE), Thermodynamic Integration, Gibbs-Duhem Integration, Free Energy calculation; Virial EOS: second virial coefficient; Special Applications: From Surface Adsorption: Adsorption Isotherm. Molecular Simulation Techniques: Molecular Dynamics and Monte Carlo Simulation, Monte Carlo Simulation in various Ensemble.

CHE F416 Process Plant Design Project I 3

This course aims to train the student on various aspects involved in design of a process plant. It may be for a Battery limit (B/L) plant or for a Grass roots project. The design will have to be submitted in the form of a standard report. There would be two major submissions: (i) Process selection and PFD, (ii) Material and Energy Balance. This part of the project in conjunction with Process Plant Design Project 2 is a Basic Process Package Report for a complete process plant.

CHE F417 Process Plant Design Project II 3

This course is an extension of Process Plant Design Project 1 and aims to train the student on various aspects involved in design of a process plant. It may be for a Battery limit (B/L) plant or for a Grass roots project. The design will have to be submitted in the form of a standard report. There would be three major submissions in relation to the process selected in Process Plant Design Project 1: (i) Process Design, (ii) Mechanical design, (iii) Costing. This part of the project in conjunction with Process Plant Design Project 1 is part of detailed engineering and economics for a complete process plant.

CHE F418 Modelling and Simulation in Chemical Engineering 3 0 3

Mathematical model and necessity, Introduction to modeling, Physical and Mathematical models, Modelling in Chemical Engineering, Formulation of dynamic models with case studies based on mass, component, momentum and energy balances, Modeling of selected fluid flow, heat transfer, mass transfer and reaction engineering phenomena, Role of Simulation and simulators, Sequential and modular approaches to Process Simulation, Equation solving approach, Decomposition of networks, Convergence promotion, Specific purpose simulation, Introduction to role of evolutionary computation in simulation.

CHE F419 Chemical Process Technology 3 0 3

Process synthesis concepts for flow sheet generation - Unit operations and unit processes, General principles applied in studying a chemical industry; Chemical processes based on agricultural and sylvi-cultural raw materials - Sugar, starch, alcohol, cellulose, etc; Selected technologies for chemicals from inorganic chemical industry covering contact process, fertilizer, chloral-alkali, cement and lime; Natural product industry covering manufacture of oils, soaps, detergents, paper and pulp, Coal and various coal-chemicals, Petroleum and petrochemical products, Raw materials and principles involved in the production of olefins and aromatics, Acetylene, Butadiene and typical intermediates from olefins and aromatics such as ethylene glycol, ethyl benzene, phenol, cumene and DMT/PTA, Dyes and pharmaceuticals.

CHE F421 Biochemical Engineering 3 0 3

Basics of Microbiology and Biochemistry; Introduction to Biochemical engineering, Mass and energy balance in microbial processes; Microbial growth, Substrate utilization and product formation kinetics; Medium and air sterilization; Enzyme kinetics and immobilized enzyme systems; Design of batch, continuous and fed-batch bioreactors; Transport Phenomena in biological reactors; Scale-up principles for biochemical processes; Instrumentation and control of bioprocesses, Bio-separations.

CHE F422 Petroleum Refining Technology 3 0 3

Current world oil and gas scenario; History and development of refining; Petroleum industry in India; Origin, formation, and composition of petroleum; Classification and evaluation of crude oils; Petroleum products and test methods; Crude oil distillation; Thermal, catalytic and finishing processes; Product blending; Lube oil and bitumen (asphalt) manufacturing processes.

CHE F423 Membrane Science and Engineering 3 0 3

Overview of membrane separation processes;Introduction to membranes; Polymeric membranes;Non-polymeric membranes; polymer synthesis;polymer characterization; Metallic membranes;Zeolites; Metal Organic Frameworks; Liquidmembranes; Phase inversion; Thermodynamics ofPhase inversion; Dip coating; Track etching; ChemicalVapor Deposition; Morphology of membranes;Hydrophilicity; Ultrafiltration; Microfiltration;Nanofiltration; Reverse Osmosis; Pervaporation;Membrane distillation; Gas separation; Biomedicalengineering applications; Plate and Frame modules;Spiral wound modules; Hollow fiber membranemodules; Membrane contactors; Pore diffusion;Solution diffusion mechanism; Mathematical modelingof membrane separation processes; Membrane fouling;Concentration polarization; Cake layer formation; Gellayer formation; Membrane cleaning; Industrialmembrane installations; Economics of membraneplants; Opportunities for membrane technology instart-up ecosystem.

CHE F424 Rheology of complex fluids 3 0 3

Introduction to complex fluids, origins of non-Newtonian behaviour; fundamentals of rheology;rheological measurements and properties; linear andnon-linear viscoelasticity; time-temperature superposition, Boltzmann superposition principle,types of flow fields; various characterizationtechniques; techniques in oscillatory shear rheology;theoretical models for visco-elastic fluids; Maxwellmodel, Kelvin–Voigt model, Generalized Maxwellmodel, Oldroyd model; rheology of dilute polymersolutions, ideal chain conformations, real chainconformations, unentangled polymer dynamics,entangled polymer dynamics; rheology of two phasesystems, rheology of soft glassy materials, physicalaging and rejuvenation.

CHE F433 Corrosion Engineering 3 0 3

Corrosion principles: electrochemical aspects, environmental effects, metallurgical & other aspects; various forms of corrosion. Materials: metals and alloys, non-metallics (polymers and ceramics). Corrosion prevention: materials selection, alternation of environment, design, cathodic and anodic protection, coatings.

CHE F471 Advanced Process Control 3 0 3

Process identification and adaptive control; Model predictive control structures; Model-based control structures; State estimation; Synthesis of control systems-some case studies; intelligent control.

CHE F491 Special Project 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

CHE F497 Atomic and Molecular Simulations 3

Particle based simulations at atomic and molecular level. Molecular dynamics (MD), Lyapunov exponent, various algorithms for integrating the equation of motion, Verlet algorithm. Monte Carlo (MC) algorithm, Trial moves, MD and MC in various ensembles, thermostats, barostats etc. Hands-on simulations using GROMACS or LAMMPS or similar. Free energy calculations and phase equilibria. Various other applications of molecular mechanics calculations. State of the art development in the field, latest force fields, parameterization techniques etc. Introduction to density functional theory (DFT), Hands on simulations using any DFT packages such ADF or GAUSSIAN or GPAW or VASP or similar.

CHE F498 Colloids and Interface Engineering

Colloids – Intermolecular forces and Properties of the colloids. Interface and Surface active agents – Thermodynamics of interfaces, interfacial rheology and transport process, surface free energy, surface tension, thermodynamics of micelle and mixed micellar formation, electrical phenomena at interfaces. Emulsion, Micro emulsion and Foam – Preparation, mechanism and stabilization, characterization and application of foams. Measurement techniques – Interfacial tension, contact angle, zeta potential and particles size. Industrial applications – Applications of various interfacial phenomena in the industries. Nanomaterials – Application of surface active agent through the surface modification for the synthesis of nanostructured material.

CHE G511 Fluidisation Engineering 3 1 4

Fundamentals, industrial applications; study, design and operation of fluidisation units.

CHE G512 Petroleum Refining and Petro- Chemicals 3 1 4

Origin, formation and composition of petroleum; history and development of refining; refinery products and test methods; classification and evaluation of oil stocks, fractionation of petroleum; thermal and catalytic processes; properties & production of petrochemicals.

CHE G513 Environmental Management Systems 3 2 5

Introduction to air & water pollutants & solid wastes; sampling & analysis techniques; impact of these on environment; national & international regulations; ISO series; conventional & non-conventional energy resources; life cycle analysis; environmental audit; sustainable developments; case studies.

CHE G514 Evolutionary Computation 5

Non-traditional optimization techniques; population based search algorithms; evolutionary strategies; evolutionary programming; simulated annealing; genetic algorithms; differential evolution; different strategies of differential evolution; Memetic algorithms; scatter search; ant colony optimization; self-organizing migrating algorithm; other emerging hybrid evolutionary computation techniques; engineering applications involving highly non-linear processes with many constraints and multi-objective optimization problems.

CHE G521 Chemical Engineering Analysis 2 2 4

Mathematical analysis of chemical engineering problems; introduction to modelling and simulation techniques in the analysis of systems; emphasis on applying mathematical techniques to real Chemical Engineering processes and on physical and mathematical interpretation of results; use of computer software for analysis and solution of mass and energy balances problems for complex processes.

CHE G522 Polymer Technology 3 1 4

Polymerisation techniques; classification of polymers; mechanism and kinetics of formation of polymers; different techniques for determination of different types of molecular weights; polymer structure; definition and measurement of glass transition and crystalline melting temperatures; viscoelasticity and rubber elasticity behaviour; degradation and stability; polymer processing; rheology and applications. The course will terminate with several design projects on real life problems.

CHE G523 Mathematical Methods in Chemical Engineering 3 2 5

An introduction to mathematical modelling and simulation, Fundamentals of functional analysis, Linear algebraic equations and related numerical schemes, ODE's IVP and related numerical schemes, Partial differential equations and related numerical schemes, Optimization and related numerical schemes, Application of the above principles to solving problems in Chemical Engineering, Role of computer programming and packages in problem solving.

CHE G524 Introduction to Multiphase Flow 3 1 4

Introduction to multiphase flow, Single particle motion, Bubble and droplet transition, Marangoni effects, Bubble growth and collapse, Cavitation, Flow patterns, Internal flow energy conversions, Homogenous flows, Flows with bubble and gas dynamics, Sprays, Granular flows, Drift flux models, System instabilities.

CHE G525 Chemical Process and Equipment Design 3 1 4

The nature and function of process design, Flow sheet preparation and drawing, Process Planning Scheduling and Flow Sheet Design, P and I diagrams, Piping Design, Pump size selection. Design information and data, Specification and design of process equipment, Rules of THUMB for design of equipment, Software use in process design, Process design of equipment in heat and mass transfer, reactors, pumps, etc., Mechanical design of selected equipment.

CHE G526 Nuclear Engineering 3 1 4

Review of Nuclear Physics, Mechanism of nuclear fission, Fission cross section, Fission products, Reactor Physics, Types of nuclear reactors, Construction and control of nuclear reactors, Heat transfer in nuclear reactors, Design and operation, Reactor shielding, Nuclear fuels, Moderators, Coolants, Reflectors and structural materials, Nuclear fuel cycle, Spent fuel characteristics, Reprocessing techniques role of solvent extraction in reprocessing, Reactor control and safety.

CHE G527 Energy Conservation and Management 3 1 4

Energy conservation, Growth and demand of energy, Energy availability, Comparison of specific energy use in select industry, Potential and status of energy in India, Energy saving potential in industries, Potential of energy efficiency in India, Energy available for industrial use and the role of conservation, Energy management and policy, Comprehensive energy conservation planning (CECP), Definition and principles of energy conservation, Energy conservation technologies, Cogeneration concept and scope, Energy audit and management. Energy conservation in utilities.

CHE G528 Introduction to Nano Science and Technology 3 1 4

Introduction to nano-science, Basic idea of solid state physics and quantum mechanics, Quantum wells, Wires and dots, Properties of nanomaterials, Carbon nanotubes, Nanosynthesis, Characterisation methods, Application of nano-materials to various fields like electronics, medical, MEMS, photonics, molecular switches and others, Special reference to Chemical Engineering as in catalysis, heat transfer and special additive and performance materials (nanofluids, nanocomposites), Future of nano science and technology, Large scale manufacture and technological issues.

CHE G529 Pulp and Paper Technology 3 1 4

Selection of pulp and paper making raw materials, Wood Anatomy- identification, Preparation of wood chips, Chip screening, Storage and chip conveying, Chemical composition of fibrous raw materials, Chemical Pulping, Mechanical Pulping, Chemical thermo-mechanical (CTP) processes, Waste Paper Pulping, Bleaching and washing, Chemical Recovery, Description of various grades of pulp & paper, Mechanical and chemical properties of pulp, Paper making, cellulose derivatives- preparation & end use, Environmental aspects in pulp and paper industry.

CHE G531 Project Engineering 2 2 4

Project feasibility studies and report; Project appraisal; Project solution and evaluation; Project planning; Economic decision making; Project preparation and management.

CHE G532 Alternate Energy Resources 3 1 4

The scope and present day technology in utilization of solar energy, wind power, tidal power, geothermal power, M.H.D. and fuel cells.

CHE G533 Petroleum Product Characterization 3 2 5

Methods of estimation of characterization parameters for pure hydrocarbons; methods of characterization of petroleum fractions and products; experimental methods on measurement of basic properties obtained from laboratory testing; methods of prediction of properties for defined mixtures from pure-component properties (normal boiling point, density, molecular weight, critical properties, etc.); methods of prediction of properties for undefined mixtures based on certain bulk properties; characterization methods for light and heavy as well as narrow and wide boiling range mixtures; predictive methods for some characteristics specifically applicable to petroleum fractions that affect the quality of a fuel; standard test methods recommended by ASTM for various properties; minimum laboratory data needed to characterize various fractions as well as analysis of laboratory data and criteria for development of a predictive method; introduction to characterization of crude oils and reservoir fluids; associated Petroleum Laboratory experiments.

CHE G541 Process Plant Simulation 2 2 4

Computer aided analysis of chemical process systems; classification and development of mathematical models to various chemical engineering systems; decomposition of networks; tearing algorithms; numerical methods for convergence promotion and solving chemical engineering problems; traditional & non-traditional optimization techniques; specific purpose simulation; dynamic process plant simulation; case study problems using professional software packages.

CHE G542 Computational Transport Phenomena 3 2 5

Concepts; partial differential equations: types, boundary conditions, finite difference scheme, error analysis, grid generation, stability criteria; conduction and convection : two-dimensional steady state problem, methods for solving coupled algebraic equations, finite element method; fluid flow : governing equations, various approach of simulation (stream-vorticity, primitive variable), staggered grid, similarity solution, Newton-Raphson method, explicit and implicit formulation; solution of Navier-Stokes equations : solution of full and parabolized equations, unsteady flow, MAC, SIMPLE algorithm, RNS method; Mass Transfer : dynamic model, mass transfer with simultaneous convection and diffusion, transient multicomponent diffusion; short projects on development of codes for various real life problems involving transport processes.

CHE G551 Advanced Separation Technology 3 2 5

A brief overview of the existing separation technologies such as adsorption-based separation, membrane separation, cryogenic separation, and biotechnology-based separation. Recent advancements on the above areas and the new concepts such as simulated moving bed adsorption, thermally coupled pressure swing adsorption, reactive distillation, bio-filtration, supercriticalfluid extraction etc. This course will terminate with several design projects on real life problems.

CHE G552 Advanced Transport Phenomena 5

Viscosity, thermal conductivity and diffusivity, Shell momentum and energy balance, equations of change for isothermal and non-isothermal systems, Concentration distribution in solids and laminar flows, momentum, thermal and concentration boundary layers near walls, origin of turbulence, length scales in turbulent flows, Reynolds (RANS) equations, estimates of Reynolds stress (k-epsilon and k-omega type models), turbulent shear flow near a wall, turbulent flow in pipes and channels, turbulent heat transfer, Introduction to large eddy simulations models, rheology and material functions, non-Newtonian viscosity and generalized Newtonian models, Linear and non-linear visco-elasticity, radiation heat transfer, multi-component systems, Coupled heat and mass transfer, evaporation, boiling and condensation, chemical reactions, Special topics: Flow through porous media, compressible flows, multiphase flow, Transport phenomena in biochemical systems.

CHE G553 Statistical Thermodynamics 4

Review: Classical thermodynamic and elementary Statistical Mechanics, Macroscopic and microscopic descriptions of the state of a system, Equilibrium ensembles, the partition function and thermodynamic properties; System of independent particles; Fluctuations and the compressibility equation; Chemical equilibrium in ideal gas mixtures; Molecular based equations of state, SAFT, Lattice statistics; Real gases, Virial equation; The liquid state: lattice models, distribution functions theories, perturbation theories; Liquid mixtures: solution theories and local composition models, Statistical thermodynamics of electrolytes.

CHE G554 Computational Fluid Dynamics 4

Introduction to CFD, Equations of change for momentum, energy and mass transport, introduction to partial differential equations, Numerical analysis and discretization techniques, Managing uncertainties in CFD, grid generation, application of CFD to solve Chemical Engineering problems, Introduction to COMSOL, data analysis, validation and post processing.

CHE G556 Electrochemical Engineering 4

Basic physics of galvanic cells, Electrochemical Energy conversion, Electrochemical Energy storage, Equivalent circuit dynamics, Impedance spectroscopy, Impedance of electrodes, Nernst equation, Fuel cells and batteries, Faradic equations in dilute solutions, Butler Volmer equation, Reactions in concentrated solutions, Ion absorption and intercalation, Concentration polarization, forced convection in fuel cells, Transient diffusion, Warburg impedance, Diffusion in concentrated solutions, Transport in bulk electrolytes, Ion concentration polarization, Double layer structure, Transport on porous media, Porous electrodes, Super capacitors, Electrostatic correlations.

CHE G557 Energy Systems Engineering 4

Cradle to grave overview of major current and future energy conversion processes. Energy sources such as coal, natural

gas, petroleum, biomass, uranium, wind, and solar. Fuel processing techniques such as Fischer-Tropsch synthesis, gasification, methane reforming, and CO_2 reforming. Power generation technologies including steam turbines, gas turbines, wind turbines, fuel cells, and solar panels. Sustainability impact factors including water consumption, smog formation, and CO_2 emissions. Advanced processing techniques such as combined cycles, turbine/fuel cell hybrids, and CO_2 capture technologies. Real world use and application.

CHE G558 Chemical Process Optimization 4

Introduction to Process Modelling and simulation, Fundamentals of analytical optimization. Survey of one dimensional line-search methods, and multi-dimensional unconstrained and constrained numerical optimization algorithms. Applications of linear programming, nonlinear programming, mixed integer linear/ nonlinear programming, and parameter estimation in chemical engineering. Feasible-path and infeasible-path techniques for chemical process flowsheet optimization, Evolutionary computation in Chemical Engineering.

CHE G559 Reactor Physics and Engineering 5

Nuclear Reactions, Binding Energy, Fission Reactions, Fissile and Fertile Materials, Radioactive Decay; Neutron Cross Sections, Nuclear Fuel Properties, Moderators, Energy Spectra, Infinite Medium Multiplication, Power Reactor Core & Kinetics, Neutron Balance & Diffusion Equation, Four-factor formula, Two-group analysis, criticality equation, Electrical power generation from nuclear fission, fundamental aspects of fission chain reaction, and reactor design. Reactor concepts & types, their static and dynamic characteristics Reactor operation and control, Startup and shut down of systems.

CHE G560 Nuclear Fuel Cycle and Waste Management 5

Processing of nuclear fuel with descriptions of mining, milling, conversion, enrichment, fabrication, irradiation & properties of irradiated fuel, reprocessing, and waste disposal. In-core and out-of-core nuclear fuel management design, Nuclear power plant and fuel cycle economics, Management of spent fuel, high-level waste, uranium mill tailings, low-level waste and decommissioning wastes. Fundamental processes and governing equations for waste management systems, safety assessment of waste disposal facilities, Chemical Engineering operations in Nuclear fuel manufacture, waste reprocessing operations and waste management, Process Engineering for Nuclear Industry.

CHE G561 Nuclear Reactor Control and Instrumentation 4

Fundamentals of process instrumentation and control, Open and closed loops, SCADA and DDC, PLC, Alarms and Safety interlocks for shutdown and emergency shutdown, special sensors and sensor specifications for Nuclear Industry, Nuclear reactor safety, Special control logic for Nuclear safety, reliability and redundancy, Nucleonics: application of Nuclear materials and radiation in measurement techniques, Nucleonics based instruments for analysis, Design, maintenance and operation of such instruments. Calorimetry, detection of alpha, beta and gamma rays including spectrometry, liquid scintillation counting.

CHE G562 Thermal Hydraulics and Heat Transfer 4

Thermal-hydraulic core design and analysis of nuclear systems, Single and two-phase flow, Flow regimes, pressure drops, frictional losses, pumping power modeling of fluid systems. Design constraints imposed by thermal-hydraulics heat generation, temperature distribution, heat removal, reactor heat sources & coolants, departure from nucleate boiling, boiling heat transfer, critical heat flux conduction in reactor components and fuel elements, heat transfer in reactor fuel bundles and heat exchangers, application of CFD in thermo-hydraulics of core.

CHE G563 Nuclear Chemical Engineering 4

Solvent Extraction, Ion Exchange, Decontamination, Isotope Separation, Unit operations and processes used in the Production of Heavy Water, Desalination, Thermo-chemical Cycle for Hydrogen Production, district heating, nuclear propulsion, waste processing including vitrification.

CHE G564 Nuclear Materials and Radiation Damage 4

Nuclear Materials; fabrication and quality control, non – destructive evaluation and irradiation behavior of uranium, plutonium and thorium based ceramic, metallic and composite fuels; fuel failure, post irradiation examination and mitigation of fuel failure; fabrication, heat treatment, property evaluation and irradiation behavior of fuel cladding and core structural materials e.g. aluminum & alloys for research reactors, zirconium alloys for water cooled nuclear power reactors and stainless steels and oxide dispersion strengthened (ODS) steel for fast reactors; physical, chemical and instrumental methods of analysis of nuclear materials and real time accounting of nuclear materials, radiation damage of nuclear fuels, pressure vessel, pressure tubes and other structural materials including radiation-embrittlement, void swelling, irradiation growth and creep, fracture toughness etc.

CHE G565 Radiation and Radio Isotopes Applications 4

Nuclear non-power research reactors, measurement of radiation and use of neutron radiography, neutron diffraction and activation analysis for materials characterization; Production of Radioisotopes and their applications in medicine and healthcare, food and agriculture including food irradiation & preservation, radiation induced mutation for seed and crop, sterilization and application of radioactive tracers in basic and applied research.

CHE G566 Nuclear Safety, Security and Safeguards 4

Radiation interaction & safety, environmental aspects, internal and external dose evaluation, reactor effluents and release of radioactivity, Operational and maintenance safety, Hazop and Hazan analysis, HSE issues and systems management in Nuclear installations and Nuclear industry and Nuclear Laboratories, Design basis threat (DBT) and threat analysis and evaluation, Detection, delay and response technologies and evaluation, Incorporating insider threat/wrong operation in DBT, Security and safety in Nuclear Materials Transportation, Nuclear forensics and consequence management, Nuclear systems safety and security analysis, Technologies and techniques for securing nuclear materials, Nuclear materials safeguard systems from theft, spillage and other unforeseen incidents, Fuel facility safeguard systems, Design of safeguard systems, Intrinsic and Extrinsic safeguard and proliferation resistance of fissile and fertile materials, Technical issues associated with Nuclear Non Proliferation, Facility inspection, safety, security and safeguard audit, Elements of non-proliferation policies, treaties and enforcement technologies.

CHE G567 Natural Gas Processing 4

Overview of Natural Gas industry; Overview of Gas Plant processing; Field operation and inlet receiving; Compression; Gas treating; Gas dehydration; Hydrocarbon recovery; Nitrogen rejection; Trace component recovery or removal; Liquids processing; Sulfur recovery; Transportation and storage; Liquefied Natural Gas; Capital cost of Gas processing facilities; Natural gas processing plants.

CHE G568 Modeling and Simulation in Petroleum Refining 4

Introduction to modeling and simulation; Numerical methods and software; Modeling and simulation of multi-component distillation columns; Reactor modeling in the petroleum refining industry; Modeling of catalytic hydro-treating; Modeling of catalytic reforming; Modeling and simulation of fluidized-bed catalytic cracking converters.

CHE G569 Petroleum Production Economics 4

Cash flow analysis in the petroleum industry (definition of cash flow, deriving net cash flow under tax/royalty systems and production sharing contracts, depreciation methods, inflation, sunk costs). Economic indicators (net present value, rate of return and other indicators). Fiscal analysis (the nature of petroleum fiscal regimes, the effects of fiscal regimes on exploration and field development decision making, economic analysis of fiscal regimes in India & abroad).

CHE G611 Computer Aided Analysis and Design 2 3 5

The course aims at developing complete self reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

CHE G613 Advanced Mass Transfer 3 2 5

Use of stage and differential contact concepts in design of mass transfer equipment; methods of determining and interpretation of rate data; multicomponent distillation, absorption and extraction.

CHE G614 Advanced Heat Transfer 3 2 5

Heat conduction with unsteady boundary conditions; recent advances in natural and forced convection; condensation and boiling phenomena; heat transfer in high speed flows; liquid metal heat transfer, radioactive metal heat-transfer between surfaces in absorbing media; complex problems involving simultaneous conduction, convection and radiation.

CHE G615 Advanced Separation Processes 3 2 5

Shortcut and rigorous methods of conventional separation processes such as multicomponent distillation, absorption, stripping and extraction; Azeotropic and Extractive distillation; adsorption based separation, simulated moving bed adsorption, thermally coupled pressure swing adsorption; cryogenic separation, gas liquefaction; membrane based separation, pervaporation, liquid membrane; biotechnology based separation, modeling approach, design considerations, biofiltration; reactive distillation; super critical fluid extraction.

CHE G616 Petroleum Reservoir Engineering 3 2 5

Origin and composition of petroleum; Geographic distribution of oil; Petroleum geology; Exploration, drilling and recovery; Drilling methods and drilling fluids; Lubricants and spotting fluids; Corrosion control; Analytical and test methods; Enhanced oil recovery; Injection fluids; Polymer and caustic flooding; Use of surfactants; Improvement of oil displacement efficiency; Environmental and economic aspects.

CHE G617 Petroleum Refinery Engineering 3 2 5

History and development of refining; Indian petroleum industry; Composition of petroleum, laboratory tests, refinery products; Classification, characterization and evaluation of crude oil; Trends of petroleum products; Atmospheric and vacuum distillation; Design of crude distillation column; Catalytic cracking; Hydrotreating and Hydrocracking; Catalytic reforming; Delayed coking and visbreaking; Furnace design; Isomerization, alkylation and polymerization; Lube oil manufacturing; Energy conservation in petroleum refineries; Environmental aspects of refining.

CHE G618 Petroleum Downstream Processing 3 2 5

Petrochemical feedstock; Pyrolysis of Naptha and light hydrocarbons; First generation petrochemicals: Ethylene, Propylene, Butylenes, Acetylene, Butadienes, Chloroprene, cyclohexane, BTX, Polymethyl Benzenes; Second generation petrochemicals: synthesis gas, methanol, ethanol, ethylene oxide, propylene oxide, acetone, allyl alcohol, glycerol, acrylonitrile, Acrylic acid and derivatives, phenol, aniline, nylon monomers, polyester monomers, styrene and other monomers; Third generation petrochemicals: plastics, rubbers, fibres, resins, detergents, pesticides, dyes, protein, explosives, petroleum coke and carbon black; Catalysts in petroleum refining and petrochemicals processes; Transportation of dangerous goods; Health and safety in petrochemical industries; Pollution and toxicity; Future of petrochemicals.

CHE G619 Process Intensification 3 2 5

A brief review of the process intensification (PI), includes philosophy and principles of PI; equipments and methods for PI; few examples of their application on the commercial scale, such as multifunctional reactors, hybrid processes, monolithic reactors, high gravity reactors etc., industrial practice of PI- methodology and applications; PI by process synthesis; PI by plant safety. This course will terminate with several design projects on real life problems.

CHE G620 Energy Integration Analysis 3 2 5

Importance and scope of application of Energy Integration; Pinch technology tools, targeting, design, synthesis and optimization of heat exchanger networks (HEN); Interfacing HEN synthesis with heat exchanger design, Retrofitting, energy integration of distillation and evaporation processes, mathematical programming approach, Artificial intelligence based approaches.

CHE G621 Fluid Dynamics 2 3 5

Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory;flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

CHE G622 Advanced Chemical Engineering Thermodynamics 3 2 5

Review of fundamental principles; statistical foundations; thermodynamic properties of pure substances and mixtures, their estimation and correlation; stability and equilibrium criteria for homogeneous and heterogeneous systems; thermodynamics of irreversible processes.

CHE G641 Reaction Engineering 3 2 5

Design of multi-phase reactors; analyses of gas-liquid and gas-liquid-solid reactions; intrinsic kinetics of catalytic reactions; residence time distribution models for micro-and macro-mixing; mathematical models for gas-liquid-solid reactors; laboratory reactors; dynamics and design of various multi-phase reactors such as trickle bed reactors, bubble column reactors, segmented-bed reactors, slurry reactors, spouted bed reactors, pulsating reactors, fluidized bed reactors, etc.; optimization of chemical reactors.

Chemistry

CHEM D101 Principles of Chemistry 3 0 3

States of matter; Elements, compounds, mixtures; Physical and chemical changes; Stoichiometry; Mole concept; Calculations of yield; Atomic and molecular masses; Molecular and empirical formula; oxidation and reduction reactions; Bohr's model of the atom; Electronic quantum numbers; s, p, d, f orbitals; Electron spin; Electronic configurations; Periodic table; Periodic trends in atomic and ionic radii, ionization energies; Electron Affinity; Chemical Bonding: Lewis octet rule; Ionic and covalent bonding; Electronegativity; Molecular shapes; VSEPR model; Hybrid orbitals; Multiple bonds; Representative main group chemistry; Ideal Gas law; Partial pressures; Kinetic molecular theory of gases; Real gases; Reaction rates; Order of reactions; half-life; Temperature and rate; Catalysis; Work, heat, internal energy, enthalpy, first law; State functions; Hess's law; Enthalpy of formation; Entropy; Second law; Free energy and equilibrium; Equilibrium Constants (Kc and Kp); Le Chatelier's principle; Solubility and saturation; Concentrations – mole fractions, molality, molarity; Aqueous solutions: Acids, bases, salts; BrÖnsted and Lewis definitions, Ka and Kb; pH; Strong and weak acids and bases; Buffers; Electrochemistry: Nernst Equation; Electrochemical Cells, batteries; Organic Compounds' IUPAC nomenclature; Inductive, electromeric, resonance and hyper conjugation effects; Free radicals, carbocations, carbanions, electrophiles and nucleophiles, types of organic reactions.

CHEM F110 Chemistry Laboratory 0 2 1

This laboratory course consists of experiments based on fundamental principles and techniques of chemistry emphasizing on physical-chemical measurements, quantitative & qualitative analysis and preparations.

CHEM F111 General Chemistry 3 0 3

Principles of thermodynamics, phase and chemical equilibrium, electrochemistry, kinetics; Atomic structure, chemical bonding, solid state and structural chemistry, molecular spectroscopy; organic compounds, functional groups, structure and isomerism, stereochemistry, reactions and mechanisms, aromaticity, coordination chemistry, chemistry of representative elements.

CHEM F211 Physical Chemistry I 3 0 3

Kinetic - molecular theory of gases; perfect gas; pressure and

temperature; Maxwell distribution; collisions, effusion, mean free path; Boltzmann distribution law and heat capacities; first law of thermodynamics; p-V work , internal energy, enthalpy; Joule-Thomson experiment; second law; heat engines, cycles; entropy; thermodynamic temperature scale; material equilibrium; Gibbs energy; chemical potential; phase equilibrium; reaction equilibrium; standard states, enthalpies; Temperature dependence of reaction heats; third law; estimation of thermodynamic properties; perfect gas reaction equilibrium; temperature dependence; one component phase equilibrium, Clapeyron equation; real gases, critical state, corresponding states; solutions, partial molar quantities, ideal and non-ideal solutions, activity coefficients, Debye-Huckel theory; standard state properties of solution components; Reaction equilibrium in non-ideal solutions, weak acids-buffers, coupled reactions; multi component phase equilibrium- colligative properties, two and three component systems, solubility; electrochemical systems- thermodynamics of electrochemical systems and galvanic cells, standard electrode potentials, concentration cells, liquid junction, ion selective electrodes, double layer, dipole moments and polarizations, applications in biology, concept of overvoltage.

CHEM F212 Organic Chemistry I 3 0 3

Basic terminology and representation of organic reactions; thermodynamics and kinetics of reactions; reactive intermediates (carbocations, carbanions, free radicals, nitrenes carbenes); aromatic chemistry; properties, preparation and reactions of alkyl halides, alcohols, ethers, amines and nitro compounds; carbonyl compounds; carboxylic acid and derivatives; carbohydrates.

CHEM F213 Physical Chemistry II 3 0 3

Origin of quantum theory - black body radiation, line spectra, photoelectric effect; wave particle duality; wave equation: normal modes, superposition; postulates of quantum mechanics, time dependence, Hermitian operators, commutator; Schrödinger equation - operators, observables, solution for particle in a box, normalization, variance, momentum; harmonic oscillator, vibrational spectroscopy; rigid rotor, angular momentum, rotational spectroscopy; Hydrogen atom - orbitals, effect of magnetic field; Variation method - variation theorem, secular determinants; Many electron atoms and molecules; Born Oppenheimer approximation, VB Theory, H2 in VB, Coulomb, exchange, overlap integrals states of H2; antisymmetric wavefunctions – two electron systems, Slater determinants, HF method; SCF method; term symbols and spectra - configuration, state, Hund's rules, atomic spectra, spin orbit interaction; basic MO theory, homonuclear diatomics - N2, O2, SCF-LCAO-MO, molecular term symbols; HMO theory - π electron approximation, conjugated, cyclic systems.

CHEM F214 Inorganic Chemistry I 3 0 3

Structure of molecules: VSEPR model; ionic crystal structure, structure of complex solids; concepts of inorganic chemistry: electronegativity, acid-base chemistry, chemistry of aqueous and non-aqueous solvents; descriptive chemistry of some elements: periodicity, chemistry of transition metals, halogens and noble gases; inorganic chains, rings, cages and clusters.

CHEM F223 Colloid and Surface Chemistry 3 0 3

Surface phenomena; intermolecular forces relevant to colloidal systems; forces in colloidal systems; experimental and theoretical studies of the structure, dynamics and phase transitions in micelles, membranes, monolayers, bilayers, vesicles and related systems; technical applications.

CHEM F241 Inorganic Chemistry II 3 0 3

Coordination Chemistry: Bonding - Valence Bond, Crystal Field, and Molecular Orbital theories; Complexes - nomenclature, isomerism, coordination numbers, structure, electronic spectra, magnetic properties, chelate effect; Reactions - nucleophilic substitution reactions, kinetics, mechanisms; descriptive chemistry of Lanthanides and Actinides; Organometallic Chemistry: structure and reaction of metal carbonyls, nitrosyls, dinitrogens, alkyls, carbenes, carbynes, carbides, alkenes, alkynes, and metallocenes; catalysis by organometallic compounds; stereochemically non-rigid molecules.

CHEM F242 Chemical Experimentation I 0 3 3

This course is based on laboratory experiments in the field of organic chemistry. Qualitative organic analysis including preliminary examination, detection of functional groups, preparation and recrystallization of derivatives, separation and identification of the two component mixtures using chemical and physical methods; quantitative analysis such as determination of the percentage/ number of hydroxyl groups in organic compounds by acetylation method, estimation of amines/ phenols using bromate-bromide solution/ acetylation method, determination of iodine and saponification values of an oil sample; single step synthesis such as benzaldehyde to cinnamic acid; multistep synthesis such as phthallic anhydride – phthallimide – anthranillic acid ; extraction of organic compounds from natural sources: isolation of caffeine from tea leaves, casein from milk, lactose from milk, lycopene from tomatoes, β- carotene from carrots etc.; demonstration on the use of software such as Chem Draw, Chem-Sketch or ISI-Draw.

CHEM F243 Organic Chemistry II 3 0 3

Introduction to stereoisomers; symmetry elements; configuration; chirality in molecules devoid of chiral centers (allenes, alkylidenecycloalkanes, spiranes, biphenyl); atropisomerism; stereochemistry of alkenes; conformation of acyclic molecules; conformations of cyclic molecules; reaction mechanisms; asymmetric synthesis; photochemistry and pericyclic reactions.

CHEM F244 Physical Chemistry III 3 0 3

Symmetry: symmetry operations, point groups, reducible and irreducible representations, character tables, SALC, degeneracy, vibrational modes IR-Raman activity identification; matrix evaluation of operators; stationary state perturbation theory; time dependent perturbation theory; virial and Hellmann-Feynmann theorems; polyatomic molecules: SCF MO treatment, basis sets, population analysis, molecular electrostatic potentials, localized MOs; VB method; configuration interaction, Moller Plesset perturbation theory; semi empirical methods-all valence electron methods: CNDO,INDO, NDDO; Density Functional Theory: Hohenberg-Kohn theorems, Kohn-Sham self consistent field approach, exchange correlation functional; molecular mechanics.

CHEM F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

CHEM F311 Organic Chemistry III 3 0 3

Applications of important reagents and reactions in organic synthesis and disconnection or synthon approach will be emphasized in this course. Basic principles of disconnection, order of events, chemioselectivity, regioselectivity etc. Common organic reagents, Organometallic reagents, Transition metal catalyzed reactions, introduction to reterosynthetic analysis using one group C-X and C-C disconnections, two group C-X and C-C disconnections, ring synthesis (saturated heterocycles), synthesis of heterocyclic compounds and complex molecules.

CHEM F312 Physical Chemistry IV 3 0 3

Weak forces; surface chemistry: interphase region, thermodynamics, surface films on liquids, adsorption of gases on solids, colloids, micelles, and reverse micellar structures; transport processes: kinetics, thermal conductivity, viscosity, diffusion, sedimentation; electrical conductivity in metals and in solutions; reaction kinetics, measurement of rates; integrated rate laws; rate laws and equilibrium constants for elementary reactions; reaction mechanisms; temperature dependence of rate constants; rate constants and equilibrium constants; rate law in non ideal systems; uni, bi and tri molecular reactions, chain reactions, free-radical polymerizations; fast reactions; reactions in solutions; heterogeneous and enzyme catalysis; introduction to statistical thermodynamics; theories of reaction rates; molecular reaction dynamics.

CHEM F313 Instrumental Methods of Analysis 3 1 4

Principles and practice of modern instrumental methods of chemical analysis. Emphasis on spectroscopic techniques such as UV-Visible, infrared, NMR (1H, 13C and other elements, NOE, correlation spectroscopies), ESR, atomic absorption and

emission, photoelectron, Mössbauer, and fluorescence. Other topics will include mass spectrometry, separation techniques, light scattering, electroanalytical methods, thermal analysis, and diffraction methods.

CHEM F320 Introductory Computational Chemistry Laboratory 0 4 2

In this course the major focus is on practical computation of electronic structure of atoms and molecules using open source and proprietary software; specific computational experiments will be in the areas of potential energy surfaces, geometry optimization, molecular geometry from symmetry and trigonometric relations without visualization software, molecular orbitals and bonding patterns, Hartree-Fock calculations, correlation energy and size-consistency, DFT based calculations, computing excited states using CIS, EOM-CCSD jobs for computing energies of excited, ionized and electron-attached states; methods to estimate activation energy, solvent effects etc.; molecular dynamics simulation, molecular mechanics will also be explored; the actual experiments may vary and can have more specific learning outcomes so as to enhance the course with the latest developments in electronic structure theories of chemistry.

CHEM F323 Biophysical Chemistry 3 0 3

The principles governing the molecular shapes, structures, structural transitions and dynamics in some important classes of biomolecules and biomolecular aggregates will be discussed. The topics will include: structure, conformational analysis, conformational transitions and equilibria in proteins and nucleic acids; protein folding; lipids - monolayers,bilayers and micelles; lipid-protein interactions in membranes.

CHEM F324 Numerical Methods in Chemistry 3 3 4

Selected problems in chemistry from diverse areas such as chemical kinetics and dynamics, quantum mechanics, electronic structure of molecules, spectroscopy, molecular mechanics and conformational analysis, thermodynamics, and structure and properties of condensed phases will be discussed. The problems chosen will illustrate the application of various mathematical and numerical methods such as those used in the solution of systems of algebraic equations, differential equations, and minimization of multidimensional functions, Fourier transform and Monte Carlo methods.

CHEM F325 Polymer Chemistry 3 0 3

Types of polymers; structures of polymers; molecular weight and molecular weight distributions; kinetics and mechanisms of major classes of polymerization reactions such as step growth, radical, ionic, heterogeneous, and copolymerization methods; polymer solutions- solubility, lattice model and the Flory- Huggins theory, solution viscosity; bulk properties- thermal and mechanical properties such as the melting and glass transitions, rubber elasticity, and viscous flow; polymerization reactions used in industry.

CHEM F326 Solid State Chemistry 3 0 3

X-ray diffraction; point groups, space groups and crystal structure; descriptive crystal chemistry; factors which influence crystal structure; crystal defects and non-stoichiometry; solid solutions; interpretation of the phase diagrams; phase transitions; ionic conductivity and solid electrolytes; electronic properties and band theory; magnetic properties; optical properties; analysis of single crystal XRD data; preparation of solid state materials and the chemistry of device fabrication.

CHEM F327 Electrochemistry: Fundamentals and Applications 3 0 3

Electrode Processes: Overpotential, Faradaic and non-Faradaic processes, the ideal polarized electrode, capacitance and charge of an electrode, electrical double layer; primary and secondary cells, variables in electrochemical cells, factors affecting electrode reaction, cell resistance; Mass transfer: steady-state mass transfer, semiempirical treatment of the transient response, coupled reversible and irreversible reactions, reference electrodes; Kinetics of electrode reactions: Arrhenius equation and potential energy surfaces, equilibrium conditions, Tafel Plots; rate determining electron transfer, Nernstian, quasi-reversible, and irreversible multistep processes; Marcus Theory; mass transfer by migration and diffusion; basic potential step methods; Ultramicroelectrodes (UME) potential sweep methods; polarography and pulse voltammetry; controlled current techniques; impedance; bulk and flow electrolysis; electrochemical instrumentation; scanning probe techniques, STM, AFM, Scanning Electrochemical Microscopy, approach curves, imaging surface topography and reactivity, potentiometric tips, applications.

CHEM F328 Supramolecular Chemistry 3 0 3

Non-covalent interactions and their role in “supermolecules” and organized polymolecular systems; concepts of molecular recognition, information and complementarity; molecular receptors: design principles, binding and recognition of neutral molecules and anionic substrates, coreceptor molecules and multiple recognition, linear recognition of molecular lengths by ditopic coreceptors, heterotopic coreceptors, amphiphilic receptors, large molecular cages; supramolecular dynamics; supramolecular catalysis: reactive macrocyclic cation and anion receptor molecules, cyclophane type receptor, metallocatalysis, catalysis of synthetic reactions, biomolecular and abiotic catalysis, heterogeneous catalysis; transport processes and carrier design: cation and anion carriers, electron, proton and light coupled transport processes, transfer via transmembrane channels; supramolecular assemblies: heterogeneous molecular recognition, supramolecular solids, molecular recognition at surfaces, molecular and supramolecular morphogenesis; supramolecular photochemistry: photonic devices, light conversion and energy transfer devices, photosensitive molecular receptors, photoinduced electron transfer and reactions, non-linear optical properties; supramolecular electrochemistry: electronic devices, molecular wires, polarized molecular wires, switchable molecular wires, molecular magnetic devices; ionic devices, tubular mesophases, ion-responsive monolayers, molecular protonics, ion and molecular sensors, switching devices and signals, photoswitching and electroswitching devices, switching of ionic and molecular processes, mechanical switching processes; self-assembly: inorganic architectures, organic structures by hydrogen bonding; helical metal complexes, supramolecular arrays of metal ions – racks, ladders and grids, molecular recognition directed self-assembly of organized phases; supramolecular polymers; ordered solid-state structures; supramolecular synthesis, assistance, replication; supramolecular chirality; supramolecular materials.

CHEM F329 Analytical Chemistry 3 1 4

Data handling; sample preparation; unit operations; volumetric and gravimetric analysis; chromatography; solvent and solid phase extraction; absorption and emission techniques; potentiometry, voltammetry; trace metal separation and estimation in biological and environmental samples with emphasis on green chemistry, sensors; laboratory training in some of these techniques.

CHEM F330 Photophysical Chemistry 3 1 4

Absorption of the electromagnetic radiation; photophysical processes such as fluorescence, phosphorescence, non-radiative transitions, and delayed luminescence, excimer and exciplex formation; triplet state: radiative and non-radiative transitions; energy transfer, fluorescence resonance energy transfer (FRET), quenching of fluorescence; fluorescence decay; protein and DNA fluorescence; time-resolved emission spectra (TRES); time-dependent anisotropy decays; application of photophysics for the characterization of biological and bio-mimicking systems. In addition to the theory, through simple experiments, laboratory training will be imparted.

CHEM F333 Chemistry of Materials 3 0 3

Solid state structure : unit cells, metallic crystal structures, polymorphism and allotropy, crystallographic direction and planes, closed packed crystal structures, polycrystalline materials, anisotropy; meso and micro porous materials: zeolites, composites, synthesis, characterization (XRD, SEM, TEM, AFM, FTIR, NMR, TGA, and DTA) and applications; ceramics and glass materials: crystalline and non-crystalline nature, glass-ceramics, processing; polymers: synthesis, structure, properties, inorganic polymers; mechanical properties: stress and strain, elastic and tensile properties, hardness, phase transformations, microstructure, alteration of mechanical properties; magnetic properties: atomic magnetism in solids, the exchange interaction, classification of magnetic materials, diamagnetism, pauli paramagnetism,

ferromagnetism, antiferromagnetism, ferrimagnetism, superparamagnetism, ferromagnetic domains, hysteresis loop, hard and soft ferrites, applications; electrical properties: conductivity, band theory, types of semiconductors, time dependence of conductivity, mobility of charge carriers, metal-metal junction, metal–semiconductor junction, n-type and p-type semiconductors; optical properties: refraction, reflection, absorption, transmission, luminescence, photoconductivity, opacity and translucency in insulators, optical fibers; thermal properties: heat capacity, thermal expansion, conductivity, thermal stresses; corrosion: electrochemistry of corrosion of metals, different forms, environmental effects, prevention.

CHEM F334 Magnetic Resonance 3 0 3

Classical treatment of motion of isolated spins; quantum mechanical description of spin in static and alternating magnetic fields; Bloch equations; spin echoes; transient and steady state responses; absorption and dispersion; magnetic dipolar broadening; formal theory of chemical shifts; Knight shift; second order spin effects; spin-lattice relaxation; spin temperature; density matrix; Bloch-Wangsness-Redfield theory; adiabatic and sudden changes; saturation; spin locking; double resonance; Overhauser effect; ENDOR; pulsed magnetic resonance: Carr-Purcell sequence, phase alternation, spin-flip narrowing, real pulses; electric quadrupole effects; spin-spin coupling; 2D correlation spectroscopies: COSY, DQF, INADEQUATE experiments; CIDNP; electron paramagnetic resonance (EPR); nuclear quadrupolar resonance; muon spin resonance; magnetic resonance imaging.

CHEM F335 Organic Chemistry and Drug Design 3 0 3

An introduction to organic chemistry principles and reactivities vital to drug design, drug development and drug action; the role of molecular size, shape, and charge, and in drug action; proteins and nucleic acids as drug targets; bioisosterism; ADME, QSAR and drug design; applied molecular modeling and combinatorial synthesis; Synthesis of some selected chemotherapeutic agents (e.g antifungal, antibacterial, antimalarial, anticancer etc.)

CHEM F336 Nanochemistry 3 1 4

Nano and nature, importance of nanoscience, chemistry behind nano; instruments for characterizing nanomaterials; diversity in nanosystems: chemical aspects of metallic, magnetic and semiconducting nanomaterials, carbon nanotubes and fullerenes, self-assembled monolayers, monolayer protected metal nanomaterials, core-shell nanomaterials; applications of nano materials in nanobiology, nanosensors and nanomedicine; hands on experience in laboratory.

CHEM F337 Green Chemistry and Catalysis 3 0 3

Definition and overview of the twelve principles of Green Chemistry, alternative starting materials; alternative synthesis and reagents; E factor and the concept of atom economy; the role of catalysis, alternate energy sources (microwave & ultrasound), catalysis by solid acids and bases, bio-catalysis, catalytic reduction, catalytic oxidation, catalytic C–C bond formation, cascade catalysis, enantioselective catalysis, alternative reaction media, renewable raw materials, industrial applications of catalysis.

CHEM F341 Chemical Experimentation II 0 4 4

This course is based on laboratory experiments in the fields of inorganic, physical and analytical chemistry. Quantitative separation and determination of pairs of metal ions using gravimetric and volumetric methods; Ion exchange chromatography; Separation & estimation of metal ions using ion exchangers and solvent extraction techniques; Determination of Keq of M – L systems by colorimetry; Preparation, purification and structural studies (magnetic, electronic and IR) of inorganic complex compounds; Physical property measurements such as conductance, pH, viscosity, surface tension, refractive index, specific rotation etc. Experiments to illustrate the principles of thermodynamics, kinetics, chemical equilibrium, phase equilibrium, electrochemistry, adsorption, etc.

CHEM F342 Organic Chemistry IV 3 0 3

The fundamental structural characteristics, synthesis and reaction of various heterocyclic compounds, natural products and biomolecules will be emphasized in this course. Structure, nomenclature and common reactions of heterocyclic compounds; synthesis, properties and reactions of three-, four-, five-, and six membered ring systems; condensed five and six membered ring systems, introduction to natural products; terpenoids, steroids, lipids, alkaloids, amino acids, peptides, proteins and vitamins.

CHEM F343 Inorganic Chemistry III 3 0 3

Inorganic elements in biological systems: role of alkali and alkaline earth metal ions, iron, copper and molybdenum; metalloenzymes. Metals in medicine: metal deficiency and disease; toxicity of mercury, cadmium, lead, beryllium, selenium and arsenic; biological defence mechanisms and chelation therapy. Molecular magnetic materials: trinuclear and high nuclearity compounds; magnetic chain compounds; magnetic long-range ordering in molecular compounds; design of molecular magnets. Other emerging topics in inorganic chemistry.

CHEM F366 Lab Project 3

CHEM F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CHEM F376 Design Project 3

CHEM F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CHEM F412 Photochemistry and Laser Spectroscopy 3 0 3

Photochemical events : absorption, fluorescence and phosphorescence; Jablonski diagrams; physical properties of molecules after photoexcitation; photochemical tools and techniques: spectrophotometers, fluorescence decay time measurement and analysis, flash photolysis; fundamental properties of laser light; principles of laser operation ; description of some specific laser systems : Helium-Neon, Argon ion, CO2, Nd-YAG and ultrafast Titanium : Sapphire lasers.

CHEM F413 Electron Correlation in Atoms and Molecules 3 1 4

Matrix algebra, Matrix representation of operators; mean-field approach: the Hartree-Fock method- formulation, coulomb and exchange integrals, Fock-operator, second quantization, Slater rules, self-consistency, correlation energy; Brillouin's theorem, Koopmans' theorem; basis-sets, restricted Hartree-Fock, Roothan-Hall equations; unrestricted Hartree-Fock method, spin-contamination; restricted open-shell Hartree-Fock method; Recovery of correlation energy time independent perturbation approach: Brillouin-Wigner and Rayleigh-Schrodinger perturbation theories; Møller Plesset and Epstein-Nesbeth partitioning of molecular Hamiltonion, many-body perturbation theory; Feynman diagrams, connected and disconnected terms, size-consistency; Recovery of correlation energy: configuration interaction and other non-perturbative approaches, variational and projection approaches for obtaining CI anasatz, truncated CI and size-consistency problem, Davidson correction, pair-coupled-pair theory, coupled-electron-pair method and coupled-cluster approach; Density functional theory, N-representability, V-representability, Kohn-Sham approach, natural orbitals, exchange-correlation functionals, Levy functional.

CHEM F414 Bio and Chemical Sensors 3 0 3

Biological and chemical recognition: reaction kinetics, signals and noise, sensitivity, specificity, selectivity; IUPAC definition of biosensors, their classification based on receptors and transducers; analytical characteristics of various types of bio and chemical sensors, performance criteria of biosensors; electrochemical, optical, thermal, piezoelectric transducer selections for immunosensors and enzyme sensors; sufrace functionaliazaiton of transducers, novel self assembly techniques, coupling of biomolecules on different surfaces and their characterization; thermal biosensors, enzyme thermistor; miniaturization of sensors and flow injection techniques; applications in analysis such as urea, penicillin, pesticides, cholesterol; optical biosensor mecha-

nisms: fluorescence and chemiluminescence techniques; electrochemical biosensors: impedimetric and amperometric biosensors; electrochemical quartz crystal micro balance, applications in chemical and biological analysis; flow injection systems vs. static measurements, protein-protein interaction and quantification; principle of inhibition based biosensor for enzyme and immunoassay, pretreatment techniques in bio-analysis.

CHEM F415 Frontiers in Organic Synthesis 3 0 3

Traditional and classic organic synthesis; modern synthetic strategies; systematic approach in terms of progress in reaction methodologies in synthesizing complex natural molecules; metal-catalyzed C-C and C-X couplings; direct functionalization via C-H and C-C activation; development of organocatalysis: metal-free catalysis; direct functionalization of olefins including hydroamination, hydrogenation, hydrosilylation, hydroformylation and other C-C bond forming reactions; the potential of radical chemistry for C-C and C-X bond formation; metal-catalyzed carbocyclization: from Ru and Rh-mediated cycloadditions to Pt and Au chemistry; one-pot multi-steps reactions: avoiding time and resource-consuming isolation procedures; tracing the development from the first total synthesis to the state of the art for some complex molecules.

CHEM F416 Applied Crystallography 3 0 3

Symmetry operations; space groups; X-ray diffraction; crystal nucleation and growth; single crystal; structure determination of a single crystal; crystal engineering; co-crystal and engineering; crystallographic databases.

CHEM F422 Statistical Thermodynamics 3 0 3

Review of classical thermodynamics, principles of statistical thermodynamics, ensemble averages; Boltzmann distribution; partition functions and thermodynamic quantities; ideal gases and crystals; thermodynamic properties from spectroscopic and structural data; dense gases and the second virial coefficient; statistical mechanics of solutions; Bose-Einstein and Fermi-Dirac statistics.

CHEM F423 Astrochemistry 3 0 3

The molecular universe; Starlight, galaxies, and clusters; Atomic and molecular astronomy, review of quantum chemistry and molecular spectroscopy; Stellar chemistry; Interstellar medium; Meteorite and comet chemistry; Cosmic-ray astrochemistry; Planetary chemistry of Venus, Mars, Titan, and other interesting planets and their satellites; Prebiotic chemistry; Primitive life forms.

CHEM F430 Atmospheric Chemistry 3 0 3

This course aims to describe the chemical and physical processes of atmosphere by different models. The specific topics will include, the measures of atmospheric compositions, atmospheric pressure, models to explain variation in concentration of chemical species in atmosphere, atmospheric transport, continuity equation to provide quantitative measures about the variation of concentration, geochemical cycles, the green-house effect, aerosols, atmospheric chemical kinetics, stratospheric ozone, oxidation in troposphere, ozone air pollution, and acid rain.

CHEM F431Sustainable Chemistry using Renewables 3 0 3

mportance of the utilization of renewable resources as alternative feedstock for the chemicals and fuels industry; alternatives to current petro-based technology and processes such as biomass utilization; chemicals from renewables, bio-refinery concept, strategies for biomass utilization, Platform molecules, Degraded molecules, Biomass conversions by new catalytic/ synthetic routes, catalytic cascade reactions, one-pot multi-product synthesis; chemistry in lignocellulose conversions; bio-based oleochemicals; fine chemicals from renewables; thermochemical conversion to fuels and other chemicals; analyticals in thermal biomass conversions, kinetics based on tunable diode laser measurements, CFD modeling; bio-ethanol : production, upgradation and valorization; glycerol as feedstock; fatty acid epoxidation; hydrogen and carbon-di-oxide, hydrogen as a feedstock, electro-catalysis, solar-photo catalysis, fuel cells, Carbon-di-oxide capture and valorization.

CHEM F491 Special Project 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

CHEM G511 Nuclear and Radio Chemistry 5

Course description is to be developed.

CHEM G513 Advanced Nuclear and Radiochemistry 5

Nuclear stability, binding energy, properties of nucleons; Nuclear models (Shell Model, Liquid drop model), Radioactive decay characteristics, decay kinetics, α, β and γ decay, nuclear reactions, types, radiative capture, reaction cross section, theory of fission; Nuclear reactors – classification, Reactor power, Breeder reactors, Nuclear reactors in India, Reprocessing of spent fuel, Nuclear waste management (HLW, LLW and ILW); Detection and measurement of activity, GM counters, Gamma counters, Liquid Scintillation counting; Application of radioactivity, Szilard Chalmers reaction, Isotope dilution analysis, Neutron activation analysis, Diagnostic and therapeutic applications of radionucleides, interaction of radiation with matter.

CHEM G521 Environmental Chemistry 5

Energy-flows and supplies, fossil fuels, nuclear energy, nuclear waste disposal, renewable energy, industrial ecology, green chemistry, ozone chemistry, effect of SO_x, NO_x as pollutants, reformulated gasoline, water pollution and treatment, organochlorine and organophosphate pesticides, eco-system effects, Toxic chemicals – Effect of dioxins, polychlorinated biphenyls (PCBs) and species of metals such as lead, mercury, cadmium etc.

CHEM G531 Recent Advances in Chemistry 5

The course is aimed at providing an overview of recent developments in selected areas of chemistry. Topics to be covered may be drawn from: modern theories of structure, bonding and reactivity, spectroscopy, chemical dynamics, phase transitions, surface phenomena, solid state materials, and synthetic and mechanistic organic and inorganic chemistry, or such other topics as may emerge in the development of the subject.

CHEM G541 Chemical Applications of Group Theory 5

Groups, subgroups and classes : definitions and theorems; molecular symmetry and symmetry groups; representation of groups; character tables; wave functions as bases for irreducible representations; direct product; symmetry adapted linear combinations; symmetry in molecular orbital theory; hybrid orbitals; molecular orbitals of metal sandwich compounds; ligand field theory; molecular vibrations; space groups.

CHEM G551 Advanced Organic Chemistry 5

Recent advances in aromatic electrophilic and nucleophilic substitution reactions and nucleophilic addition reactions; oxidation and reduction; enolates in organic synthesis; retro synthetic analysis; multiple step synthesis; protecting groups.

CHEM G552 Advanced Inorganic Chemistry 5

Advanced coordination chemistry, reactions, kinetics and mechanism; advanced organometalic chemistry, bonding models in inorganic chemistry, inorganic chains, rings, cages and clusters; group theory and its applications to crystal field theory, molecular orbital theory and spectroscopy (electronic and vibrational); inorganic chemistry in biological systems.

CHEM G553 Advanced Physical Chemistry 5

Equilibrium: The laws of Thermodynamics, applications to phase equilibrium, reaction equilibrium, and electrochemistry; Struc-

ture: Principles and techniques of quantum mechanics, applications to atomic and molecular structure and spectroscopy, statistical thermodynamics, molecular interactions, macromolecules, solid state; Dynamics: Molecular motion in gases and liquids, reaction rate laws, mechanisms and rate theories of complex reactions, molecular reaction dynamics, surface processes, electron transfer dynamics.

CHEM G554 Physical Methods in Chemistry 5

Advanced spectroscopic and non-spectroscopic techniques used in chemistry; Topics will include electronic absorption spectroscopy of organic and inorganic compounds, ORD, CD; vibrational rotational spectroscopy symmetry aspects; Dynamic and Fourier transform NMR, NOE, Multipulse methods, Two-Dimensional NMR; EPR; NQR; Mossbauer spectroscopy; Magnetism; Ionization Methods: Mass spectrometry, Ion Cyclotron Resonance; Photoelectron Spectroscopy; Microscopic techniques: TEM, STM, AFM; EXAFS, XANES; X-ray Crystallography.

CHEM G555 Chemistry of Life Processes 4

Synthesis and structures of biopolymers such as proteins and nucleic acids; nucleic acid replication, transcription and translation; lipids and biomembranes; transport across membranes; neurotransmission; enzyme and enzyme inhibitors; citric acid cycle, pentose phosphate pathway and nucleic acid metabolisms; photosynthesis; electron transport systems in respiration and oxidative phosphorylation.

CHEM G556 Catalysis 4

A comprehensive survey of the catalytic processes along with the fundamental aspects of the catalyst design and evaluation; several classes of heterogeneous industrial catalysts; their preparation, characterization and applications, recent developments in catalysis, application of nanomaterials in catalysis.

CHEM G557 Solid Phase Synthesis and Combinatorial Chemistry 4

A comprehensive understanding of solid phase synthesis and combinatorial chemistry, basic principles of solid phase organic synthesis; solid phase organic synthesis strategies; introduction to combinatorial chemistry; analytical techniques in combinatorial chemistry; applications of the combinatorial approach in chemistry, drug development and biotechnology.

CHEM G558 Electronic Structure Theory 5

Advanced methods in theoretical and computational chemistry based on Quantum Mechanics: Review of mathematical background, N-Dimension complex vector spaces, linear variational problem, many electron wave functions and operators, operators and matrix elements; Ab-initio methods: Hartree-Fock (H-F), Configuration Interaction (CI), Many Body Perturbation Theory (MBPT); Density Functional Theory: Thomas-Fermi model, Hohenberg-Kohn theorems, derivation of Kohn-Sham equations; Development and use of software for such models.

CHEM G559 Bioinorganic Chemistry 4

Fundamentals of inorganic biochemistry; essential and non-essential elements in bio-systems, metalloproteins and metalloenzymes; role of metal ions in oxygen carriers, synthetic oxygen carriers, bioinorganic chips and biosensors; fixation of dinitrogen, environmental bioinorganic chemistry; transport and storage of metal ions *in vivo*, metal complexes as probes of structure and reactivity with metal substitution; fundamentals of toxicity and detoxification, chelating agents and metal chelates as medicines, nuclear medicines.

CHEM G561 Heterocyclic Chemistry 5

The fundamental structural characteristics; synthesis and reactions of various heterocycles with nitrogen, oxygen and sulphur heteroatom in the ring; heterocyles such as pyrrole, thiophene, furan, imidazole, thiazole, oxazole, indole, benzofuran, pyridine and quinoline; advanced synthesis and reaction mechanism of heterocyclic compound.

CHEM G562 Solid State Chemistry 4

Basics of solid state chemistry, comprehensive survey of different synthesis techniques, properties and their structural-property relationship of solid materials; introduction to special nanomaterials, ceramics, polymers, biopolymers and nanocomposites; thermal and mechanical properties of nanomaterials; nanocomposites in hydrophobic applications; recent advances in material science and technology.

CHEM G563 Advanced Statistical Mechanics 5

Review of ensembles, fluctuations, Boltzmann statistics, quantum statistics, ideal gases and chemical equilibrium; imperfect gases; distribution function theories and perturbation theories of classical liquids; electrolyte solutions; kinetic theory of gases; continuum mechanics; Boltzmann equation; transport processes in gases and Brownian motion; introduction to time-correlation function formalism.

Chinese

CHI N101T Beginning Chinese 3 0 3

Basic grammar; sentence construction; vocabulary building; conversations; dialogues; listening; translation of simple passages.

Computer Science

CS F111 Computer Programming 3 1 4

Basic Model of a Computer; Problem Solving-Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files.

Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

CS F211 Data Structures & Algorithms 3 1 4

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Recursive Data Types, Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues); Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, Quick Sort and Randomization), Lower Bound on Complexity of Sorting Algorithms. Unordered Collections: Hash tables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Probabilistic/Randomized Data Structures (such as Bloom Filters and Splay Trees). Generalized Trees – Traversals and applications. Text Processing – Basic Algorithms and Data Structures (e.g. Tries, Huffman Coding, String search / pattern matching). External Memory Data structures (B-Trees and variants). Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees).

CS F212 Database Systems 3 1 4

Data modeling, database design theory, data definition and manipulation languages, relational data model, relational algebra and relational calculus, SQL, functional dependencies and normalization, storage and indexing techniques, query processing and optimization, transaction management - concurrency control and crash recovery; distributed databases.

CS F213 Object Oriented Programming 3 1 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; overloading and overriding; static and dynamic binding; multithreaded programming; event handling and exception handling; process of object oriented requirements specification,

analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages. Object Oriented Design Patterns: Behavioral, Structural and Creational.

CS F214 Logic in Computer Science 3 0 3

propositional logic – syntax, semantics, satisfiability & validity, predicate or first order logic – syntax, semantics, satisfiability & validity, completeness & compactness, Undecidability & incompleteness; Godel's incompleteness theorem; SAT solvers; verification by model checking, linear-time temporal logic (LTL), & computational tree logic (CTL). Program verification using Hoare logic & proofs of correctness; Modal logic & logic programming paradigm.

CS F215 Digital Design 3 1 4

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits ; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

CS F222 Discrete structures for Computer Science 3 0 3

Sets & operation on sets; relations & equivalence relations; number theory; weak & strong form of mathematical induction; principle of inclusion & exclusion, pigeonhole principle; recurrence relations & generating functions; digraphs & graphs, graph isomorphism & sub-graphs, spanning trees, Euler & Hamiltonian graphs, planar graphs, chromatic numbers & graph coloring; groups; Lagrange theorem finite groups; Rings & Fields.

CS F241 Microprocessors & Interfacing 3 1 4

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams ; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system . This course will have laboratory component.

CS F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

CS F301 Principles of Programming Languages 2 0 2

The course covers features of programming languages and introduces the main programming paradigms. It covers, in detail, the semantics of the features of programming languages – Control Abstraction, Data Types and Data Abstraction, Scope and Parameter passing and Concurrency related features. It covers various aspects of runtime environments like global and local data, code, function call stacks, dynamically allocated data, runtime features for exceptions and threads. Introduction to programming paradigms. Functional paradigm – formal elements of lambda calculus, introduction to syntax of common functional programming languages and programming exercises that explore the functional paradigm. Logic programming paradigm - formal elements of logic programming and programming tasks that explore the logic paradigm. Scripting as a paradigm. Domain specific languages. Applications of the principles of programming languages –program verification, software testing and security.

CS F303 Computer Networks 3 1 4

Introduction; Need for Computer Networks; Top-down vs. Bottom-up approaches; Network Services, and Protocols; Network Reference Models and Architectures, Architecture of the Internet, Types and Applications of contemporary and emerging Networks, Application-Layer Requirements, Concepts, Services and Protocols: Protocols for Web, Email, File transfer, Name Resolution, Address Assignment / Discovery, Remote Access Services, Voice/Video over IP, Webcasting, Video-Conferencing and Telepresence, Network Management Protocols and Overlay Networks; Transport Layer Requirements, Services, Concepts and Protocols; Network Layer Requirements, Concepts, Services and Protocols, Routing vs. Layer-3 Switching; QoS; Link Layer and Physical Layer Requirements, Concepts, Services and Protocols, Logical Link and Medium Access Control concepts, Physical medium dependent function, Modes of Signaling and Communication at the lower layer; IEEE 802 architecture, Bridging versus Layer-2 Switching; VLANs, VPNs, Performance vs. Security, Emerging Trends and Best Practices related to design of computer networks and internetworks.

CS F314 Software Development for Portable Devices 2 1 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and assessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

CS F315 Information and Communication Technologies and Development 3 0 3

Development models; Sustainable Development Goals and Millennium Development Goals; role of Information and Communication Technologies (ICTs) in development; case studies of successes and failures in different domains like low cost communication networks, education, information kiosks, livelihood, health, etc.; theories that have emerged over the years and their criticisms; evaluation of the role of ICTs in development

CS F316 Quantum Architecture and Programming 3 0 3

Quantum computing basics, quantum computer architectures, reversible computing, quantum gates, computing models, Ehrenfest's urn model, Kac-Ring model, designing quantum ALUs, Pendulum instruction set architecture (PISA), fault-tolerant architectures, the Steane code, Quantum processing elements, quantum RAM and quantum addressing, reversible programming, quantum compilers.

Pre-requisite: CS F215: Digital Design

CS F317 Reinforcement Learning 3 0 3

Introduction to RL and its applications, RL Goals and Rewards, Finite Markov Decision Processes, Temporal Difference Learning, Value function and Policy Evaluation, Tabular Methods, Function approximation, Sarsa, Q-learning, Approximate Solution Methods, Multi-agent RL, Actor-Critic methods including Advantage Actor Critic (A2C) and Asynchronous Advantage Actor Critic (A3C).

CS F320 Foundations of Data Science 3 0 3

Introduction to Data Science, Review of Probability, Random Variables and Probability Distributions, Bayesian probabilities, Conditional Gaussian distributions, Marginal Gaussian distributions, Bayes' theorem for Gaussian variables, Maximum likelihood and Bayesian Inference for the Gaussian, Mixtures of Gaussians, Probability Bounds, Nonparametric Methods - Kernel density estimators, Nearest-neighbour methods, Bayesian Curve Fitting, Introduction to constrained and unconstrained optimization, High Dimensional Data & Curse of Dimensionality, Dimensionality Reduction, PCA & SVD, Data Visualization Techniques, OLAP and Multidimensional Data Analysis, Data Pre-processing, Big Data & Big Data Analytics, Social Media data.

CS F342 Computer Architecture 3 1 4

Processor performance criteria, performance benchmarks, arithmetic circuits, CPU design - instruction set architecture, instruction execution, Single and Multicycle implementation, Pipeline design, Hazards, methods of overcoming hazards, Branch prediction, Memory subsystems including cache optimization, Instruction level Parallelism.

CS F351 Theory of Computation 3 0 3

Review of Set Theory - Cardinality, Countable and Uncountable Infinite Sets, Relations and Functions, Equivalence Relations. Introduction to Languages and Operations Applicable to Languages. Regular Expressions. Finite State Automata - Deterministic and Non-Deterministic – Equivalence, FSAs and Regular

Expressions – Closure Properties of Regular Languages – Equivalence Classes of a Language and Minimal Automata. Non-Regular Languages. Context Free Grammars and Push Down Automata – Equivalence and Closure Properties – Normal forms and Concepts in Parsing – Languages that are not Context Free. Turing Machines – Unrestricted Grammars – Equivalence – Various Forms of TMs and their Equivalence. Recursive functions. Universal Turing machine – Reductions – Decidability – Undecidable Languages. Complexity Classes – P, NP and NP-Completeness.

CS F363 Compiler Construction 2 1 3

Introduction - Compilation and Execution Environments - Compilers and Interpreters – Requirements and Motivation; Front-end and Back-end of compilers/interpreters; Intermediate Representation and Intermediate Languages; Compile Time vs. Execution Time; Translators, and Assemblers; Virtual Machine - Just-in-Time Compilers. Structure of a Compiler – Phases and Passes. In-memory data - intermediate versions of code, symbol table. Lexical Analysis: error handling & tool construction, DFA, Defining tokens using regular expressions, Designing and implementing scanners / lexical analyzers. Parsers: Context Free Languages (introduction where needed)and Recognizing CFLs. Parsing techniques – LL , LR - LR (0),LR(1), LALR) . Intermediate Representation: Parse Trees and Abstract Syntax Trees; 3-address code. Semantic Analysis. Back End Phases: Machine Independent optimizations: Loop Optimization Techniques - Loop Unrolling, Induction variable based optimization, Loop-Invariant code elimination. Procedure Call Optimization, and Dead Code Elimination. Target Code Generation : Data Flow Analysis, Register Allocation, Instruction Selection & Scheduling. Memory Management : Memory allocation support, Memory- de-allocation – Garbage Collection Techniques. Advanced Topics :Issues in compiling Object Oriented Languages, Functional Languages, Concurrent Languages, Script & Query Languages.

CS F364 Design and Analysis of Algorithms 3 0 3

Basic Design Techniques – Divide-and-Conquer, Greedy, Dynamic Programming (Examples, Analysis, General Structure of Solutions, Limitations and Applicability). Specialized Design Techniques: Network Flow, Randomization (Examples, Analysis, Limitations). Complexity Classes and Hardness of Problems – P, NP, Reductions, NP-hardness and NP-Completeness, Reduction Techniques, Basic NP-complete problems. Design Techniques for Hard Problems – Backtracking, Branch-and-Bound, and Approximation (General approaches and structure of solution, Analysis, and Limitations). Linear Programming – LP Problem and Simplex Algorithm, Approach for using LP for modeling and solving problems. Introduction to Design and Analysis of Parallel and Multi-threaded Algorithms.

CS F366 Lab Project 3

CS F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CS F372 Operating Systems 3 0 3

Introduction to operating systems; Various approaches to design of operating systems ; Overview of hardware support for 0perating systems; Process/thread management: synchronization and mutual exclusion, inter process communication, CPU scheduling approaches ;Memory management: paging, segmentation ,virtual memory, page replacement algorithms ; File systems: design and implementation of file systems; Input/Output systems; device controllers and device drivers; Security and protection ; Case studies on design and implementation of operating system modules.

CS F376 Design Project 3

CS F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CS F401 Multimedia Computing 3 0 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codecs, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

CS F402 Computational Geometry 3 0 3

Introduction to Computational Geometry, degeneracies and robustness, convex hull in 2D, line-segment intersection, doubly-connected edge list, computing the overlay of two subdivisions, art gallery theorem, guarding and triangulation, monotone polygons, partitioning arbitrary polygon into monotone polygons, triangulating a monotone polygon, range search problem, Kd-trees, range trees, fractional cascading, point location problem, trapezoidal maps, randomized incremental algorithm to compute trapezoidal map, post-office problem, Voronoi diagram and its properties, Algorithm to compute Voronoi diagram, Delaunay triangulation and relation with Voronoi diagram, Computing Delaunay triangulation, line and point duality, arrangement of lines, application of computational geometry.

CS F404 Computer Crime and Forensics 2 0 2

Introduction to Computer Forensics: collection, preservation, analysis, preparation and presentation of computer based evidence for the purposes of criminal law enforcement or civil litigation. Structure of Storage Media: Study of different file systems (FAT12, FAT16, FAT32, NTFS, EXT2/EXT3, etc). Study of digital forensic techniques: Disk forensics, Network forensics and Device forensics. Understanding Computer Crime, Data Acquisition, Forensic Analysis (Internet History files, Email files and major operating system files for different OS's). Study of Steganography: information hiding and retrieval. Live versus Dead forensics. Use of Forensic Tools for file system analysis, registry analysis, network analysis, etc. Introduction to computer crimes in India and abroad.

CS F406 Ethical Hacking 2 2 3

Techniques and tools for ethical hacking and countermeasures; exploit approaches – social engineering, scanning, foot-printing, enumeration, sniffers, buffer overflows, web-hacking including cross scripting, SQL injection, privilege escalation, root kits, search engine highjack, covert channel, binary auditing, services specific hacking like DNS, Email, Web servers, Proxy; techniques of bypassing security mechanisms and hardening systems and networks for countermeasures of security analysis, monitoring and analysis tools including network traffic and system logs.

CS F407 Artificial Intelligence 3 0 3

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving.

The course also aims at understanding its implementation using LISP and PROLOG languages.

CS F413 Internetworking Technologies 3 0 3

Introduction to internetworking concepts; the internet architecture; goals and key issues related to internetworking technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security; case studies.

CS F415 Data Mining 3 0 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of

neural networks and machine learning for tasks of classification and clustering.

CS F422 Parallel Computing 3 0 3

Introduction to parallel computing; Models of parallel computers; Interconnection networks, basic communication operations; Introduction to parallel algorithms; Parallel programming paradigms; issues in implementing algorithms on parallel computers; Parallel programming with message passing interface; Performance analysis; Scalability analysis; Basic design techniques for parallel algorithms; Parallel algorithms for selected topics like sorting, searching and merging, matrix algebra, graphs, discrete optimization problems and computational geometry.

CS F424 Software for Embedded Systems 3 1 4

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis – Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

CS F425 Deep Learning 3 0 3

Basic neural networks, derivative-based optimisation, gradient descent and its variants, various learning algorithms: SGD, RMSProp, Adam, Shallow Networks, Stacking, multilayer perceptron, activation functions, parameter initialisation strategy, cost function, backpropagation using gradient descent, visual data, convolution operation, pooling, variants of convolution function, CNN architectures: Dense convolutional neural networks (DenseNets), AlexNet, VGG, etc., sequence models, GRU, LSTM, encoders-decoders, vanishing gradient, autoencoders, generative modelling, VAE, real world applications.

CS F426 Graph Mining 3 1 4

Managing and mining graphs which are massive and cannot held in main memory, applications of graphs are web, social networks, computational biology, communication networking etc., static graphs, dynamic graphs, indexing and querying graphs, graph representation, random walks, page rank, triangular computation, Node classification, Graph clustering, graph similarity and alignment, Graph summarization, subgraph mining, streaming graphs, Deep learning for graphs

Pre-requisite: CS F211 **:** Data Structure and Algorithms

CS F427 Performance Analysis of Computer Networks 3 0 3

Network Delay Models, Queuing Models, Delay modelling using multi-dimensional markov chain, M/G/1 models for network systems, Erlan-B, BCC and BCQ models for TDM/FDM systems, analysing networking protocols and cellular system, Network traffic modeling, long range dependent propertied of network traffic, Network of queues, closed queuing networks, Network Simulation, discrete event simulation, simulation work flow, experimental planning and factor reduction.

Pre-requisite: CS F303 : Computer Networks

CS F428 Special Topic in Computer Science 1 0 1

This is a one-unit course. This course allows a special topic of study for individuals or small groups of students who wish to gain particular or additional knowledge in a special topic. The topics can be chosen from certain recent / emerging areas of knowledge or alternatively it could also be used of covering certain advance concept and recent developments supplementing the existing full course .

CS F429 Natural Language Processing 3 0 3

Introduction to NLP and its applications, N-Gram Language Models, Vector representation of words, Parts Of Speech Tagging, Topic Modelling using Latent Dirichlet allocation, Statistical Machine Translation, Constituency Grammars, Logical Representations of Sentence Meaning, Information Extraction, Word Senses and WordNet, Question Answering, Dialog Systems and Chatbots.

CS F430 Approximation Algorithms 3 0 3

P vs NP, NP-optimization problems, approximation ratio; multiplicative and additive. Design techniques for approximation algorithms: greedy, local search and other combinatorial techniques, dynamic programming and approximation schemes, randomized techniques, LP based techniques; randomized rounding, primal-dual, iterative rounding, local ratio, dual-fitting, semi-definite programming based techniques. Hardness of approximation: approximation classes, non-approximability results, gap technique, approximation preserving reductions, and the PCP theorem.

Pre-requisite: CS F364: Design & Analysis of Algorithms

CS F431 Combinatorial Optimization 3 0 3

Linear programming(LP), simplex algorithm, duality in LP, dual simplex algorithm, applications of duality and primal-dual algorithm to solve graph problems. Polynomial-time algorithms for LP: ellipsoid algorithm, interior point methods; Karmakar's algorithm. Integer linear programming (ILP); total unimodularity and its applications. Algorithms for solving ILP problems.

Pre-requisite: CS F211: Data Structures & Algorithms

CS F432 Brain-inspired Deep Learning 3 0 3

Introduction to Brain-inspired Deep Learning, Deep Learning and Knowledge Representation in the Brain; Spiking Neurons and Neural Networks; Neural Information Processing; Evolving networks and Reservoir Computing; Applications of Brain-inspired Deep Learning and case studies; Neuromorphic technologies and hands-on coding with state-of-the-art neuromorphic software and hardware. Pedagogical approach will emphasise on student-led learning, creative thinking, and dissemination.

CS F433 Computational Neuroscience 3 0 3

Biophysics of action potentials, local field potentials (LFP) and electroencephalogram (EEG), and their recording and analysis techniques; modelling a neuron - starting with the Nobel-prize winning Hodgkin-Huxley model; information processing in neural populations; synaptic mechanisms and learning by association; meso- and macro-scale neural population networks and their dynamics; modelling of neurological disorders as observed in higher level brain signals such as the LFP, EEG, functional magnetic resonance imaging (FMRI); validation of neural models with data. Alongside theory, students will be introduced to software tools (using python/Matlab/C based on student preferences) to simulate neural computations and models.

CS F441 Selected Topics from Computer Science 3

This course is primarily intended to introduce the students of computer science to topics, either in recent advances or of special interest. Topics may be taken from one or more of the areas like artificial intelligence, theory of computing, networking and distributed processing, digital control, information theory, super computers, special purpose architectures and language processors.

CS F444 Real–Time Systems 3 0 3

Introduction to real-time systems, clock synchronization, task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time databases, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

CS F446 Data Storage Technologies and Networks 3 0 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

CS F451 Combinatorial Mathematics 3 0 3

Course description is to be developed.

CS F468 Information Security Project 0 3 3

Malware and Malware Identification, Terminate-and-Stay-Resident programs, Identification of signatures/patterns of viruses, Developing Antivirus tools, Single system firewalls and rules, Rootkits and identification of rootkits, Virtual machines, Sandboxes and run-time monitors.

CS F469 Information Retrieval 3 0 3

Organization, representation, and access to information; categorization, indexing, and content analysis; data structures for unstructured data; design and maintenance of such data structures, indexing and indexes, retrieval and classification schemes; use of codes, formats, and standards; analysis, construction and evaluation of search and navigation techniques; search engines and how they relate to the above. Multimedia data and their representation and search.

CS F491 Special Project 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

CS G501 Mobile Computing 5*

Course description to be developed.

CS G511 Design and Analysis of Algorithms 3 2 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

CS G512 Introduction to Authoring Systems 4

Characteristics and principles of expert systems; construction and transfer of expertise; meta-knowledge; tools and formalisms for expert systems; application through programs in prolog; state of art characteristics and principles of authoring systems; implementation techniques.

CS G513 Network Security 3 1 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, securitystandards, security system interoperation and case studies of the current major security systems.

CS G514 Object Oriented Analysis and Design 2 2 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

CS G515 Queueing Systems Theory 3 2 5

Resource sharing issues and theory of queueing systems; Review of Markov chains and baby queueing theory; Method of stages. M/Er/1. Er/M/1. Bulk arrival and bulk service systems. Series-parallel stages. Fundamentals of open and closed queueing networks. Intermediate queueing theory: M/G/1; G/M/m. Collective marks. Advanced queueing theory: G/G/1; Lindley integral equation; spectral solution. Inequalities, bounds, approximations.

CS G516 Advanced Database Systems 3 1 4

Object-oriented databases, Parallel databases, Distributed databases, NoSQL databases, Deductive databases, Spatial databases, Multimedia databases, Query optimization, Information retrieval, XML.

CS G517 Network and System Security 4*

Course description is to be developed.

CS G518 Internet of Things: Design and Development 3 1 4

Logical design of IoT and enabling technologies, IoT protocol stack, IoT architecture and middleware design, introduction to Raspberry Pi and Python, QEMU simulator, application layer protocol like MQTT, CoAP, XMPP, XMPP-IoT, transport protocols like UDP, DTLS, TLS, RTP, STUN, data link protocols like 6LoWPAN, Wi-Fi, Bluetooth, Zigbee, WiMax, LR-QPAN, WPA2, L2CAP, SAFER+, IoT data and cloud computing, IoT data and machine learning, network performance and SDN and NFV, Blockchain and IoT.

Co-requisite CS F303 :Computer Networks OR EEE F414 OR ECE F414 : Telecommunication Switching Systems and Networks OR EEE F346 : Data Communication Networks

CS G519 Social Media Analytics 3 1 4

Basics of social media, its modelling & representation, node classification, community detection, user behaviour, herd behaviour, influence, recommendations in SM, controversy detection, sarcasm detection, fake post detection, behavioural analysis, SM driven problems such as mental health, spreading rumours, etc.

Equvalent: SS G519

CS G520 Advanced Data Mining 3 1 4

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

CS G521 Object Oriented Programming 2 2 4

Basics of object oriented programming: objects, classes, instances; inheritance; polymorphism; operator overloading; static and dynamic binding; small talk, C++, cases from other object oriented languages like Ada, Loop, Flavors, Objective-C, etc.; object oriented software engineering.

CS G523 Software for Embedded Systems 3 2 5

Real-time and embedded systems; software issues in embedded system; software development process; requirement analysis: use cases, identification and analysis of use cases, use case diagrams; design: architectural design, design patterns and detailed design; implementation: languages, compilers, runtime environments and operating systems for embedded software; testing: methodologies, test cases. The course will also consist of laboratory practices and development of software for embedded systems.

CS G524 Advanced Computer Architecture 3 0 5

Basics of Parallelism, Instruction Level Parallelism, Simultaneous Multi-Threading, Design and Optimization Techniques for Cache and DRAM; Pipelining and Super-scalar Techniques, Multiprocessor and Multi-core architecture, Shared Memory and Cache Coherence Issues; Multi-vector and SIMD computers, Performance evaluation methods, Interconnect Design Techniques.

CS G525 Advanced Computer Networks 3 2 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

CS G526 Advanced Algorithms & Complexity 3 2 5

Advanced Algorithm Design Strategies such as Randomization, Approximation and Game-Theoretic Techniques. Design of Parallel and Distributed Algorithms. Design of algorithms for application domains such as Internet / Web, and Computational Biology.

CS G527 Cloud Computing 5

Review of Distributed computing - Concurrency, message passing, connectivity and failure models, replication. Computing Infrastructure - Processing Power, Storage aggregation, I/O & Communication, Clusters and Data Centers. Resource modeling and virtualization - CPU virtualization, memory and storage virtualization, virtualized networks. Services - Service models and service contracts; Programming on the cloud. Cloud Applications - Software on the Cloud and Infrastructure Services. Cloud infrastructure - Private vs. Public Clouds, Resource scaling and Resource provisioning. Quality of Service - Performance models, scalability, Performance measurement and enhancement techniques. Security issues - Data/ Storage Security, Resource Access Control, Process Isolation and Control, Service Policies and Privacy Issues.

CS G531 Testable Design & Fault Tolerant Computing 3 2 5

Fault: types, modelling and simulation; testing methodologies, coverage, economics and quality; test vector generation: design for testability, built-in self tests; fault tolerant computing; fault tolerant software.

CS G541 Pervasive Computing 4*

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

CS G551 Advanced Compilation Techniques 5

Generic Code Optimization Techniques - loop optimization, inlining, and other transformations. Impact of architectures on code generation and optimization: RISC architectures, VLIW architectures, special-purpose architectures. Architecture-specific code optimizations – register allocation, instruction scheduling. Code Optimizations under real-time / embedded constraints - cacheless / diskless memory models, bounded time responses. Garbage Collection Techniques. Virtual Machines and Just-in-Time Compilation techniques - HotSpot-like optimizations. Implementation of exception handling, concurrency, and generic jumps (like call/cc).

CS G553 Reconfigurable Computing 5

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and Switch Networks. Design and Synthesis of Combinational and Sequential Elements. Placement and Routing. Pipelining and other Design Methodologies. Fine-grained and Coarse-Grained FPGAs. Static and Dynamic Reconfiguration. Partitioning. Hardware/Software Portioning and Partial Evaluation. Systolic Architectures.

CS G554 Distributed Data Systems 3 2 5

Distributed File Systems - File System Models; Replication and Synchronization - Caching; Failure & Recovery; File System Security. Distributed Databases - Distributed Data Sources and Updates; Database Connectivity; Concurrency Control and Distribution mechanism; Distributed indexing schemes. Database security. Data on the Web - Web as a distributed data repository. Data Collection and Use Crawlers, Search Engines, and Indexing Schemes. Information Retrieval Techniques.

Data Exchange - Hierarchical Data Models, XML, and query languages. Semi-structured / Unstructured data -querying and synchronization.

Pervasive Data - Data distribution and access for non-computing devices, small computing devices, embedded computing devices and sensory devices.

CS G555 System Specifications and Modelling 3 3 4

Requirement analysis, specification formalisms, system modeling issues, system modeling languages, Hardware Specification and verification languages, EDA tools and its applications.

CS G557 Distributed Computing 5*

Course description is to be developed.

CS G559 Database Security 5*

Course description is to be developed.

CS G562 Advanced Architecture and Performance Evaluation 3 2 5

Introduction to advanced architectures; parallel processing; pipelining and vector processing; array processing; SIMD computers and processor enhancement; performance evaluation methods, statistics and discrete math applications; modelling for evaluation of virtual memory; time sharing environments.

CS G564 Advanced Cryptography 5*

Course description is to be developed.

CS G566 Secure Software Engineering 5*

Best practices for designing secure systems, software engineering principles for designing secure systems, criteria for designing secure systems; analysis of system properties and verification of program correctness; use of formal methods and verification for security; tools for verification of security properties; techniques for software protection (such as code obfuscation, tamper-proofing and watermarking) and their limitations; analysis of software based attacks (and defenses), timing attacks and leakage of information, and type safety.

CS G568 Network Security Project 0 3 3

Network Intrusion and Intrusion Detection Techniques and Tools; Denial-of-Service attacks and Techniques/Tools for handling them; Network Firewalls and Firewall policies/mechanisms; Network-wide authentication schemes for users/clients/servers; Network-wide storage and storage security models and implementations.

CS G611 Distributed Processing Systems 2 2 4

Concepts of distributed processing, networkable architectures, inter process and processor communication algorithms, process migration and porting techniques etc.

CS G612 Fault Tolerant System Design 2 3 5

Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems, configurations, design aspects etc.

CS G622 Local Area Networks: Design and Implementation 2 3 5

Introduction to Local Networks; carrier sense networks; shared memory and device systems; protocol and token passing techniques & algorithms; security and integrity problems; algorithms and implementation; and selected current topics.

CS G623 Advanced Operating Systems 3 2 5

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, aggrement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, thereads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

CS G631 Devices, Data Communications and Control 3 2 5

Principles of operations of I/O devices; device handlers; master-slave control & controllers; Intelligent mode of operation; device handlers; most popular data communication methods; synchronisation and handshaking; design of controllers for selected devices.

CS G632 Application Driven System Design 0 4 4

General principles of application driven systems, examples from space and high speed digital imaging systems, Bandwidth considerations, design aspects etc

CS G641 Microprocessor-Based Systems Design 2 3 5

Small systems organisation; bus architectures; building blocks

around a microprocessor; memory techniques; RAM disks; paged memory modules; communications and data transfers; monitors and operating systems; engineering applications of microprocessors as device controllers; concept of local and central control.

CS G642 Recent Advances in Computing 2 2 4

Introduction to transputing and transputers, minimization algorithms, design aspects. Neural networks modelling, simulation and design. Optical computing and recent advances.

CS G651 Symbolic Computing & Computer Algebra 2 2 4

Course description is to be developed.

CS G652 Digital Communications and Message Switching 3 2 5

Signals & transmission types; noise; coding & decoding; modulation techniques; filters; time and frequency multiplexing; message switching; protocols; packet switching systems; remote networks; satellite linking communications.

CS G653 Software Architectures 3 2 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

CS G671 Advanced Computer Graphics 3 2 5

Overview of computer graphics and graphic devices; two dimensional & three dimensional curve representations, rotations and transformations; surfaces, generation, representation, rotation and transformations; modelling techniques; concepts in geometric design.

Design Engineering

DE G511 Advanced Methods in Applied A Mathematics 5

Suitable topics from amongst the following: linear algebra; vector analysis; numerical methods to solve different types of equations; approximate numerical solutions of ordinary and partial differential equations; integral transform; linear and nonlinear optimization techniques; mathematical programming; mathematical modelling; calculus of variations; random variates and statistical techniques; decision models and analysis.

DE G512 Finite Element Analysis 5

Element properties, Isoparametric elements, Finite element methods and analysis, Applications in design including continuum mechanics, Dynamic systems, Heat conduction and Electrical potentials, etc. will be taken up.

DE G513 Tribiology 3 2 5

Introduction, lubricants and lubrication, surface texture, bearing materials, fundamentals of viscous flow, reynolds equation and applications, thrust bearings, journal bearings, squeeze-film bearings, hydrostatic bearings, gas bearings, dry and starved bearings, selecting bearing type and size, principles and operating limits, friction, wear and lubrication.

DE G514 Fracture Mechanics 3 2 5

Introduction, energy release rate, stress intensity factor and complex cases, anelastic deformation at the crack tip, elastic plastic analysis through J-integral, crack tip opening displacement, test methods, fatigue failure, numerical analysis, mixed mode crack initiation and growth.

DE G521 Instrumentation and Applied Electronics 5

Generalized instrumentation system for measurement and control; performance characteristics of instruments; analytical techniques - time and frequency domain analysis, Laplace and Fourier transform techniques; sensors and transducers; Feedback measurement system, ynalmg and digital signal conditioning and conversion techniques, telemetry techniques, improvement of signal-to-noise ratio, statistical instrumentation techniques; transducers interfacing; computer control instrumentation, electronic bench instruments, etc.

DE G522 Design Projects 3 2 5

Practice in engineering design through projects emphasizing creative solutions to engineering design problem. Illustrative case studies of design will be taken up. The course will be conducted through selected group/individual projects.

DE G531 Product Design 3 2 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

DE G532 Quality Assurance & Reliability 5

Quality planning and control, economics of quality control, Specifications, tolerances and process capability studies, total quality control concepts in quality circles, quality incentives. Fundamental concepts of reliability engineering, Failure analysis, Reliability versus quality control, Systems reliability evaluation, reliability allocation, maintainability, and designing for reliability. Illustrative examples of design ensuring reliability to be taken up.

DE G611 Dynamics & Vibrations 3 2 5

Steady and transient Vibration of single and multi degree freedom systems. Systems with distributed mass and elasticity. Nonlinear and self-excited vibrations, structural damping, Random vibrations, vibration analysis, vibration control - reduction, isolation and vibration absorbers.

DE G621 Digital & Microprocessor Based Systems 5

Digital system design using combinational and sequential circuits; processor architecture, assembly programming and system design using peripheral devices such as PPI, Interrupt controller, DMA controller, etc. Microcontroller architecture and typical applications; concept of bus based system design and PC based system design.

DE G631 Materials Technology & Testing 5

Study of characteristics and technology of metals, plastics, rubbers, ceramics, polymers, composites, optical fibres and other modern engineering materials and their application with particular reference to Railways. Destructive and non-destructive testing techniques and their applications in Railways.

Electronics and Communication Engineering

ECE F211 Electrical Machines 3 1 4

Transformer: Constructional features, equivalent circuit and phasor diagram - regulation and efficiency, parallel operation. Three phase transformer connections; Harmonic in transformers; Testing; Phase conversion; Autotransformer. D.C Machines: Construction, armature windings, armature voltage and torque equations, classification. D.C generators, performance characteristics; D.C motors - torque/speed characteristics, speed control and braking. Testing and efficiency. Induction machines: Constructional features and rotating magnetic field. Circuit model and phasor diagram.

Steady state characteristics. Testing, starting and speed control. Time harmonics and space harmonics. Wound rotor induction motors, Single phase induction motors - classification and equivalent circuit. Synchronous machines: Constructional features; synchronous generators and motors; equivalent circuit and phasor diagram; power and torque characteristics and capability curves. Parallel operation. Salient pole synchronous machine - phasor diagram and determination of synchronous reactances; starting and speed control of synchronous motors. Special machines- universal motors, Induction generators.

ECE F212 Electromagnetic Theory 3 0 3

Review of mathematics - scalar and vector fields, calculus of scalar and vector fields in Cartesian and curvilinear coordinates, Dirac delta function; Electrostatics - electric field, divergence &

curl of electric field, electric potential, work and energ y in electrostatics, conductors, electric dipole; Electrostatics in Matter - polarization and field of a polarized object, electric displacement, linear dielectrics; Magnetostatics - Lorentz force law, Biot-Savart law, divergence & curl of magnetic field, magnetic vector potential, magnetic dipole; Magnetostatics in matter - magnetization and field of a magnetized object, the H-field, linear & non-linear magnetic media; Electrodynamics - electromotive force, electromagnetic induction, Maxwell's equations in free space, plane wave solutions of Maxwell's equations in free space.

ECE F214 Electronic Devices 3 0 3

Crystal structure and growth of semiconductor, electrical conduction in solids, Elementary quantum physics (Photoelectric effect, uncertainty principle, Schrodinger wave equation and tunneling), energy bands in solids, charge carriers in semiconductors, excess carriers in semiconductors, Fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, metal-semiconductor junctions Bipolar junction transistors, field effect transistors (JFET, HEMT, MOSFET), Special diodes (varactor diode, solar cell, LEDs, Tunnel diode and HBT), dielectric materials and insulation (Polarization mechanisms, frequency dependence, dielectric strength and insulation breakdown).

ECE F215 Digital Design 3 1 4

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits ; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

ECE F216 Electronic Devices Simulation Laboratory 0 2 2

Hands on simulation experience of Electronic Devices (Diodes, BJTs, MOSFET and MOS Capacitor) using Sentarus TCAD; Simulation of electrostatics of various Electronic Devices and their effects on the device performance.

Pre-requisites:

EEE F214 / INSTR F214 / ECE F214 : Electronic Devices

ECE F241 Microprocessors and interfacing 3 1 4

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams ; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system. This course will have laboratory component.

ECE F242 Control Systems 3 0 3

Modeling and classification of dynamical systems, Properties and advantages of feedback systems, time-domain analysis, frequency-domain analysis, stability and performance analysis, State space analysis, controller design.

ECE F243 Signals and Systems 3 0 3

This course is intended to provide a comprehensive coverage of Signals and Systems, a fundamental subject of Electrical Engineering. The topics covered are: Continuous-time and discrete time signals and systems, convolution, properties of linear time-invariant (LTI) systems, Fourier series, Fourier transform, Z transform, Laplace transform; System analysis, frequency response, analog filters, Sampling and reconstruction.

ECE F244 Microelectronic Circuits 3 0 3

Basic microelectronic circuit analysis and design, biasing in discrete and integrated circuit amplifiers, an overview of modeling of microelectronic devices single and two transistor amplifier configurations with passive and active loads; current mirrors & current sources; single-ended and differential linear amplifiers , differential and multistage amplifiers; 2 stage CMOS OPAMP, frequency response of amplifiers; negative feedback in amplifiers, R-C frequency compensation.

ECE F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

ECE F311 Communication Systems 3 1 4

Analysis and design of communication systems; analog and digital modulation and demodulation, frequency conversion, multiplexing, noise and distortion; spectral and signal-to-noise ratio analysis, probability of error in digital systems, spread spectrum.Introduction to the basic principles of the design and analysis of modern digital communication systems. Topics include source coding, channel coding, baseband and passband modulation techniques, receiver design, and channel equalization.

ECE F312 EM Fields and Microwave Engineering La- 0 1 1 boratory

Experiments in Microwaves and antennas using Microwave benches and simulation softwares.

ECE F314 Electromagnetic Fields and Microwave En- 3 0 3 gineering

Electromagnetic waves; Maxwell's equations; Poynting theorem and wave equations; propagation of EM waves; transmission lines; microstrip lines; wave guides; cavities and antennas; microwave generators, microwave amplifiers; measurement at microwave frequencies.

ECE F341 Analog Electronics 3 1 4

Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short; Analysis of simple operational amplifier circuits; Effects of real operational amplifier parameters on circuit performance . Linear applications of operational amplifiers: Instrumentation and Isolation amplifiers; Current and voltage sources; Active filters. Non-linear applications of operational amplifiers: Comparators,; Linearization amplifiers; Logarithmic amplifiers, multifunction modules & circuits, true rms convertors, Precision and signal conditioning circuits, Waveform Generation: sinusoidal and non-sinusoidal signal generation; Wave shape converters. Timer 555 based circuits, Phase lock loop circuits & applications, IC regulators, Output stage and large signal amplifiers, Power amplifiers, Tuned amplifiers, Analog and Digital interface circuits: A/D, D/A Converters.

ECE F343 Communication Networks 3 03

Packet switching and circuit switching; layered network architecture (OSI model), point-to-point protocols and links: physical layer, error detection and correction, ARQ retransmission strategy, framing, X.25 standard, queueing theory and delay analysis: Little's theorem, analytical treatment of M/M/1 and M/M/m queuing systems, simulation of queueing systems, delay analysis for ARQ system, multi-access protocols and techniques: Aloha systems, CSMA, IEEE-802 standards, routing and flow control. TCP/ IP protocols, ISDN, ATM, network security, design of a LAN system with commercially available functional units. Wireless LAN: adhoc network, security issues.

ECE F344 Information Theory and Coding 3 0 3

Random variables and random processes; Information sources and source coding theorem, Kraft inequality, Shannon-Fano codes, Huffman codes, Arithmatic Codes, Lempel-Ziv-Welch algorithm, universal source codes; channel capacity: channel capacity; noisy channel coding theorem for discrete memoryless channels; channel capacity with feedback; continuous and Gaussian channels; error control coding: linear block codes and their properties, hard-decision decoding, convolution codes and the Viterbi decoding algorithm, iterative decoding; turbo codes and lowdensity-parity-check codes; rate distortion theory: rate distortion function, random source codes; joint source-channel coding and the separation theorem; cryptography: basic concepts on cryptography and cryptoanalysis, security issues; private-key encryption algorithms- stream ciphers, block ciphers, Shannon's theory; introduction to number theory - modular arithmetic, exponentiation and discrete logarithms in Galois field; public-key encryption algorithms- Diffie-Hellman public-key distribution scheme, RSA public-key cryptosystem; Message authentication, hashing functions, digital signatures.

ECE F366 Lab Project **3**

ECE F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ECE F376 Design Project **3**

ECE F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ECE F414 Telecommunication Switching Systems and Networks **3 0 3**

Intoduction, electromechanical switching, pulse dialing and DTMF dialing, stored program control, space division switching, speech digitization and transmission, time division switching, fundamentals of traffic engineering, telephone networks, signaling, data networks, layered architecture and protocols, LANs, packet switching networks, TCP/IP, ISDN, ATM networks.

ECE F416 Digital Communication **3 0 3**

Introduction, the modeling and characterization of information sources, algorithms for source coding and encoding of analog output sources; Information transmission through AWGN channels using digital modulation methods and BER estimation; Digital communication through band limited Gaussian noise channels; channel coding and decoding; Wireless communication channels: its characterization and modulation schemes for such channels; emerging trends in the above field.

ECE F418 Modern Communication Technologies **3 0 3**

Modern communication systems overview, Digital modulation techniques, Channel capacity and coding, Digital link improve techniques, Digital receiver design and performance analysis, Wireless communication systems: wireless channel models and link improvement techniques, multiple access schemes. Basic concept of mobile network, Optical Communication Systems: Transmitters, receivers and other optical Communication subsystem, Optical wireless systems.

ECE F423 Electronic Material Design and Simulations Laboratory **1 2 3**

Reviewing the basic Theory for Crystalline Solids (Crystal group, real Space, reciprocal space), Introduction of the Concept of Density Functional Theory (Many Electron Scenario, Born-Oppenheimer Approximation, Hartree's Formulation, Hohenberg and Kohn Theorems, Energy Functional, Kohn Sham Scheme), Familiarization with Quantum Espresso (Plane Wave Basis Set, Exchange Correlation Functional, Pseudopotential, Brillouin Zone Sampling, Quantum Espresso input file format), Theoretical Calculation of Structural Properties of Materials (Unit Cells and Super Cells, Lattice Vectors, Ground-state Energy, Bond-Length and Bond Angles), Theoretical Calculation of Electronic Properties of Materials (Energy Band Profiles and Density of States, Projected Density of States), Theoretical Calculation of Optical Properties of Materials (Optical Spectrum), Introduction of Doping in Materials (Effects on Electronic and Optical Properties), Introduction of Strain in Materials (Effects on Electronic and Optical Properties) Simulation of 2D materials like Graphene and MoS2.

Pre-requisites:

EEE F214 / INSTR F214 / ECE F214 : Electronic Devices

ECE F424 Smart Grid for Sustainable Energy **3 0 3**

Introduction to Smart grid, Renewable Power Generation and Energy Storage, Microgrid, Power System Economics and Electricity Markets, Demand Response, Various Sensing, Communication, and Control technologies, and Application of Data Science.

Pre-requisites:

EEE F242 / INSTR F242 / ECE F242 : Control Systems

ECE F428 Energy Storage Systems **3 0 3**

Need of Energy Storage; Broad classification of Energy Storage Systems and applications; Electrochemical Energy Storage Systems; Battery Storage; Application oriented choice of Batteries; Electrical interface system design for Batteries with Renewable Energy sources; Battery Management Systems (BMS); Hydrogen Energy Storage; Its application as Fuel cell, Electrical Energy Storage; Thermal Energy Storage; Mechanical Energy Storage and their applications.

ECE F431 Mobile Telecommunication Networks **3 0 3**

Fundamentals of mobile telecommunications, with an overview of first generation (analog) systems and more detailed coverage of second generation (digital) technologies; technology basics including descriptions of wireless network elements, spectrum allocation, frequency re-use, characteristics of the transmission medium; over the-air (OTA) interface characteristics; capacity, coverage, speech coding, channel coding and modulation techniques of TDMA and CDMA technologies; network characteristics; architecture, signaling, element management of IS-41 and GSM networks; call processing; call setup and release, handoff, roaming, advanced services; mobile data communications; circuit and packet switched data services, third generation (wideband data) mobile communications system requirements/ architecture.

ECE F434 Digital Signal Processing **3 1 4**

Introduction; design of analog filters; design of digital filters (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

ECE F472 Satellite Communication **3 0 3**

Review of microwave communications and LOS systems; the various satellite orbits like GEO, MEO, LEO; the satellite link analysis and design; the communication transponder system like INSAT, INELSAT etc; the earth segment and earth station engineering; the transmission of analog and digital signals through satellite and various modulation techniques employed; the multiple access techniques like FDMA, TDMA, CDMA, DAMA, etc; the INSAT program; salient features of INSAT – systems and services offered; satellite services offered by INTELSAT, INMARSAT and future satellites like IRIDIUM etc; future trends in satellite communications.

ECE F491 Special Project **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

Economics

ECON F211 Principles of Economics **3 0 3**

Nature and scope of economic science, its relationship with other social sciences; quantification of economic variables, theories of consumer behaviour and of the firm: linear economic models; market structures; social accounting and basic elements of economic planning.

ECON F212 Fundamentals of Finance and Accounts **3 0 3**

Introduction to basic accounting principles for measuring and communicating financial data, single and double entry, ledgers, journals, trading, profit and loss and appropriation accounts, trial balance and balance sheet; cash flow statements, risk-return trade off notions, security analysis, structure of capital market, primary and secondary market, introduction to financial system

and its components, financial market reforms.

ECON F213 Mathematical & Statistical Methods 3 0 3

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like standard deviation, variance, Kurtosis, correlation coefficient; Sampling Methods - Simple random sampling, with and without replacement, stratified random sampling. Statistic and sample moments, Sampling Distributions - Properties of Student's – t, Chi-square and F-distributions. Theory of Estimation - Point estimation, method of moments; maximum likelihood; interval estimation. Testing of Hypothesis - Statistical hypothesis, simple and composite hypothesis,critical region, types and size of error, test of simple hypothesis versus simple alternative. Analysis of Variance - Analysis of one-way classified data, application in the study of relationships. Theory of Index Numbers - Calculation of Laspeyre's, Paasche's, Fisher's and Chain index numbers, criteria of a good index number, cost of living index numbers, base shifting, splicing and deflating of index numbers. Introduction to Regression Analysis - Specification of simple linear regression model, least square method of estimation, classical assumptions, general and confidence approach to hypothesis testing.

ECON F214 Economic Environment of Business 3 0 3

Business and Economics, Government and business; market an the role of the Government, market failure, Government and the market, government and the firm, Fiscal policy and the environment, Macroeconomic environment; macroeconomic environment of business, Business activity, employment and inflation, monetary policy and economic environment, balance of payment accounting, Business in the international environment; World trade and international monetary system; international investing; investment decisions in multinational markets; country risk; multinational corporate strategy; multinational treasury management; currency risk; globalization and multinational business, FDI, FII, pricing strategy and business.

ECON F215 Computational Methods for Economics 3 0 3

Introduction to Python; Basic econometrics with Python; Machine learning techniques in economics; Basic numerical methods in economics; Introduction to R & analysis with economic data; Introduction to MATLAB; MATLAB's applications in economics and finance.

ECON F241 Econometric Methods 3 0 3

Business environment and economy, industrial policy, industrial licensing, role of industry in economic development, monetary and fiscal policy, inflation, foreign trade and balance of payment, MRTP, FERA and FEMA Acts, business ethics and corporate governance, IPR, technology issues, liberalization, privatization and disinvestment, globalization, FDI, MNCs, international business environment.

ECON F242 Microeconomics 3 0 3

Consumer behavior under risk, production function and linear programming applications, derivation of cost and supply functions, commodity pricing under imperfect market structures, factor pricing, multimarket equilibrium, optimization over time, welfare optimization, game theory applications.

ECON F243 Macroeconomics 3 0 3

Systems of national accounts; input-output systems; flow of fund systems; monetary circulation and exchange; basic model of income determination; classical macroeconomic models; obstacles of full employment; Keynes model, derivation of IS-LM functions; three sector model; four sector model; inflation and Phillips curve; real business cycles and new Keynesian economics; monetary policy, fiscal stabilization policy; consumption hypothesis; absolute income hypothesis, permanent income hypothesis, life-cycle income hypothesis, relative income hypothesis, investment models; money supply and money demand.

ECON F244 Economics of Growth and Development 3 0 3

Economic growth and development; models of economic growth; harrod domar model, solow model, neoclassical models of economic growth, the Feldman model, Cambridge model of growth,models of technical progress, the problem of economic development; causes of underdevelopment, human development index, theories of economic development, classical and neoclassical theory of economic development, Rostow stages theory, balanced and unbalanced growth, the lewis theory of economic development, Big-push theory, Critical Minimum effort Hypothesis theory.

ECON F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

ECON F311 International Economics 3 0 3

The international economy; early trade theories; comparative advantage model; neo-classical trade theories; gains from trade; offer curves, terms of trade; Edge-worth box, factor endowments and the Heckscher-Ohlin model; alternative models of trade and intra-industry trade; the imitation-lag hypothesis; product cycle theory; international trade and economic growth; international trade policy; tariff, non-tariff trade barriers, economic integration, international trade and economic development, balance of payment accounting, foreign exchange markets and exchange rates, exchange rate determination, open economy macroeconomics; income and price adjustment mechanisms, adjustment policies, macroeconomic policy in open economy.

ECON F312 Money, Banking and Financial Markets 3 0 3

Overview of the financial system, interest rate and their role in valuation, fluctuation in interest rate, risk and term structure of interest rate, rational expectation and efficient market hypothesis, central banking and the conduct of monetary policy, money supply and credit creation, monetary transmission mechanisms, fundamentals of financial institutions, banking and management of financial institutions, commercial banking industry, risk management in financial institutions, credit risk, analysis of various financial and economic crisis.

ECON F313 Issues in Economic Development 3 0 3

Income and Growth; Facets of Underdevelopment; Structural Features; contemporary models of development and underdevelopment, poverty, inequality and development, population and economic development, urbanization and rural-urban migration, education and health in economic development, environment and economic development, trade and economic development, FDI and economic development, infrastructure and economic development. Sustainable development.

ECON F314 Industrial Economics 3 0 3

Economic analysis of the theory and practice of organization of firms and industries. Nature of competition among firms and their behaviour in various markets, with specific emphasis on imperfectly competitive markets. Tools for empirical and theoretical approaches to the analysis of industries. Issues related to price discrimination, vertical integration, advertising, research and development activities and entry and exit of firms. Government regulation of industries.

ECON F341 Public Finance Theory and Policy 3 0 3

Role of Government in modern economy, Theory of Public good and public choice; public goods and externalities, equity in distribution, Public Expenditure and Macro-economy: Determining optimal size of government, financing of public expenditure, debt versus tax financing, impact of public expenditure on the level and composition of output and employment, Government budget and cost benefit analysis, Taxation; Direct and Indirect taxes, efficiency and equity, tax incidence, models of taxation incidence, theory of optimal taxation, recent developments in theory of taxation, evolution of tax structures, tax evasion and avoidance, designing of modern tax system, reforms in direct and indirect taxes, value added tax, fiscal federalism, designing optimal government expenditure policy; Fiscal Policy Issues: Budget deficit and public debt, interdependence of fiscal and monetary policies, theory of inter-governmental transfers, theory and policy of

subsidies, theory of fiscal federalism, issues of equity and efficiency, role of planning and finance commission, goods and services tax in India, new direct tax code, role of central and state FRBMs.

ECON F342 Applied Econometrics 3 0 3

This course provides a introduction to advanced estimation and econometric techniques of analysis, with particular emphasis on how these techniques can be used for the empirical testing of economic theories and/or policy prescriptions. Topics to be studied include specification, estimation, and inference in the context of models that include then extend beyond the standard linear multiple regression framework. Multiple regression analysis; analysis of generalized linear and nonlinear models; instrumental variables; maximum likelihood, generalized method of moments (GMM), and two step estimation methods; simultaneous equation models; time series processes; identification and estimation of time series models; techniques for assessing model fit; forecasting; time series analysis and models of expectations; univariate time series analysis, stationary vs. non-stationary series; ARIMA, GARCH, VAR, cointegration, granger causality, error correction and limited dependent variable models; auto regressive distributed lagged variable models multivariate time series analysis; dynamic models; analysis of panel data, balanced and unbalanced panel data, mixed, fixed and random effect models.

ECON F343 Economic Analysis of Public Policy 3 0 3

This course deals with the contributions of economic analysis to public policy and governance. It focuses on evaluating the rationale for government intervention in the economy and evaluating the efficiency, incentive, and distributional effects of social and economic policies. Introduction to of economic analysis; economic tools in valuing outcomes; measuring outcomes in policies and programme; policy making; the market and the public policy, policy framework and regulation, market and government issues, distribution and policy analysis; applications in tax policies, welfare policies, government policies relating to contracting, health, education, labour and employment, energy policy, competition policy, gender, rural-urban development, food security, climate change, infrastructure policy, financial and trade policy.

ECON F344 Models in Operations Management 3 0 3

Project Management Tools and Techniques, Forecasting Techniques, Quality Management Tools, Facility layout and location models, inventory management, aggregate planning, and scheduling.

ECON F345 Behavioral Economics 3 0 3

Behavioral decision theory; perspective on psychology and economics; heuristics and biases; bounded rationality; classical expected utility model; choice under uncertainty (and certainty); probabilistic judgment; and inter-temporal choice; responses to games; analogous games.

ECON F351 Indian Economic Development 3 0 3

Indian Economic Development; Understanding the Indian Economy, Growth of GDP and Per Capita Income, Planning for the economy; plan models, Five Year Plans, Sectoral Aspects; Regional Variations, Economic Reforms, Monetary Policy, Nationalization of Banks, Financial Sector Reforms; Role of Central Banking in India. External Sector; Growth and structure of India's international trade; Balance of Payments, Import and Export Policies, India ,World Bank and IMF. Agricultural Policy; Land Reform, Agricultural Growth and Productivity, Irrigation; Green Revolution and After, Price Policy; Subsidies; Impact of WTO. Industrial Policy; Industrial Controls and Licensing, Productivity and Growth, Industrial Credit Industrial Sickness-Foreign Investment, Industrial Reforms, Investment, Regional Variations, Impact of WTO, Social Sectors, Health and Education, Poverty and Inequality in India, Human Development Indicators.

ECON F352 Management of Banks and Financial Institutions 3 0 3

Overview Of Banking Industry And Regulations; Critical Analysis Of Bank's Balance Sheet, Cost Of Funds Evaluation Of Bank Performance; Management Of Profit & Loss Accounts Of A Bank; Management Of Non-Interest & Non-Fund Income and Expenses; Assessment & Management of Risks; Interest Rate Risk, Credit Risk, Market Risk, Operational Risk, Liquidity Risk Etc., Basel Accords, Correspondent Banking; Mortgage And Asset-Backed Securities; Securitization, Innovation In Banking.

ECON F353 Energy Economics and Policy 3 0 3

Global Energy and Climate Policy; population and energy, energy intensity, energy crisis and alternate sources; understanding cost-benefit analysis, life-cycle cost analysis and pricing developments, analysing and managing risks; energy and environment, energy security and governance ; economics of changing role of crude oil, natural gas, coal, nuclear power and renewable power; global energy markets and the challenge of mitigating global climate change. Geopolitical dimensions of energy supply and demand, regulatory approaches to cutting greenhouse gases and building a low-carbon economy; future of energy scenario.

ECON F354 Derivatives and Risk Management 3 0 3

Overview of Financial Markets. Introduction to derivatives. Definition of future, forward, option and swap. Difference between various players of derivative market, their motives and types of position they can hold. Mechanics of future, option & swap markets. Hedging strategies. Option Pricing and understanding of various factors affecting option price. Calculations of Greeks. Introduction to interest rates, yield, term structure and forward rates. Mechanics of Bond Market. Review of concept of compounding and time value of money. Difference between floating rate and fixed income bonds. Price quotes and accrued interest. Pricing of Bonds. Computation of yield. Bond Price volatility. Duration, Modified Duration and convexity. Factors affecting Bond Yields and the Term Structure. Concept of Risk. Perspective of Risk from view point of individuals, companies & financial institutions. Commercial Banks and risks faced by them. Different types of Insurance and risk faced insurance companies. Introduction to various risks: Market Risk, Credit Risk, Operational Risk, Liquidity risk & Model Risk. Concept of Value at Risk.

ECON F355 Business Analysis and Valuation 3 0 3

Theory of finance, value maximization, stakeholder theory, and corporate objective function: value creation – ways and means, business analysis: The techniques of strategy and competitive analysis, value chain analysis for competitive advantages, business valuation – approaches and methods, the dark side of valuation: strategic investment decisions.

ECON F356 Strategic Financial Management 3 0 3

Company Value and the Manager's Mission: Introduction to Valuation, Why Value Value? The Value Manager, Cash Is King and Value-Based Management. Approach to Valuation - A Practitioner's Guide: Frameworks for Valuation. Valuation Methods: Discounted, Relative and Contingent Claim. Analyzing Historical Performance. Forecasting Performance. Estimation of Discount Rates. Estimation of Cash Flows. Estimation of Growth Rates. Valuation Models: Dividend-Discount Models, Free-Cash-Flow-To-Equity Discount Models, Free-Cash-Flow-to-firm Approach, Price / Earnings Ratio, Price/Book Value Ratio and Price/Sales Ratio. Measuring and Managing the Company Value: Company Value vs. Shareholders Wealth Maximization - TSR. Economic Value Added, Market Value Added and Cash Value Added. Wealth Creator by the Indian Corporates. Analyzing the Company Performance - Application of Balanced Scorecard (BSC). Applying Valuation: Multibusiness Valuation. Mergers, Acquisition , and Joint Ventures.

ECON F357 Management Control System 3 0 3

The nature of management control system, management control environment; understanding strategies, revenue and expense centers, profit centers, transfer pricing, measuring and controlling assets employed, The management control process; strategic planning, budget preparation, analyzing financial performance, performance measurement, management compensation, Variation in management control; controls for differentiated strategies, service organizations, multinational organizations,

management control projects.

ECON F366 Lab Project 3

ECON F367 Lab Project

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ECON F376 Design Project 3

ECON F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ECON F411 Project Appraisal 3 0 3

Criteria for selection of a project; factor intensity; commercial profitability; national economic-profitability; limitations of market prices; estimation of shadow prices; linkup project appraisal to national objectives; McGaughey and Thorbeck approach; Little-Mirrlees method; UNIDO guidelines approach; limitations of the conventional project appraisal; towards a new framework for project appraisal.

ECON F412 Security Analysis and Portfolio Management 3 0 3

Introduction to investment and securities; profile of financial assets; new issue market or primary market, initial public offerings (IPO); secondary market; framework of risk & return; fundamental analysis- economy, industry; company analysis; stock evaluation models; multiple holding period and multiple growth rate; bond analysis and bond management strategies; technical analysis; efficient market theory; portfolio management; Markowitz model; Sharpe's Single Index model; capital asset pricing model; financial derivatives-options & futures.

ECON F413 Financial Engineering 3 0 3

Introduction; Review of Markets, Players, and Conventions; Cash Flow Engineering with Forward Contracts; Engineering Simple Interest Rate Derivatives; Swap Engineering; Report Market Strategies; Dynamic Replication Methods and Synthetics; Mechanics of Options; Options Engineering with Applications; Pricing Tools; Applications of Fundamental Theorem of Finance; Fixed Income Engineering; Tools for Volatility Engineering: Volatility Swaps and Volatility Trading; Engineering of Equity Instruments: Pricing and Replication, computational methods such as Monte Carlo Simulation.

ECON F414 Creating and Leading Entrepreneurial Organizations 3 0 3

Fundamentals of entrepreneurship; entrepreneurship development in emerging markets; entrepreneurial leadership; creativity and business ideas; identifying business opportunities; legal aspects of business; entrepreneurship and intellectual property rights; business plans; marketing plan; operation and production plan; venture team and organizational plan; insights from financial statements; issues in raising finance; venture capitalist evaluation of business plans; launching a venture; corporate strategies for growth; people skills, Public issue; revival, exit and end to a venture.

ECON F415 New Venture Creation 3 0 3

Entrepreneurship as career option, idea to opportunity – market analysis and segmentation, presenting a pitch deck, building the startup team, industry and competition analysis, lean startups, product development, protection of intellectual property, sales and marketing, business models, financing options and strategies, launching a business, growth and exit strategy, social entrepreneurship, business plan presentation skills.

ECON F416 Regional Economics 3 0 3

Concept of a region; scope and method of regional economics; criteria for location of economic activities; regional economic structure; measurement of regional economic activity; interregional theory of income and trade; regional economic growth and its impact on regional structure; public policy.

ECON F418 Quantitative Analysis of International Trade 3 0 3

Global trade and empirical facts of International trade, Nature of Globalization process and benefits and costs associated with it, Theory and empirical testing of trade theories, Alternative trade theories and their empirical tests, Gains from trade and the impact of trade on income distribution, Instruments of trade policy and welfare effects, International factor movements and the impact and spillover effects of FDI and portfolio investments, Different forms of Economic integration and their benefits and costs, Technology and growth, International Technology Transfer, Exchange rate and balance of payments, Trade policy simulation using software, WTP Negotiations

ECON F419 Advanced Microeconomics 3 0 3

Household behaviour and consumer choice; firm's Behaviour; Partial equilibrium analysis; Imperfect competition models; Price discrimination strategies; General equilibrium analysis: with and without production; Linear Programming and input-output analysis; Asymmetric information issues in economics; Modern welfare criteria; Arrow's impossibility theorem; Elements of welfare economics.

Pre-requisites: ECON F242 Microeconomics

ECON F420 Applied Macroeconometrics 3 0 3

Macroeconomic data; Basic Time Series Concepts; Time series aggregation and Cycles; Univariate Time Series Models; Multivariate Time Series Models - VAR models, Granger Causality, Impulse Response Function, Cointegration, and Vector Error-Correction Models; Panel Data Methods; Macro-models - Dynamic Stochastic General Equilibrium Models (DSGE), Real Business Cycle (RBC) Model, Heterogeneous Agent Models, Monetary Models.

ECON F422 Functions and Working of Stock Exchanges 3 0 3

Overview of financial markets and instruments; stock exchanges in India; trading and settlement procedures; listing; risk management; primary markets; debt markets; indices; mutual funds; derivatives; exchange traded funds; corporate governance; SEBI and regulation of the markets; important events in the stock markets; market microstructure; empirical studies on the Indian markets.

ECON F471 Resources and Environmental Economics 3 0 3

Introduction to Environmental Economics; Economy-Environment interaction; Environment vs. Development, Environmental Kuznet's curve, Economics of Exhaustible Resources; Solow-Harwick's Rule; Market structure and optimal extraction policy; Uncertainty and the rate of resource extraction; Resource scarcity, Economics of Renewable Resources ; Economics of Biodiversity, The Theory of Externality and Public Goods ; Concepts; Market Failure; Pigouvian Solution; Buchanan's Theory; Coase's theorem and its critique; Pigouvian vs. Coasian solution; Detrimental externality and non convexities in the production set; Property rights; Collective action, Techniques of Valuation; Physical linkage methods; Abatement cost methods; Behavior linkage methods; Social cost benefit analysis, Environmental impact assessment.

ECON F491 Special Projects 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

ECON G511 Dynamic Modeling and Control of National Economies **5**

ECON G521 Modern Cost Engineering **5**

Course description for the above courses are to be developed.

ECON G531 Theory of Macroeconomic Policy **5**

This course focuses on macroeconomic policy as the major application of the theoretical material and also considers the implications of macroeconomic events for asset price determination, management, decisions, social problems and personal employment and retirement planning.

Topics to be covered are: the foundations of aggregate supply and demand: use of AD-AS model; the business cycle; applications in the areas of asset market, management decisions, social problems, etc.

ECON G541 Economic Systems Analysis **5**

Course description is to be developed.

ECON G542 Accounting Theory and Empirical Research **4**

Introduction; Association between returns and earnings; Earnings response coefficients; Earnings announcements; Earnings and the variance of returns; Earnings and the volume of trade; Market Efficiency (Post-Earnings Announcement Drift); Earnings and Prices/Returns – Theory; Cash versus Accruals; Accounting Measurement and Value Relevance; Voluntary Disclosures; Disclosure Level and the Cost of Equity; Accounting Choice and Equity Contracts; Accounting Choice and Debt Contracts; Accounting Choice and Political Costs; Modelling Discretionary Accruals; Adoption of IFRS; Process of conducting empirical accounting research.

ECON G543 Advanced Corporate Finance **4**

Information asymmetry and agency problem; Investment at the Firm Level; Corporate Cash Holdings; Corporate Financial Policy and the Value of Cash; Corporate Cash Reserves and Acquisitions; Within Firm Capital Allocation; Corporate Diversification and Firm Value; Corporate Restructuring; Mergers & Acquisitions; Leveraged Buyouts, Spin offs and Divestitures; Corporate Governance; Introduction to Behavioral Finance; Managerial Optimism; CEO Overconfidence.

ECON G544 Empirical Asset Pricing **4**

Preliminaries: Background and Statistics of Asset Pricing; Pricing Tests and Market Efficiency; Cross-Sectional and Time-Series Asset Pricing Test; Market Efficiency, Inefficiency, and Limits to Arbitrage; Return Predictability and Performance Evaluation; Evaluating Portfolio Managers; Alphas and Betas; Value & Momentum; New Directions in Empirical Asset Pricing; Robustness of Anomalies; Other Asset Markets; The Financial Crisis and the Future of Quantitative Investing; Trading and Liquidity; Algorithmic and High-Frequency Trading.

ECON G545 Financial Economics **4**

Decision making under uncertainty; Expected utility representations; Risk aversion and insurance premium; Stochastic dominance; Mean variance portfolio analysis; Characterization of minimum variance portfolio and its properties; Case of riskless asset; Asset pricing models; Capital asset pricing model; Arbitrage pricing theory; Intertemporal consumption and equity premium puzzle; Market efficiency and its critique; Forms of efficiency and tests of efficiency; Anomalies and noise trader model.

ECON G546 Topics in Econometrics **4**

Introduction; Fundamentals of Randomization Inference: The basic problem of causal analysis; Potential outcomes causal model; Approaches to identification: Randomized trials; Selection on observable; Difference-in-Differences; Two way fixed effects with differential timing; Synthetic control methods; Matching and subclassification: Exact matching and approximate matching Instrumental variables; Homogeneous treatment effects; Two-stage least squares; Weak instruments; Heterogeneous treatment effects; Identification; Estimation; Placebo checks; Interpretation; External validity; Quantile regression for causal analysis; Quantile regression with exogenous repressors and instrument variable strategies with quantile regression; Regression discontinuity design; Sharp regression discontinuity design and fuzzy regression discontinuity design; Identification; Estimation; Falsification checks; Multiple cut-offs; Multiple running variables; External validity; Regression kink designs.

ECON G547 Topics in Macroeconomics **4**

Equilibrium output and models of employment & wages; The quantity theory of money; The classical theory of the interest rate; Fiscal and Monetary Policy implications of the Classical equilibrium model; Models of income determination; Components of aggregate demand; Consumption theory; Investment theory; Determination of rate of interest; The IS-LM model in a closed and open economy; Policy effect of IS-LM model in closed and open economy; The AD-AS model; Monetarist model; Models of inflation, output and unemployment; Rational Expectations and New Classical Macroeconomics; Real Business Cycle theory (Real Business Cycle and Inter-temporal substitution of labor, Technology Shock, Neutrality of money and flexibility of wages and prices, Real Business cycle view on great depression); New Keynesian Theory (Imperfect competition and price setting, Menu cost models, implicit wage contract theory, efficiency wage theory, Insider-Outsider model); The Solow growth model; Infinite-horizon and Overlapping generation model (The Ramsey-CassKoopman Model, The diamond model); Endogenous growth model; Optimal Macroeconomic Policy; Financial Frictions; House Prices; Unconventional Monetary Policy; Pandemic and Macroeconomic Policy.

ECON G548 Topics in Mathematical Economics **4**

Metric Spaces; Set properties- compactness, convexity, connected; Equivalence relations of a set; Functions- concave, convex, quasiconcave, homogeneity, homotheticity; Economic applications and implications of these; Fixed point theorems and applications; Geometry of matrices; Quadratic forms; Solutions to system of equations; Partitioned matrices; Characteristic roots and vectors; Vector and matrix differentiation; Definiteness of matrices; Generalized eigenvalues and eigenvectors; Applications of linear independence; Input-Output matrices; Static Optimisation- constraint and unconstrained optimization, Equality constraints, Inequality constraints, Kuhn-Tucker theorem, Concave Programming without differentiability, Multipliers, Value functions, Comparative statics; Dynamic Optimisation- Autonomous systems- asymptotic behavior, steady states and stability, calculus of variations, Bellman's equation, Optimal control theory, Discounting, Phase diagram, Multi-period optimal investment models, Multi-period optimal consumption models.

ECON G549 Topics in Microeconomics **4**

Preferences & Utility; Intertemporal Consumption Analysis; Welfare Analysis; Empirical Issues; Behavioural Developments; Modelling Household Behaviour; Uncertainty and Risk; Modelling Risk Aversion; Anomalies and Way Forward; Financial Markets; Firm's Behaviour; Pricing Theory; General Equilibrium; Welfare Theorems; Comparative Analysis of Different Market Structures; Externality; Public Goods; Coase Theorem; Endowment Effects; Adverse Selection and Moral Hazard; Asymmetric Information Issues in Banking Sector; Asymmetric Information Issues in Policy Implementation; Auctions.

Electronics and Computer Engineering

ECOM F211 Data Structures & Algorithms **3 1 4**

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Recursive Data Types, Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues); Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, Quick Sort and Randomization), Lower Bound on Complexity of Sorting Algorithms. Unordered Collections: Hash tables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Probabilistic/Randomized Data Structures (such as Bloom Filters and Splay Trees). Generalized Trees – Traversals and applications. Text Processing – Basic

Algorithms and Data Structures (e.g. Tries, Huffman Coding, String search / pattern matching). External Memory Data structures (B-Trees and variants). Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees).

Equivalent: CS F211 & IS F211: Data Structures & Algorithms

ECOM F213 Object Oriented Programming 3 1 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; overloading and overriding; static and dynamic binding; multithreaded programming; event handling and exception handling; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object-oriented programming languages. Object Oriented Design Patterns: Behavioural, Structural and Creational.

Equivalent: CS F213 & IS F213: Object Oriented Programming

ECOM F214 Electronic Devices 3 0 3

Crystal structure and growth of semiconductor, electrical conduction in solids, Elementary quantum physics (Photoelectric effect, uncertainty principle, Schrodinger wave equation and tunneling), energy bands in solids, charge carriers in semiconductors, excess carriers in semiconductors, Fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, metal-semiconductor junctions Bipolar junction transistors, field effect transistors (JFET, HEMT, MOSFET), Special diodes (varactor diode, solar cell, LEDs, Tunnel diode and HBT), dielectric materials and insulation (Polarization mechanisms, frequency dependence, dielectric strength and insulation breakdown).

Equivalent: EEE F214, INSTR F214 &ECE F214 : Electronic Devices

ECOM F215 Digital Design 3 1 4

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits ; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

Equivalent: CS F215, ECE F215, EEE F215 & INSTR F215: Digital Design

ECOM F222 Discrete Structures for Computer Science 3 0 3

Sets & operation on sets; relations & equivalence relations; number theory; weak & strong form of mathematical induction; principle of inclusion & exclusion, pigeonhole principle; recurrence relations & generating functions; digraphs & graphs, graph isomorphism & sub-graphs, spanning trees, Euler & Hamiltonian graphs, planar graphs, chromatic numbers & graph coloring; groups; Lagrange theorem finite groups; Rings & Fields.

Equivalent: CS F222 & IS F222: Discrete structures for Computer Science

ECOM F241 Microprocessors and Interfacing 3 1 4

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams ; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system. This course will have laboratory component.

Equivalent: CS F241, ECE F241, EEE F241 & INSTR F241: Microprocessors and Interfacing

ECOM F242 Control Systems 3 0 3

Modeling and classification of dynamical systems, Properties and advantages of feedback systems, time-domain analysis, frequency-domain analysis, stability and performance analysis, State space analysis, controller design.

Equivalent: ECE F242, EEE F242 & INSTR F242: Control Systems

ECOM F243 Signals and Systems 3 0 3

This course is intended to provide a comprehensive coverage of Signals and Systems, a fundamental subject of Electrical Engineering. The topics covered are: Continuous-time and discrete time signals and systems, convolution, properties of linear time-invariant (LTI) systems, Fourier series, Fourier transform, Z transform, Laplace transform; System analysis, frequency response, analog filters, Sampling and reconstruction.

Equivalent: ECE F243, EEE F243 & INSTR F243: Signals and Systems

ECOM F244 Microelectronic Circuits 3 0 3

Basic microelectronic circuit analysis and design, biasing in discrete and integrated circuit amplifiers, an overview of modeling of microelectronic devices single and two transistor amplifier configurations with passive and active loads; current mirrors & current sources; single-ended and differential linear amplifiers , differential and multistage amplifiers; 2 stage CMOS OPAMP, frequency response of amplifiers; negative feedback in amplifiers, R-C frequency compensation.

Equivalent: ECE F244, EEE F244 & INSTR F244: Microelectronic Circuits

ECOM F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

ECOM F313 Analog & Digital VLSI Design 3 0 3

Moore's Law, Y chart, MOS device models including Deep Sub-Micron effects; an overview of fabrication of CMOS circuits, parasitic capacitances, MOS scaling techniques, latch up, matching issues, common centroid geometries in layout. Digital circuit design styles for logic, arithmetic and sequential blocks design; device sizing using logical effort; timing issues (clock skew and jitter) and clock distribution techniques; estimation and minimization of energy consumption; Power delay trade-off, interconnect modelling; memory architectures, memory circuits design, sense amplifiers; an overview of testing of integrated circuits. Basic and cascaded NMOS/PMOS/CMOS gain stages, Differential amplifier and advanced OPAMP design , matching of devices, mismatch analysis, CMRR, PSRR and slew rate issues, offset voltage , advanced current mirrors; current and voltage references design, common mode feedback circuits, Frequency response, stabilty and noise issues in amplifiers; frequency compensation techniques.

Equivalent: EEE F313 & INSTR F313: Analog & Digital VLSI Design

ECOM F321 Real Time Operating Systems 3 1 4

Introduction to Real-Time Systems, Overview of General Purpose Operating Systems, Real-Time Systems – Hardware Components, Real-Time Operating Systems, Task Scheduling for RTOS, Resource Sharing and Access Control in RTOS, Concurrent Programming in RTOS, Fault Tolerance in Real Time Operating Systems.

Pre-requisites: CS F111: Computer Programming

ECOM F342 Computer Architecture 3 1 4

Processor performance criteria, performance benchmarks, arithmetic circuits, CPU design - instruction set architecture, instruction execution, Single and Multicycle implementation, Pipeline design, Hazards, methods of overcoming hazards, Branch prediction, Memory subsystems including cache optimization, Instruction level Parallelism.

Equivalent: CS F342: Computer Architecture

ECOM F343 Communication Networks 3 0 3

Packet switching and circuit switching; layered network architecture (OSI model), point-to-point protocols and links: physical layer, error detection and correction, ARQ retransmission strategy, framing, X.25 standard, queueing theory and delay analysis: Little's theorem, analytical treatment of M/M/1 and M/M/m queuing

systems, simulation of queueing systems, delay analysis for ARQ system, multi-access protocols and techniques: Aloha systems, CSMA, IEEE-802 standards, routing and flow control. TCP/ IP protocols, ISDN, ATM, network security, design of a LAN system with commercially available functional units. Wireless LAN: adhoc network, security issues.

Equivalent: ECE F343: Communication Networks

ECOM F366 Lab Project **3**

ECOM 367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ECOM F376 Design Project **3**

ECOM F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ECOM F462 Network Programming **3 0 3**

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

Equivalent: IS F462: Network Programming

ECOM F491 Special Project **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

Environmental Engineering

EE G501 Environmental Sampling and Analytical Methods **3 2 5**

Principles of sample collection and data analysis / interpretation, Gravimetric methods, titrimetric methods, electrochemical methods, Spectrometric methods of analysis, Chromatographic methods of analysis, Sampling techniques for air and water pollution, Biological methods of analysis, Interpretation of data in environmental monitoring

EE G502 Water and Wastewater Treatment Systems **3 2 5**

Introduction to water management. Water quality Management and; Assessment: Water and wastewater sources and characteristics, Water quality and effluent standards, Issues related to water supply and disposal of wastewater, General considerations for the source of water for different beneficial uses. Fundamentals of water and wastewater treatment: Water and wastewater collection systems. Considerations for the layout of the treatment plant. Unit operations in water and wastewater treatment plants. Design criteria for units in water and wastewater treatment plants: preliminary, primary, secondary and tertiary treatment units. Household and Small-scale Treatment Systems. Construction and operation of water and wastewater treatment plants. Sustainability Principles in Water Management.

EE G503 Environmental Systems Modelling **3 2 5**

Introduction to air quality models, Atmospheric stability and turbulence, Gaussian dispersion models, single source and multi-source models, Transport and fate of pollutant in aquatic systems, Introduction to modeling of river, lake and estuarine hydrodynamics, Stratification and eutrophication of water bodies, Dissolved oxygen model for water streams, Computational methods in environmental modeling and simulation, Transport and fate of pollutants in soils and ground water, Applications of public domain models and software; Case studies.

EE G504 Physico Chemical Treatment Principles and Design of Wastewater Treatment Systems **3 2 5**

Pollutant classification, Source selection process, Selection of treatment chain, Plant siting, Physical treatment methods like screening, sedimentation, filteration, etc., Chemical treatment principles like precipitation, coagulation, ozonation etc., adsorption, Novel processes like membranes, electrodialysis, etc., Design of physico-chemical systems for wastewater treatment, Case studies.

EE G505 Biological Treatment Principles and Design of Wastewater Treatment Systems **3 2 5**

Fundamentals of biological treatment, Biochemistry and kinetics of biochemical processes like oxidation, nitrification & denitirification, Dephosphatization, Acedogensis and methogenasis, Aerobic and anaerobic treatment processes, Basic description of equipment and design methodologies, Design of reactors and configurations; Case studies for industrial and wastewater treatment.

EE G506 Environmental Statistics **3 2 5**

Introduction to probability and Statistics, Probability concepts and probability distributions, Fundamentals of data analysis, Uncertainty in Measurement, Precision and accuracy, Reproducibility/repeatability, Types of errors, Error propagation, Confidence intervals, Hypothesis testing for equality of mean and standard deviation: t-test, chi-square test and F-test, Errors in hypothesis testing, Experiment design and analysis of variances, Autocorrelation, crosscorrelation and sensitivity analysis in data sets, Linear leastsquares regression. Precision of parameter estimates, Coefficient of determination; Interpreting statistical results, documentation and recommendations, Theory of attributes, Time series analysis, Case studies.

EE G507 Industrial Pollution Abatement **5***

Different types of wastes generated in an industry, their effects on living and non-living things; environmental regulatory legislations and standards and climate changes; quantification and analysis of wastewater and treatment; different unit operations and unit processes involved in conversion of highly polluted water to potable standards; atmospheric dispersion of air pollutants, and operating principles, design calculations of particulate control devices; analysis and quantification of hazardous and non-hazardous solid wastes, treatment and disposal.

EE G508 Urban Water Management **5***

The urban water cycle (description, social imperatives, environmental considerations, and economic challenges); water supply (availability, service levels, and technical options); free basic water, demand management, loss control, use of recycled water; sewage (public health considerations, service levels and technical options, the dryversus-wet sanitation debate, social acceptance, and grey water management); drainage (service levels and technical options, sustainable urban drainage systems (SUDS), urban litter management, urban rivers, risk management, and groundwater issues); management (water sensitive urban design, introduction to asset management, GIS as a water management tool, and sustainability indicators).

EE G601 Energy Generation and Management in Waste Treatment Plants **3 2 5**

Energy audit and minimization in waste treatment facilities; Novel energy conservation technologies, Estimation of energy potential of waste; Selection of energy generation technologies coupled with waste treatment, e.g. incinerators, pyrolysis units, bio-digesters and purification and enrichment of off gases from these units; Utilization of fuel &fertilizer value of gases & liquids from bio-digesters and pyrolysis units; Energy generation from waste sludge.

EE G602 Environmental Remote Sensing and GIS **3 2 5**

Principles of remote sensing, Components of GIS: Hardware,

Software and Organization Context, Types of Maps; Spatial and Non Spatial, Types of Projections, Editing the Raster and Vector data structures, Analysis using raster and Vector Data, Data Retrieval, Data Reclassification, Data Overlaying and Buffering; Data Output; Pollution data gathering in GIS area under consideration through terrestrial and aerial stations, unmanned aerial vehicles (UAV) equipped with imaging and spectroscopic probes; Pollution mapping coupled to GIS through wireless network; Water body pollution monitoring instruments coupled to GIS through wireless network, Thermal and microwave remote sensing, Space imaging, Case studies on various applications of GIS for environmental management.

EE G603 Air Pollution Control Technologies 3 2 5

Introduction to air pollution, Atmospheric diffusion of air pollutants, Particulate control, Gaseous pollutant control, Methods for monitoring and control, Selection and design of control equipments, Meteorological aspects of air pollution, Applications and case studies.

EE G604 Solid Waste Management 3 2 5

Introduction to solid waste management: Sources and classification, Composition and Properties of Solid Waste and emerging e-waste, Onsite handling, storage and processing including segregation, Collection of solid waste, Transfer and transport, Recycling, Incineration pyrolysis and composting, Processing technique and equipment, Recovery of resources, conversion products, and energy, Biomedical and hazardous waste, Electronic waste, Regulatory framework, categorization, generation, collection, transport, treatment and disposal, Leacheate collection and treatment, Bioleaching and bioremediation; Case studies.

EE G605 Environmental Process Engineering 3 2 5

Origin, Nature and composition of solid, liquid and gaseous emissions from various processes in Industries, institutions and human habitats, Assessment of pollution potential through study of process chemistry and process engineering, Understanding block flow diagrams (BFD), Process Flow Diagrams (PFD) and Piping and Instrumentation Diagram (P&ID) and Process Pollution Flow Diagram (PPFD), Maximum Attainable Control Technologies (MACT) and Best Available Control Technologies (BACT), Reasonably Available Control Technology (RACT) and Lowest Attainable Emission Rate (LAER), List of equipment and processes for BACT/RACT/LAER and their description, Estimating thermophysical and thermodynamic data for pollutants, Use of software in Environmental Process Engineering Equipment design and datasheet generation, Technical audit of Existing process technology, Environmental carrying capacity calculations; Interpretation of field/on-site and laboratory data, Case studies.

EE G606 Environmental Impact and Risk Assessment 3 2 5

Introduction to Environmental Impact Assessment (EIA), Environmental assessment framework, Impact assessment methodologies; Air and water quality Impact analysis (AQIA / WQIA), Energy and noise impact analysis (EnIA / NIA), Vegetation, wild life and socio-impact analysis, Environment risk assessment, Environmental Impact statement.

Electrical and Electronics Engineering

EEE F111 Electrical Sciences 3 0 3

Course covers basic passive circuit elements, dependent and independent sources, network theorems, circuit analysis techniques and response of first and second order circuits. Introduction to three - phase circuits, magnetic circuits, transformers, basics of rotating machines. Semiconductors - operation of diodes, zener diodes, bipolar junction transistors and field effect transistors. Biasing techniques and applications of diodes and transistors. Introduction to operational amplifiers and applications. Introduction to Digital Electronics.

EEE F211 Electrical Machines 3 1 4

Transformer: Constructional features, equivalent circuit and phasor diagram - regulation and efficiency, parallel operation. Three phase transformer connections; Harmonic in transformers; Testing; Phase conversion; Autotransformer. D.C Machines: Construction, armature windings, armature voltage and torque equations, classification. D.C generators, performance characteristics; D.C motors - torque/speed characteristics, speed control and braking. Testing and efficiency. Induction machines: Constructional features and rotating magnetic field. Circuit model and phasor diagram.

Steady state characteristics. Testing, starting and speed control. Time harmonics and space harmonics. Wound rotor induction motors, Single phase induction motors - classification and equivalent circuit. Synchronous machines: Constructional features; synchronous generators and motors; equivalent circuit and phasor diagram; power and torque characteristics and capability curves. Parallel operation. Salient pole synchronous machine - phasor diagram and determination of synchronous reactances; starting and speed control of synchronous motors. Special machines- universal motors, Induction generators.

EEE F212 Electromagnetic Theory 3 0 3

Review of mathematics - scalar and vector fields, calculus of scalar and vector fields in Cartesian and curvilinear coordinates, Dirac delta function; Electrostatics - electric field, divergence & curl of electric field, electric potential, work and energy in electrostatics, conductors, electric dipole; Electrostatics in Matter - polarization and field of a polarized object, electric displacement, linear dielectrics; Magnetostatics - Lorentz force law, Biot-Savart law, divergence & curl of magnetic field, magnetic vector potential, magnetic dipole; Magnetostatics in matter - magnetization and field of a magnetized object, the H-field, linear & non-linear magnetic media; Electrodynamics - electromotive force, electromagnetic induction, Maxwell's equations in free space, plane wave solutions of Maxwell's equations in free space.

EEE F214 Electronic Devices 3 0 3

Crystal structure and growth of semiconductor, electrical conduction in solids, Elementary quantum physics (Photoelectric effect, uncertainty principle, Schrodinger wave equation and tunneling), energy bands in solids, charge carriers in semiconductors, excess carriers in semiconductors, Fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, metal-semiconductor junctions Bipolar junction transistors, field effect transistors (JFET, HEMT, MOSFET), Special diodes (varactor diode, solar cell, LEDs, Tunnel diode and HBT), dielectric materials and insulation (Polarization mechanisms, frequency dependence, dielectric strength and insulation breakdown).

EEE F215 Digital Design 3 1 4

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits ; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

EEE F216 Electronic Devices Simulation Laboratory 0 2 2

Hands on simulation experience of Electronic Devices (Diodes, BJTs, MOSFET and MOS Capacitor) using Sentarus TCAD; Simulation of electrostatics of various Electronic Devices and their effects on the device performance.

Pre-requisites:

EEE F214 / INSTR F214 / ECE F214 : Electronic Devices

EEE F241 Microprocessors and Interfacing 3 1 4

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams ; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system. This course will have laboratory component.

EEE F242 Control Systems 3 0 3

Modeling and classification of dynamical systems, Properties and advantages of feedback systems, time-domain analysis, frequency-domain analysis, stability and performance analysis, State space analysis, controller design.

EEE F243 Signals & Systems 3 0 3

This course is intended to provide a comprehensive coverage of Signals and Systems, a fundamental subject of Electrical Engi-

neering. The topics covered are: Continuous-time and discrete time signals and systems, convolution, properties of linear time-invariant (LTI) systems, Fourier series, Fourier transform, Z transform, Laplace transform; System analysis, frequency response, analog filters, Sampling and reconstruction.

EEE F244 Microelectronic Circuits 3 0 3

Basic microelectronic circuit analysis and design, biasing in discrete and integrated circuit amplifiers, an overview of modeling of microelectronic devices single and two transistor amplifier configurations with passive and active loads; current mirrors & current sources; single-ended and differential linear amplifiers , differential and multistage amplifiers; 2 stage CMOS OPAMP, frequency response of amplifiers; negative feedback in amplifiers, R-C frequency compensation.

EEE F245 Control System Laboratory 0 1 1

Experiments and simulations on concepts related to conventional and advanced control systems.

EEE F246 Electrical and Electronic Circuits Laboratory 0 2 2

Experiments in Electrical sciences, Electronic devices, motors, transformer windings, machine windings, electronic circuits and signals, systems etc.

EEE F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

EEE F311 Communication Systems 3 1 4

Analysis and design of communication systems; analog and digital modulation and demodulation, frequency conversion, multiplexing, noise and distortion; spectral and signal-to-noise ratio analysis, probability of error in digital systems, spread spectrum.Introduction to the basic principles of the design and analysis of modern digital communication systems. Topics include source coding, channel coding, baseband and passband modulation techniques, receiver design, and channel equalization.

EEE F312 Power Systems 3 0 3

Review and importance of power system, Present power system scenario, Transmission line parameters and modeling, Characteristics and performance of lines, Load flow studies, Optimal system operation, Automatic Generation and voltage Control, Power system fault analysis, Power Systems stability, Introduction of power system protection, Introduction of HVDC Transmission.

EEE F313 Analog & Digital VLSI Design 3 0 3

Moore's Law, Y chart, MOS device models including Deep Sub-Micron effects; an overview of fabrication of CMOS circuits, parasitic capacitances, MOS scaling techniques, latch up, matching issues, common centroid geometries in layout. Digital circuit design styles for logic, arithmetic and sequential blocks design; device sizing using logical effort; timing issues (clock skew and jitter) and clock distribution techniques; estimation and minimization of energy consumption; Power delay trade-off, interconnect modelling; memory architectures, memory circuits design, sense amplifiers; an overview of testing of integrated circuits. Basic and cascaded NMOS/PMOS/CMOS gain stages, Differential amplifier and advanced OPAMP design , matching of devices, mismatch analysis, CMRR, PSRR and slew rate issues, offset voltage , advanced current mirrors; current and voltage references design, common mode feedback circuits, Frequency response, stabilty and noise issues in amplifiers; frequency compensation techniques.

EEE F341 Analog Electronics 3 1 4

Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short; Analysis of simple operational amplifier circuits; Effects of real operational amplifier parameters on circuit performance . Linear applications of operational amplifiers: Instrumentation and Isolation amplifiers; Current and voltage sources; Active filters. Non-linear applications of operational amplifiers: Comparators,; Linearization amplifiers; Logarithmic amplifiers, multifunction modules & circuits, true rms convertors, Precision and signal conditioning circuits, Waveform Generation: sinusoidal and non-sinusoidal signal generation; Wave shape converters. Timer 555 based circuits, Phase lock loop circuits & applications, IC regulators, Output stage and large signal amplifiers, Power amplifiers, Tuned amplifiers, Analog and Digital interface circuits: A/D, D/A Converters.

EEE F342 Power Electronics 3 1 4

Need for power conversion; Power electronic converters: classifications and scope; Power semiconductor switches: diodes, SCR , GTO and transistors (BJT, MOSFET and IGBT): Ratings, static and dynamic characteristics, drive and switching aid circuits and cooling; DC to DC conversion: Buck, Boost and Buck-Boost converters: circuit configuration and analysis with different kinds of loads; Choppers: single quadrant and two quadrant operation with DC motor load and steady state analysis; Rectifiers: single phase and three phase operation, power factor, harmonics and effect of source inductance; Dual converters; Drive concept: Four quadrant drive and load characteristics, selection of motor, control and stability of electric drives, feed back control of drives; DC motor drive; Inverters: single phase and three phase bridge inverters and PWM inverters; Single phase AC voltage regulators and cycloconverter; Induction motor drive - Variable frequency operation of 3-phase induction motor, stator voltage control and V/f control methods; Non-drive application of power electronic converters: UPS, active power line conditioner, electronic ballast and induction.

EEE F345 Power Apparatus & Networks 3 0 3

Essential fundamentals of power networks: overview of power systems and changing landscape; sources of electrical energy and environmental consequences; the Indian power industry; fundamental principles of power networks; magnetic prerequisites. Apparatus in power networks: transformers; synchronous generators; transmission lines, cables, HVDC; loads and power quality. Analysis and operation: power flow; rotor angle and voltage stability; control of large interconnected power networks. Protection: fault calculations, relay co-ordination and circuit breakers; transient overvoltages, protection by surge arrestors, and insulation co-ordination. Management of vertical utilities, utility deregulation and open access: operational economics of the power industry, privatization; deregulation and energy markets.

EEE F346 Data Communication Networks 2 0 2

Communication Concepts; Data and Voice Communications; Hardware Systems and Configurations; Network Topologies and Design Aspects; Protocols; Networking Software; Local Area Networks; Network Security and Management; Emerging Trends in Communications.

EEE F347 Communication Networks Laboratory 0 2 2

Experiments on analytical studies of communication networks through network simulation, analysis of network performance, LANs, Cellular or Satellite networks, Wireless Adhoc or Sensor Networks, Wi-Fi and WIMAX networks, information theory and coding etc.

EEE F348 FPGA Based System Design Laboratory 0 2 2

Introduction to Field Programmable Gate Arrays, Overview of FPGA design tools, Implementation of Data Flow Graph in FPGA, Analysis of performance tradeoffs (Pipelining, Retiming, Unfolding), Bus protocols (SPI, I2C), FPGA based DSP System Design , ADC/DAC interface, Real time signal processing system design.

EEE F366 Lab Project 3

EEE F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

EEE F376 Design Project 3

EEE F377 Design Project 3

These courses are intended to impart training in design of prod-

uct/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

EEE F411 Internet of Things 3 1 4

Introduction to IoT, Sensors and Actuators for IoT,Programming IoT end points, Communications andnetworking in IoT, Data management in IoT, Securityissues in IoT, Emerging technologies.

EEE F414 Telecommunication Switching Systems & Networks 3 0 3

Intoduction, electromechanical switching, pulse dialing and DTMF dialing, stored program control, space division switching, speech digitization and transmission, time division switching, fundamentals of traffic engineering, telephone networks, signaling, data networks, layered architecture and protocols, LANs, packet switching networks, TCP/IP, ISDN, ATM networks.

EEE F416 Digital Communication 3 0 3

Introduction, the modeling and characterization of information sources, algorithms for source coding and encoding of analog output sources; Information transmission through AWGN channels using digital modulation methods and BER estimation; Digital communication through band limited Gaussian noise channels; channel coding and decoding; Wireless communication channels: its characterization and modulation schemes for such channels; emerging trends in the above field.

EEE F417 Computer Based Control Systems 3 0 3

Introduction to process control and Computer based control, elements of computer based control loop, digital sensors and their applications, field buses and specifications, types of digital and intelligent controllers, types of industrial control valves and their selections, PID vs Fuzzy and Neural Techniques of control, programmable logic controllers, SCADA and its applications, distributed ontrol systems comparison between PLC, DCS, Fuzzy. ANN, industrial network hierarchy, industrial standards for networking, application of PLC in power system and process industries.

EEE F418 Modern Communication Technologies 3 0 3

Modern communication systems overview, Digital modulation techniques, Channel capacity and coding, Digital link improve techniques, Digital receiver design and performance analysis, Wireless communication systems: wireless channel models and link improvement techniques, multiple access schemes. Basic concept of mobile network, Optical Communication Systems: Transmitters, receivers and other optical Communication subsystem, Optical wireless systems.

EEE F419 Flexible and Stretchable Electronics 3 1 4

Introduction to flexible and stretchable electronics (FSE), material systems and scaling issues; materials and substrates for flexible and printed electronics, Material Considerations and various properties, techniques for fabrication and characterization of FSE devices, mechanics of thin-films and flexible devices, various flexible and stretchable devices: solar cells, displays, thin-film transistors, sensors, artificial skin and actuators; human-machine interfaces, wearable electronics for emerging applications.

Pre-requisite: EEE/INSTR/ECE F214: Electronic Devices

EEE F420 Biomedical Signal Processing 3 1 4

Introduction to biomedical signals and images, fundamental and advanced filtering techniques for artifacts removal, event detection, feature extraction of the biomedical signals, Homophorphic filtering, modeling biomedical signals and systems using pole-zero modeling and all-pole modeling, cochlear signal processing, deep learning and stochastic decision-making approach for diagnostic decisions, various case studies of biomedical signals for artifact removal and event detection will be discussed.

Pre-requisite: EEE F434 or ECE F434 : Digital Signal Processing

EEE F422 Modern Control Systems 3 0 3

State variable characterization of linear continuous - time and discrete - time systems, controllability, observability, stability; sampled data systems; Z transforms; non-linear systems; phase plane and describing function methods; calculus of variations; optimal control.

EEE F423 Electronic Material Design and Simulations Laboratory 1 2 3

Reviewing the basic Theory for Crystalline Solids (Crystal group, real Space, reciprocal space), Introduction of the Concept of Density Functional Theory (Many Electron Scenario, Born-Oppenheimer Approximation, Hartree's Formulation, Hohenberg and Kohn Theorems, Energy Functional, Kohn Sham Scheme), Familiarization with Quantum Espresso (Plane Wave Basis Set, Exchange Correlation Functional, Pseudopotential, Brillouin Zone Sampling, Quantum Espresso input file format), Theoretical Calculation of Structural Properties of Materials (Unit Cells and Super Cells, Lattice Vectors, Ground-state Energy, Bond-Length and Bond Angles), Theoretical Calculation of Electronic Properties of Materials (Energy Band Profiles and Density of States, Projected Density of States), Theoretical Calculation of Optical Properties of Materials (Optical Spectrum), Introduction of Doping in Materials (Effects on Electronic and Optical Properties), Introduction of Strain in Materials (Effects on Electronic and Optical Properties) Simulation of 2D materials like Graphene and MoS2.

Pre-requisites:

EEE F214 / INSTR F214 / ECE F214 : Electronic Devices

EEE F424 Smart Grid for Sustainable Energy 3 0 3

Introduction to Smart grid, Renewable Power Generation and Energy Storage, Microgrid, Power System Economics and Electricity Markets, Demand Response, Various Sensing, Communication, and Control technologies, and Application of Data Science.

Pre-requisite:

EEE F242 / INSTR F242 / ECE F242 : Control Systems

EEE F425 Power System Analysis and Control 3 0 3

Course description is to be developed.

EEE F426 Fiber Optics & Optoelectronics 3 0 3

Theory of optical fibres; image transmission by fibres; technology of fibre production; fibre testing; characterization of optical fibres; detectors and sources for fibre optic systems; active fibres; applications of optical fibres; optoelectronic devices and applications.

EEE F427 Electric Power Utilization and Illumination 3 0 3

Introduction to industrial utilization of electric power, types of drives, its characteristics, insulation materials used, Industrial applications such as electric heating, welding etc.., traction systems, DC and AC systems of railway electrification, Train movement and factors effecting Energy Consumption, Speed-time curve, Tractive effort, Power of traction motors. Braking systems, Regenerative braking, Mechanical braking, control equipments. Illumination, laws of illumination, lighting calculation, interior and exterior illumination systems, design of various lighting schemes, types of lamps, high or low pressure lamps and discharge tubes.

EEE F428 Energy Storage Systems 3 0 3

Need of Energy Storage; Broad classification of Energy Storage Systems and applications; Electrochemical Energy Storage Systems; Battery Storage; Application oriented choice of Batteries; Electrical interface system design for Batteries with Renewable Energy sources; Battery Management Systems (BMS); Hydrogen Energy Storage; Its application as Fuel cell, Electrical Energy Storage; Thermal Energy Storage; Mechanical Energy Storage and their applications.

EEE F429 Smart Materials and Applications 3 1 4

Basics of Piezoelectric Materials, constitutive relationship, electromechanical coupling coefficients, piezoelectric constants, polyvinyldene fluoride, piezoelectric composites and also design of sensors & actuators using piezoelectric materials. Shape Memory Alloys: Phase Transformations, Basic Material Behaviour, Properties of SMAs for Biomedical Applications, SMA

based actuators and sensors. Composition and properties of MR fluid & ER fluids, applications of ER and MR fluids in active vibration control and damping. Magnetrostrictive, Electrostrictive materials, Magnetic Shape Memory Alloy, Ionic Polymer Metal Composites and micro electro mechanical systems (MEMS) using smart materials.

EEE F430 Green Communications and Networks 3 0 3

Need for Green radios, Sustainable development goals (SDGs), Historical developments, Fundamental trade-offs, Practical constraints, End-to-end green communication system, Energy harvesting (EH) components, Physical layer (PHY) of Green communication network, Wireless power transfer (WPT), Simultaneous wireless information and power transfer (SWIPT), energy efficiency optimization of PHY, Green wireless network architectures, green cooperative and spectrum sharing networks, Green sensor networks, EH-Internet of things (EH-IoT), Energy-efficient protocols, Big data management in green IoT, Introduction to green UAVs, Current trends in green communication networks, Game theory perspectives, Artificial intelligence (AI) uses for green communications.

Pre-requisite:

EEE F311: Communication Systems

EEE F431 Mobile Telecommunication Networks 3 0 3

Fundamentals of mobile telecommunications, with an overview of first generation (analog) systems and more detailed coverage of second generation (digital) technologies; technology basics including descriptions of wireless network elements, spectrum allocation, frequency re-use, characteristics of the transmission medium; over the-air (OTA) interface characteristics; capacity, coverage, speech coding, channel coding and modulation techniques of TDMA and CDMA technologies; network characteristics; architecture, signaling, element management of IS-41 and GSM networks; call processing; call setup and release, handoff, roaming, advanced services; mobile data communications; circuit and packet switched data services, third generation (wideband data) mobile communications system requirements/ architecture.

EEE F432 Medical Instrumentation 3 0 3

Basic components of bio-medical instruments, bio-electric signals & recording electrodes, transducers, recording and display devices. Patient care and monitoring systems, cardiovascular measurements-blood pressure, blood flow, cardiac output, heart sounds etc.; instrumentation for respiratory and nervous systems, analysis of EEG, ECG, EMG, EOG and action potentials, non- invasive diagnostic measurements - temperature, ultrasonic diagnosis, CAT scan techniques, sensory measurements-motor response, analysis of behaviour etc. biotelemetry, biofeedback, clinical laboratory instruments, X-ray diagnosis. Recent advances in biomedical instrumentation- microprocessor based systems, lasers & optical fiber based systems.

EEE F433 Electromagnetic Fields & Waves 3 0 3

Maxwell's equations; application of circuit theory and field theory; Maxwell's equations in free space and time varying fields; plane waves in dielectric and conducting media; solution of wave equations; the poynting vector; the poynting theorem; poynting vector in conducting media and circuit application; wave polarization; linear, elliptical and circular polarization; wave reflection, refraction and diffraction; transmission lines and resonators; Smith chart, and its applications in stub matching and impedance matching; discontinuties; antennas and radiation; halfwave dipole antenna; loop antenna; helical antenna; directive arrays; frequency independent antennas; reflector and lens antennas; horn antennas; antenna arrays; Friis formula; antenna practices and antenna measurements.

EEE F434 Digital Signal Processing 3 1 4

Introduction; design of analog filters; design of digital filters (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

EEE F435 Digital Image Processing 3 0 3

Introduction to multidimensional signal processing-- 2-D convolution and filtering, discrete-time Fourier , filter design 2-D sampling and reconstruction transform, human visual system, Brightness perception , Temporal properties of vision, 2-D Block transforms-- Walsh-Hadamard, Karhunen Loeve, Discrete Hartley, Filter Banks and Wavelets etc. , Image Compression , Image Enhancement , Medical Image Processing , 3D techniques.

EEE F436 Electromagnetic Compatibility 3 1 4

Basic concepts of EMI/EMC – sources, units, coupling, issues and regulation, Electrical signals and spectral properties, Time and frequency relations, Measurement, Behavior of electrical circuits, Self and mutual impedances, Transmission lines and signal integrity, Non-ideal behavior of wires and lumped components, Emission and Susceptibility –conducted and radiated, Emission models – common mode and differential, Measurement of emissions, System design for EMI, High speed circuit boards, Electrostatic discharge, Cross-talk, Three conductor transmission lines, Grounding, Shielding, Cabling, Filtering, Decoupling, Other EMI related issues.

EEE F462 Advanced Power Systems 3 0 3

Symmetrical components, sequence impedances; fault calculations; short circuit studies; circuit breakers and their selections; power system stability, power system protection--generators, transformers and lines; waves on transmission lines, protective devices -- grounded and ungrounded systems.

EEE F472 Satellite Communication 3 0 3

Review of microwave communications and LOS systems; the various satellite orbits like GEO, MEO, LEO; the satellite link analysis and design; the communication transponder system like INSAT, INELSAT etc; the earth segment and earth station engineering; the transmission of analog and digital signals through satellite and various modulation techniques employed; the multiple access techniques like FDMA, TDMA, CDMA, DAMA, etc; the INSAT program; salient features of INSAT – systems and services offered; satellite services offered by INTELSAT, INMARSAT and future satellites like IRIDIUM etc; future trends in satellite communications.

EEE F473 Wind Electrical Systems 3 0 3

Thermodynamics of wind energy, Types of Wind energy conversion devices, Aerodynamics of wind rotors, design of wind turbine rotor, Power -speed characteristics, torque-speed characteristics, Wind turbine control systems, Wind speed measurements , Wind speed statistics, Site and turbine selection, Induction Generators, Wound field synchronous Generator, Permanent Magnet synchronous machine, Doubly fed induction generator, Power Flow equations, Power Semiconductor devices, Converters, Inverters, power quality, Reactive power compensation, Wind diesel hybrid systems, Wind photovoltaic systems, Role of Govt. and policies for market development.

EEE F474 Antenna Theory and Design 3 1 4

Introduction into antenna theory and practice, Radiation integrals and auxiliary potential functions; basic EM theorems in antenna problems, Antenna characteristics, Infinitesimal dipole; wire and loop radiating elements, Wire antennas – dipoles, monopoles, Arrays – analysis and design, Reflector antennas, Broadband antennas, Micro-strip patch antennas , Smith Chart Review in line with antenna theory and Design , Antenna measurements, Antenna design using commercial software, study of radiation pattern of various antennas.

EEE F475 Special Electrical Machines 3 1 4

Construction, principle of operation and performance of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C. motors, permanent magnet synchronous motors.

EEE F476 Switchgear and Protection 3 1 4

Working applications of various switchgears and protective elements. Switches and fuses, Elementary principles of Circuit Breakers, Description and Operation of different types of circuit breakers, Electromagnetic and Static Relays, operation, construction and characteristics, Generator Protection, Transformer Protection, Feeder and Bus-Bar Protection, Neutral Grounding, Protection against over voltages.

EEE F477 Modeling of Field-Effect NanoDevices 3 0 3

Physical principles and MOS transistor phenomena, developing

models including effective mobility, temperatures effects, and source/drain resistances. small-dimensional effects, impact ionization, velocity saturation drain-induced barrier lowering (DIBL), ballistic operation, polysilicon depletion, quantum effects, gate-tunneling currents, gate-induced drain leakage (GIDL) , fundamentals of low-power (low-voltage) CMOS design issues; the threshold voltage shift (due to SCE) , increased leakage power, sources of power , SOI MOS, (PDSOI, FDSOI) , multigate (MG) MOSFET, electrostatic integrity and short channel control, quantum mechanical origin, basics of BSIM CMG, compact models for multigate MOSFETs , mobility in multiple gate devices, improvement of the mobility ,crystallographic orientations, strained Si channels.

EEE F478 Power Systems Laboratory 0 2 2

Experiments on relays, circuit breakers, transmission lines, switch gear and protection , energy generation methods, and application of artificial intelligence techniques, electric energy utilization including illumination, electrical drives etc.

EEE F491 Special Projects 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

EEE G510 RF Microelectronics 5

Introduction; application of RF electronics in modern systems; basic concepts in RF circuit design, active RF components: various RF diodes and transistors and their circuit models, matching and biasing networks, RF amplifier design: low power, low noise and broadband amplifiers, RF oscillator design; negative resistance oscillator; dielectric resonator oscillators, phase noise. RF Mixers: Balanced mixers; low noise mixers; noise in RF circuits, microwave transmitters and receivers.

EEE G511 Integrated Electronics 3 2 5

Review of basic semiconductor devices and ICs, fabrication and design of integrated circuits, comparison of current bipolar and MOS technologies, VLSI design methodology and layout examples, etc. The main objective of this course is to enable the students to keep pace with the rapidly changing semiconductor technology.

EEE G512 Embedded System Design 3 1 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

EEE G513 Machine Learning for Electronics Engineers 4*

Machine Learning approaches - supervised, unsupervised, semi-supervised, and reinforcement learning. Multi-Layer Perceptron, Convolutional Neural Networks, Recurrent Neural Networks, Generative Deep learning, Deep learning techniques and their application to various types of electronic systems/subsystems such as control-dominated systems, NLP systems, vision-based systems, communication systems, embedded systems and IoT systems. Multi-modal and Multi-task learning, Transfer learning, challenges in the implementation of ML techniques, complexity analysis of the ML architectures for hardware implementation, efficient architectures/ topologies for ML implementation, Hardware Platforms, Tools, and Software Packages for ML.

EEE G514 Nanoelectronic Memories and Technology 3 2 5

Introduction to memory devices in SRAM, DRAM and 3DNAND Flash, circuit and device considerations, device fabrication techniques and scaling avenues, memory array addressing, readout circuits, device characterization, reliability characterization. Non-volatile memory cell structures like (1T-1C 6T, 4T, 1T-1R, 0T-1R, 1S-1R, floating gate FLASH, SONOS, NROM), and memory organization (open bit-line, folded bit-line, NAND, NOR, cross-point etc.), new memory devices and concepts including (e.g. magnetic tunnel junction memory (MRAM, SST-RAM), ferroelectric memory (FRAM), phase change memory (PCM), metal oxide resistive switching memory (RRAM), nanoconductive bridge memory (CBRAM)

Pre-requisites:

EEE F214: Electronic Devices OR EEE F313: Analog and Digital VLSI design OR MEL G621: VLSI Design OR MEL G631: Physics and Modelling of Microelectronic Devices

EEE G520 Wireless and Mobile Communication 3 2 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum systems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

EEE G521 Optoelectronic Devices, Circuits &Systems 3 2 5

Physics of optical radiation and principles of calculation in radiation physics & optics, fundamental laws of photometry. Interaction between optical radiation and matter. Radiation sources. Parameters of IR detectors and junction photodetectors, parameters common to emitters and receiver, radiation measurements, optoelectronic components, optoelectronic integrated devices, photodetector circuits, methods of modulation and optoelectronic system design and applications.

EEE G522 Advanced Satellite Communication 5*

Radio wave propagation effects, low, medium and geo-synchronous earth orbits and their main characteristics. Various sub-systems of the satellite , the outer space and its impact on the design of spacecraft subsystems, LEO satellite network and its routing calls; Battery technology , propagation loss models, modulation and error correction techniques, Digital Video Applications, Satellite Mobile including NGEO, satellite access techniques, third generation satellite communication, remote sensing, bandwidth utilization and throughput capability, the Indian National Satellite System (INSAT), INTELSAT and other international satellite programs, VSAT, Mobile and Personal Satellite communication, principles of Global Positioning System (GPS), GPS receivers and its applications, regulatory and interference issues. Study and design of uplink transmitter, down link receiver, spacecraft transponder, satellite communication links.

EEE G531 Testable Design and Fault Tolerant Computing 3 2 5

Fault: types, modelling and simulation; testing methodologies, coverage, economics and quality; test vector generation: design for testability, built-in self tests; fault tolerant computing; fault tolerant software.

EEE G541 Distribution Apparatus and Configurations 3 2 5

Basic configuration of a distribution set-up at the consumer end. Transformer types, specifications, performance, protection, and sizing. Types of cables and insulation, cable parameters, ampacity and protection. Ratings of LV switchgear and their use in selection, switching transients and clearing time. Properties of fuses with reference to ampacity. Meters, instrument transformers, and their application. Voltage control at distribution levels. Elementary concepts of power quality: power factor, frequency, and harmonic content.

EEE G542 Power Electronic Converters 3 2 5

The importance of the converter as an interface between source and load. DC-DC converters: Buck, boost, and buck-boost configurations. AC-DC converters: Diode and thyristor converters in single and three phase. Inversion in thyristorised converters and applications of line commutated inverters. DC-AC converters: Switch mode voltage source inverters in single and three phase, PWM operation of different types, VSI's operating in multi-levels, space vector modulation techniques. AC-AC converters: Thyristor fed AC loads, the cycloconverter. Matrix converter arrays and their operation as DC-DC and DC-

AC converters.

EEE G543 Power Device Microelectronics and Selec- 3 0 3 tion

Thermal features of power device packaging, the issues of $R_{\theta JC}$and $R_{\theta CS}$, heat flow and effect on device temperature, heat sink design and selection. The two-layer junction behaviour, the concept of drift region, characterisation of power diodes. The base operation in a thick film BJT, steady state characteristics, turn ON and turn OFF times, the multistage power Darlington. The four-layer junction behaviour, two transistor model of a thyristor, dynamic model for a four layer junction device. GTO thyristors, the turn OFF mechanism in four layer junction devices, current technological problems. MOS operation and characteristics, characterisation and structure of the power MOSFET. Development of the MOSFET to IGBT, technological advantages, characterisation, and dynamic behaviour. Current technological problems in insulated gate technologies. Introduction to matrix converters.

EEE G544 Steady State and Dynamics of Electric Mo- 3 2 5 tors

Direct current machines, dynamic characteristics of PM and shunt DC motors. The Reference Frame theory, balanced steady state phasor relations and voltage equations. Symmetrical induction machines: commonly used reference frames and per-unit system, analysis of steady state and dynamic operation and free acceleration characteristics from different reference frames. Synchronous machines: equations in different reference frames, per-unit system, steady state analysis, dynamic analysis for load changes and faults. Brushless DC machines: voltage and torque equations in machine variables, and rotor reference frame variables, analysis of steady state and dynamic performance. Operational impedances and time constants for synchronous machines. Linearised machine equations, and reduced order machine equations. Symmetrical and asymmetrical two-phase induction machines: conversion to stationary reference frame, analysis of steady state operation of the asymmetrical machine, single phase induction machine.

EEE G545 Control and Instrumentation for Power 3 0 3 Electronic Systems

The regulation and control problem with reference to power electronic converters. Converter models for feedback: basic converter dynamics, fast switching, piece-wise linear models, discrete-time models. Voltage mode and current mode controls for DC-DC converters, comparator based control for rectifier systems, proportional and proportional-integral control applications. Control design based on linearisation: transfer functions, compensation and filtering, compensated feedback control systems. Hysteresis control basics, and application to DC-DC converters and inverters. General boundary control: behaviour near a boundary, and choice of suitable boundaries. Basic ideas of fuzzy control techniques, and performance issues. Sensors for power electronic circuits, speed and torque transducers.

EEE G546 Systems Simulation Lab. 4

Simulation tutorial problems on single- and three-phase AC-DC converters, DC-DC buck-, boost-, and buck-boost converters, DC-AC inverters in single and three phase with different levels of control complexity. Simulation of practical applications from utility and drives. May also include a small project.

EEE G547 Device Drivers 3 2 5

Introduction to operating system, Introduction to Linux Basics, commands, file system , kernel and introduction to Android, Process Synchronization ,Semaphores, Message Passing, Mailboxes and debugging, Module programming/ Shell programming / Character Device Driver, Timing and Interrupts--, Device Driver Programming as applicable to Linux/ Android/ Windows, Parallel/ Serial Port Driver/ Block /USB /NETWORK/ PCI/ Drivers, tty Subsystem

EEE G552 Solid State Drives 3 2 5

Introduction to the drive system: requirements, components and benchmarks; Review of motor theory; Power electronic control of motors: requirements and operational issues; Static speed control of induction motors: the AC power controller, slip energy recovery, VSI and CSI controlled induction motors; Speed control of synchronous motors and associated machines; The problem of DC motor speed control: rectifier and chopper controllers; Advanced induction motor drive control: vector control, current modulation, importance of microcontroller based systems; Organisation of microcontrollers: sensing and actuation of signals, interrupt handling and timing, priority of tasks in a microcontrolled drive system.

EEE G553 Utility Applications of Power Electronics 3 0 3

Static excitation systems: converters as used in SES, control and the IEEE types, enhancement of stability. HVDC transmission: configurations of line-commutated converters, constant current and constant extinction angle control at device terminal level, individual phase and equidistant pulse firing control at device level, active and reactive power considerations. FACTS: impedance type and inverter type FACTS devices, the static var compensator, the thyristor controlled series reactor, the STATCOM and its developments in the form of UPFC and SSSC. Active filters: the power quality problems at distribution level, inverter control by transient p-q theory, configuration of active filters and their control, existing bottlenecks.

EEE G554 Soft Switching Converter Technologies 3 0 3

Series, parallel, series-parallel resonant DC-DC converters, half and full bridge topologies, analysis and design. Sinusoidal analysis of resonant converters, soft switching, load resonant properties, exact characteristics. Soft switching mechanisms of semiconductor devices, zero current and zero voltage switching quasi resonant converters, resonant switch topologies, soft switching in PWM converters and inverters, multi resonant converters, control of resonant and soft switching converters, EMI suppression, snubbers, load resonant converters, passive components at high frequencies.

EEE G555 Transformer and Motor Design 3 0 3

Course description for the above course is to be developed.

EEE G556 DSP Based Control of Electric Drives 3 0 3

State space and transfer matrix representations, representation of nonlinear systems by update of parameters, output feedback and state feedback control, basic notion of state estimation. Sampling of signals, discrete representation of signals, *z*-transforms. Nature of discrete time poles and zeros. A/D and D/A converters as system elements. FIR and IIR behaviour, noise and its nature. AR, MA, and ARMA models of systems. The Fourier transform and what it conveys. Processing requirements of a DSP, floating point DSP's: the TMS320C3x family. Memory organisation, interrupt systems, and I/O interface with the TMS320C3x family. The TMS320C31 as an embedded controller, drive control features. Applica tions in vector and direct torque control of synchronous motors, vector and direct torque control of induction motors, torque control of SRM's.

EEE G557 Drives for Electronic Transaction 3 0 3

Course description is to be developed.

EEE G558 DSP Based Implementation Drivers 3 0 3

Course description is to be developed.

EEE G559 Advanced Power Electronics 5

Qualitative, Quantitative, and Simulation studies of Power electronic circuits like AC to DC, DC to DC, DC to AC and AC to AC converter circuits for their theory, performance, design, testing and applications. Use of these circuits for industrial, motor control, FACTS, HVDC, PF improvement and energy conservation applications.

EEE G581 RF & Microwave Engineering 3 2 5

Introduction to radio frequency engineering; advantages; various frequency bands; propagation; transmission lines; microwave waveguides and components; their characterizations; s-parameters and their use; microwave transistor; FETs, Gunn diode, IMPATT diodes; microwave tubes; Klystron; two cavity Klystron amplifier analysis; reflex Klystron; TWTs; high power tubes; cross field tubes; microstriplines; MMICs; microwave measurements; microwave antennas and microwave communi-

cation system; microwave applications; ISM applications; introduction to EMI and EMC; microwave hazards.

EEE G582 Telecom Network Management 5

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

EEE G591 Optical Communication 3 2 5

Optical communication systems and components; optical sources and transmitters (basic concept, design and applications); modulators (electro-optic, acousto-optic and laser modulation techniques); beam forming; focussing and coupling schemes to optical repeators; optical amlifiers; optical field reception; coherent and non-coherent lightwave systems; fibre optic communication system design and performance; multichannel lightwave systems; long haul communications; fibre optic networks.

EEE G592 Mobile & Personal Communication 3 2 5

History of mobile radio; the mobile radio signal environment; review of statistical techniques; pathover flat as well as hilly terrain; effects of RF system design on propagation; received signal envelope and phase characteristics; modulation schemes employed; functional design of mobile radio systems, diversity schemes-space; frequency and polarization diversity; mobile radio system functional design; signal error analysis versus performance criteria; multiple access schemes; classification of the concepts of sensitive topics; new concepts data transmission via cellular; spectrum and technology of WLL.

EEE G593 Power Quality 5

Power Quality Introduction and terms and definitions, Voltage sags and interruptions, Transient Over Voltages, Fundamentals of harmonics, Harmonic Solutions, Long duration voltage variations, Distributed generation and power quality, Wiring and grounding, Power quality monitoring.

EEE G594 Advanced VLSI Devices 5

Device physics of and engineering of advanced transistors, review of metal oxide semiconductor (MOS) with quasi-ballistic and ballistic transport, Short-channel effects (SCEs) in nanometer regime, scaled MOSFETs, Device physics and engineering of sub-100nm MOSFETs , Limits of the state-of-the-art silicon device technology, issues in the miniaturization, Alternative device structures ,non-conventional MOSFETs, and transport in novel nanodevices. Analytical expression (supported by TCAD simulation) for the one-dimensional transport and interpretation of novel device characteristics.

EEE G595 Nanoelectronics and Nanophotonics Technology 5

Semiconductor Fundamentals, Band Theory, Quantum Structures and Quantum Mechanics, Transport in Quantum Structures, Optical Properties of Semiconductor Quantum Structures, Strain Engineering, Electro- Optic Effects, Photonic / electronic Devices based on Nano structures.

EEE G611 Computer Aided Analysis and Design 3 2 5

The course aims at developing complete self reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

EEE G612 Coding Theory & Practice 3 2 5

Codes for data-compression: instantaneous codes; Kraft inequality; Mcmillan theorem; Huffman codes; codes for error-detection and correction; binary symmetric channel; channel capacity, Shannon's fundamental theorem; linear codes; Macwilliam's identity; Reed-muller codes; cyclic codes; BCH codes; codes for secrecy and security; private-key cryptosystems; affine codes; twisted codes; one-time-pads; public-key cryptosystems based on large primes and discrete logarithms.

EEE G613 Advanced Digital Signal Processing 5

Review of stochastic processes, models and model classification, the identification problem, some field of applications, classical methods of identification of impulse response and transfer function models, model learning techniques, linear least square estimator, minimum variance algorithm, stochastic approximation method and maximum likelihood method, simultaneous state and parameter estimation of extended kalman-filter, non-linear identification, quasi linearization, numerical identification methods.

EEE G614 Advanced Wireless Communications 3 2 5

Evolution of wireless cellular technologies to 5G and beyond, review of matrix and signal theory for communication applications, introduction to stochastic geometry for performance analysis of wireless networks, D2D communications- modeling and analysis, cooperative communications-buffer-aided relaying and performance analysis, modulation and multiple access techniques-NOMA, OTFS, OAM. Introduction to potential technologies for beyond 5G/6G communications: IRS, molecular communications, and AI in wireless communications.

Pre-requisite:

EEE F311: Communication systems

EEE G621 Advanced Electronic Circuits 3 2 5

Linear and non-linear operational circuitry, controlled sources, Active filters, power amplifiers, Power supplies, Analog switches and comparators, combinational and sequential logic circuitry. Data transmission and display, Electronic Controllers, Transducer interfacing and measurement circuits, etc.

EEE G622 Advanced Digital Communication 3 2 5

Introduction to Digital communication, review of probability and statistic processes; review of source coding and characterization of signals; optimum receivers for additive white gaussian noise channel; carrier & symbol synchronization; channel capacity & coding; block & convolutional codes; communication through band – limited linear filter channels; adaptive equalization multicarrier systems; digital communication through fading multipath channel; future trends in digital communication.

EEE G625 Safety Critical Embedded Systems Design 4

Course description is same as given under HTSL ZG631.

EEE G626 Hardware Software Co-Design 4

Course description is same as given under HTSL ZG641.

EEE G627 Network Embedded Applications 3 1 4

This course deals with the three main application areas of Network Embedded Systems – Wireless Sensor Networks, Automotive Networks, and Industrial Networks– Network Architecture , Deployment Issues, Network Protocol stack: Modular and Cross Layer Design. Network Node: Architectures, Operating System and Applications. Middleware Issues and Design. Security and Encryption

EEE G641Applied Estimation Theory 3 2 5

Review of random processes, linear algebra and matrix theory, ML phase and timing estimation in digital communication, Scalar estimation, estimation in real and complex vector space, Study of performance degradation due to estimation errors, Frequency diversity and equalization, Study of MLSE for equalization, Estimation of Single Input-Single Output (SISO) channel to very complex Multi Input-Multi Output (MIMO) channels, study of different estimators such as MMSE, linear MMSE, orthogonal frequency division multiplexing (OFDM) basics, OFDM channel estimation, Channel quality estimation, Impact of channel estimation errors on performance, Introduction to WLAN standards, IEEE 802.11n, channel estimation, MATLAB experiments and projects.

English

ENGL G511 Growth of the English Language 5

The Origin and development; old English, middle English and modern English; foreign influences; changes in grammar and phonology; rise of standard English; English in the international context.

ENGL G512 Language and S & T 5

Historical development of communication in science; communicative process in science and technology; language of science & technology; scientific literature; growth and role of scientific journals.

ENGL G513 Social Impact of S&T 5

Elements of scientific thinking; role of science and technology in social change; impact of science on environment; technology and social growth; impact of science & technology in terms of developments in transportation and communication and innovations in sources of energy; impact on the quality of life.

ENGL G521 Principles of Language Teaching 5

Teaching different language skills; grading; sequencing and presentation; teaching at different levels; remedial teaching; techniques of teaching comprehension, grammar, composition; lesson planning; syllabus design; testing.

ENGL G522 Aesthetics and Technology 5

Aspects of aestheticism; emergence of aestheticism; influence of aesthetics on technology; impact of technological explosion on human sensibility and its expression in selected art forms.

ENGL G531 Applied Linguistics 5

Linguistics and language teaching; contrastive linguistics and its applications; error analysis; a linguistic theory of translation; linguistic approach to literature.

ENGL G541 Interpretation of Literature 5

Literary forms and conventions and their development; different critical approaches; practical criticism.

ENGL G551 Information Technology Lab I 5

(This course is specially designed to prepare the stream of input, viz. traditional English graduates, in the use of technology in communication).

This course is built around the theme of use of modern technology for the purpose of presentation and processing of information for effective communication within an organisation. Consistent with this theme, assignments would be drawn from the student's work environment and from one or more areas of the following: Computerized text processing; use of utility software packages for information processing and production; desk top graphics; desk top video; computerized graphics packages; office automation equipment such as electric typewriters; photography; equipment for projection and preparation of projection material; reprography equipment; duplication equipment; audio visual technology involving equipment such as video systems, audio systems and audio-visual recording equipment; techniques for display and exhibition of formatted information, etc. The course will be unstructured in nature and assignments may require study of the principles of the above areas, or the actual use of equipment and techniques.

ENGL G561 Information Technology Lab II 5

(This course is specially designed to prepare the stream of input, viz. traditional English graduates in the use of technology in communication)

This is a sequal to the first course of the same name. The theme of use of modern technology for the purpose of presentation and processing of information for effective communication within an organization would be further developed. However, assignments would invariably emphasize the integration between various technologies for totality of communication.

ENGL G571 Applied Communication I 5

(This course is specially designed to prepare the stream of input, viz. engineering and hard science graduates in communication methods)

Process of communication; elements of speech; role of body language; dyadic communication; participation in different types of discussion groups, audio-visual aids.

ENGL G581 Applied Communication II 5

(This course is specially designed to prepare the stream of input viz. engineering and hard science graduates, in communication methods)

Elements of effective writing; methods of written exposition; art of condensation; writing technical articles, research papers, proposals, reports, manuals and letters, preparation and use of graphic aids; mechanics of writing; technical editing.

ENGL G591 Project Formulation and Preparation 5

This course is designed to inculcate principles of technical documentation as required within S&T organizations. Through this course, students are expected to acquire familiarity with several of the following: Proposals, feasibility reports, formal project reports, short reports, memos, negotiations, contracts, etc. In the process principles of project formulation and evaluation, such as technical considerations; performance specifications; preliminary block diagrams, types and analysis of contracts; cost estimation concepts, work breakdown structure; project data preparation, scheduling facilities etc., would be introduced. The course would invariably include the preparation of a detailed report embodying as many of the above concepts as appropriate.

ENGL G611 Twentieth Century English Literature 5

Margret Atwood, Tony Morrison, Samuel Beckett, Harold Pinter, Philip Larkin,Ted Hughes.

Finance

FIN F212 Fundamentals of Finance and Accounts 3 0 3

This course is a broad introduction to finance and related areas. An introduction to basic accounting principles for measuring and communicating financial data about a business enterprise to external parties, single and double entry, ledgers, journal, trading, profit and loss and appropriation accounts, trial balance and balance sheet; cash flow statements; capital budgeting and risk management using risk return trade-off notions; introduction to working capital management; structure of capital market; primary and secondary markets; financial market reforms, source of investment information; portfolio selection.

FIN F213 Mathematical and Statistical Methods 3 0 3

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like standard deviation, variance, Kurtosis, correlation coefficient; Sampling Methods - Simple random sampling, with and without replacement, stratified random sampling. Statistic and sample moments, Sampling Distributions - Properties of Student's – t, Chi-square and F-distributions. Theory of Estimation - Point estimation, method of moments; maximum likelihood; interval estimation. Testing of Hypothesis - Statistical hypothesis, simple and composite hypothesis,critical region, types and size of error, test of simple hypothesis versus simple alternative. Analysis of Variance - Analysis of one-way classified data, application in the study of relationships. Theory of Index Numbers - Calculation of Laspeyre's, Paasche's, Fisher's and Chain index numbers, criteria of a good index number, cost of living index numbers, base shifting, splicing and deflating of index numbers. Introduction to Regression Analysis - Specification of simple linear regression model, least square method of estimation, classical assumptions, general and confidence approach to hypothesis testing.

FIN F214 Economic Environment of Business 3 0 3

Business and Economics, Government and business; market an the role of the Government, market failure, Government and the market, government and the firm, Fiscal policy and the environment, Macroeconomic environment; macroeconomic environment of business, Business activity, employment and inflation, monetary policy and economic environment, balance of payment accounting, Business in the international environment; World trade and international monetary system; international investing; investment decisions in multinational markets; country risk; multinational corporate strategy; multinational treasury management; currency risk; globalization and multinational business, FDI, FII, pricing strategy and business.

FIN F242 Introduction to Financial Mathematics 3 0 3

Basic financial calculations; financial securities, time value of money, Annuties and equation of values; discounting and accumulations, flat rate and APRs, Capital Budgeting Techniques and compound interest problems; NPV, IRR, payback period. Arbitrage, Forward contracts, and term structure of interest; rationale of arbitrage assumptions; forward contracts, calculating the forward price, hedging, fixed cash income, spot rate and forward rate, term structure of interest rate, yield curves, yield to maturity, interest rate risk calculation, Stochastic interest models and investments; simple stochastic interest rate models, fixed and varying interest model, log normal distribution, fixed interest

government borrowings, government bonds, tax, government bills, convertibles, property, derivatives, future, clearing house, margin, bond futures, short interest futures, stock index futures etc.

FIN F243 Functions and Working of Stock Exchanges 3 0 3

Overview of financial markets and instruments; stock exchanges in India; trading and settlement procedures; listing; risk management; primary markets; debt markets; indices; mutual funds; derivatives; exchange traded funds; corporate governance; SEBI and regulation of the markets; important events in the stock markets; market microstructure; empirical studies on the Indian markets.

FIN F244 Indian Financial System 3 0 3

Indian Financial System, financial markets, financial intermediaries and financial instruments. Components and structure of the financial system. Financial Assets & Financial Markets: Meaning of financial assets & types, role and structure of money market and capital market – Call money market, Treasury bill market, Commercial bill market including commercial paper and certificate of deposits, Discount market – Government securities market – Debt Market – Industrial Securities Market. Markets for derivatives; futures and options, and other derivatives. Definition and types of non-bank financial institutions, LIC, UTI, Mutual Funds, Venture Capital, bankassurance; their growth and impact on India's economic development. Organisational set up & functions of regulators: Reserve bank of India, SEBI, IRDA, Financial sector reforms.

FIN F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

FIN F311 Derivatives & Risk Management 3 0 3

Overview of Financial Markets. Introduction to derivatives. Definition of future, forward, option and swap. Difference between various players of derivative market, their motives and types of position they can hold. Mechanics of future, option & swap markets. Hedging strategies. Option Pricing and understanding of various factors affecting option price. Calculations of Greeks. Introduction to interest rates, yield, term structure and forward rates. Mechanics of Bond Market. Review of concept of compounding and time value of money. Difference between floating rate and fixed income bonds. Price quotes and accrued interest. Pricing of Bonds. Computation of yield. Bond Price volatility. Duration, Modified Duration and convexity. Factors affecting Bond Yields and the Term Structure. Concept of Risk. Perspective of Risk from view point of individuals, companies & financial institutions. Commercial Banks and risks faced by them. Different types of Insurance and risk faced insurance companies. Introduction to various risks: Market Risk, Credit Risk, Operational Risk, Liquidity risk & Model Risk. Concept of Value at Risk

FIN F312 Fundamental of Taxation & Audit 3 0 3

Legal business entities and tax assessments; profit and gains of business or profession; capital gains; Tax planning for business entities; tax accounting principles; VAT , excise duty, custom duty etc.; computation of tax liability; appeal procedure; auditing procedure and taxation principles; auditing concepts; generally accepted auditing standards; audit documentation and evidence; role of internal N-131 control and concurrent audit; audit mechanism, valuation of assets, and auditing of depreciation, provisions, reserves, profits and dividends, etc.

FIN F313 Security Analysis and PortfolioManagement 3 0 3

Introduction to investment and securities; profile of financial assets; new issue market or primary market, initial public offerings (IPO); secondary market; framework of risk & return; fundamental analysis- economy, industry; company analysis; stock evaluation models; multiple holding period and multiple growth rate; bond analysis and bond management strategies; technical analysis; efficient market theory; portfolio management; Markowitz model; Sharpe's Single Index model; capital asset pricing model; financial derivatives-options & futures.

FIN F314 Investment Banking and Financial Services 3 0 3

Merchant banking function- perspectives; organization of merchant banking function; managing new issues; negotiating terms with financial institutions, brokers, investors and under writers; pricing of further issues- SEBI guidelines; syndication of loans from banks; preparation of loan dossiers and application for financial assistance; negotiations; public deposits to finance working capital; agencies mobilizing public deposits; regulations governing raising of public deposits; cost of public deposits, factoring, forfeiting , structured finance, securitization and personal finance like house loan, personal loan and other individual loans, non-fund based services -credit rating, business advisory services, mergers, de-mergers and acquisition, asset management and insurance commodities services and wealth management.

FIN F315 Financial Management 3 0 3

Concepts and techniques of financial management decision; concepts in valuation - time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

FIN F341 International Financial Markets and Services 3 0 3

Currency futures, options and swaps; interest rate determination and asset pricing in face of volatile nominal and real exchange rates; international portfolio management; treasury risk management and performance measurement; major international stock exchanges: New York; ISE London; Tokyo; trading and settlement practices; listing of Indian derivatives on Brussles stock exchange; arranging foreign collaboration; floating India funds; syndication of Euro-dollar loans.

FIN F342 Project Finance 3 0 3

Project identification, feasibility; appraisal of projects from technical, financial and economic view points; design of capital structure; factors influencing form of capital; instruments; shares, preference shares, debentures, convertible debentures; borrowing from development finance institutions.

FIN F366 Lab Project 3

FIN F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

FIN F414 Financial Risk Analytics and Management 3 0 3

Financial risk (which includes interest rate risk, credit risk, foreign exchange risk and portfolio risk), Application of Asset price Theory, CAPM and Modern Portfolio Theory, Multifactor models of risk and return, Capital adequacy, BASEL Norms; Comprehensive Capital Analysis and Review, Basel Committee on Banking Supervision guidelines, Value at Risk (VaR), VaR from regulator perspective, Responsive VaR Model, Addressing VaR weakness, Backtesting Concepts - Checking the Strength of VaR Model, Issues with the Standard VaR models, Risk Not in VaR (RNIV) to VaR migration of risk, Volatility Clustering, Quantifying and Modeling volatilities, Hedging techniques, Options Greeks, Managing Risk with Deriatives.

FIN F491 Special Project 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The in-

structor-in- charge may assign specific hours for formal brainstorming sessions.

French

FRE N101T Beginning French **3**

Basic grammar; vocabulary; reading practice; translation of simple passages.

Not available for meeting the requirements of any programme except as prerequisite for another French course. Can be taken only on audit.

FRE N102T Technical French **3 0 3**

Prerequisite : FRE N101T

Phrases and sentence patterns in technical literature; special technical vocabulary; reading and translation of current technical literature from French to English with the help of a dictionary.

This course is designed to meet the foreign language requirement of the Ph.D. Programme and is not available for meeting the requirement of any other programme. Can be taken only on audit.

German

GER N101T Beginning German **3 0 3**

Basic grammar; vocabulary; reading practice; translation of simple passages.

Not available for meeting the requirements of any programme except as prerequisite for another German course. Can be taken only on audit.

GER N102T Technical German **3 0 3**

Prerequisite : GER N101T

Phrases and sentence patterns in technical literature; special technical vocabulary; reading and translation of current technical literature from German to English with the help of a dictionary.

This course is designed to meet the foreign language requirements of the Ph.D. programme and is not available for meeting the requirements of any other programme. Can be taken only on audit.

General Studies

GS F211 Modern Political Concepts **3 0 3**

Nature and scope of political science; emergence and basis of the state; rights and duties; forms of government; democracy, fascism, capitalism, socialism, anarchism, communism, Maoism, radicalism and Gandhism.

GS F212 Environment, Development & Climate Change **3 0 3**

Specific topics on environment, development and climate change; regional, national and international climate debates; review of international climate negotiations such as Kyoto, Copenhagen and other declarations; environment problems: causes, sustainability and policies; population, resources and sustainability; population dynamics, capacity and conservation; food security, poverty, impact and global solutions; energy resources: renewable, wind, oil, natural gas, nuclear energy; growth, technology and greenhouse gas emissions, carbon credit; regional impacts of climate change and adaptation strategies; techniques in modeling; water resources and pollution: monsoon, drought, rainwater harvesting, traditional practices in water conservation; case studies.

GS F213 Development Theories **3 0 3**

Course description is to be developed.

GS F221 Business Communication **3 0 3**

Managerial communication – national and international contexts, Interpersonal Communication, persuasive communication, communication technology, effective listening group communication, professional presentation.

GS F222 Language Lab Practice **0 3 3**

Writing: Grammar and usage, sentence completion, jumbled sentences, emphatic word order, vocabulary building, message organization, paragraph development techniques and note taking. Reading: Skimming, scanning, rapid reading, analytical reading, factual reading, and aesthetic reading. Listening: Content listening, critical listening, aesthetic listening, empathetic listening, listening to short conversations, stories, lectures.

GS F223 Introduction to Mass Communication **3 0 3**

Mass communication: an overview, history of media and media plan, cinema, radio, television, theatre, advertising, audience and media, public relations, writing for media, new information technology: software revolution, internet, social media, video conferencing.

GS F224 Print and Audio-Visual Advertising **3 0 3**

The Dimensions of Advertising; Advertising and Marketing; Creative strategy and Creative process; Creative Execution: Art and copy; Media strategy; Advertising research; Relationship Building: Public relation and Corporate advertising; Ethical issues.

GS F231 Dynamics of Social Change **3 0 3**

Nature of society, social institutions; concept and nature of socio-cultural change, obstacles, rate and direction of change; factors of social change-ideological, economic, technological and political demographies; agencies of social change-education, leadership, propaganda, legislative reforms; five-year plans and social change, peasant and land reform, bhoodan and gramdan; changing pattern of family, marriage, caste and religion.

GS F232 Introductory Psychology **3 0 3**

The development of psychology as a science -- individual and the environment; nature; kinds and determinants of perceptions; response mechanism and kinds of responses, motivations, modifications of behaviour through learning, memory and transfer of training; thought processes, problem solving and creative thinking; nature and characteristics of psychological tests; nature and evaluation techniques of intelligence and personality.

GS F233 Public Policy **3 0 3**

Public Policy-meaning nature and types; approaches and models of public policy; nature of public process-process in the executive; parliamentary processes; processes to manage the ruling party-government interfaces; strategic thinking on the process of policymaking, judicial policy making.

GS F234 Development Economics **3 0 3**

Concept of development; statistical foundation of decisions; nutrition, disease and climate as influences on growth; critical importance of population; importance of agriculture, international trade and industry; cost- benefit analysis and planning process.

GS F241 Creative Writing **2 1 3**

Principles of creative writing; stimulating creative activity; techniques of creating images; constructing events and creating characters, writing short stories, plays and poems, writing critical essays on works of art.

The course will require from the student a comprehensive report on the techniques learnt and include samples of his creative writings.

GS F242 Cultural Studies **3 0 3**

Introduction to Cultural studies, Importance of cultural studies, types of cultural studies, relation to Critical theory, relation to Literary Criticism. Introduction to theories such as Communication studies, Film studies, Feminist theory, Art history/Criticism, Societal impact, business relevance, introduction to myriad practices, institutions, beliefs and varied social structures within a given culture.

GS F243 Current Affairs **3 0 3**

Introduction, importance and scope; domains: political, social, religious, scientific, developmental, etc.; categories: controversial, non controversial, neutral; sources of information: newspapers, magazines, posters, pamphlets, manifestoes, etc.; reading skills: skimming, scanning, extensive and intensive reading; understanding, interpreting and analysing news, events and information; forming, balancing and expressing opinion.

GS F244 Reporting and Writing for Media **3 0 3**

Reporters and their functions; What makes news; Analysing the components; Getting the information and putting it together; Organizing a news story; Building colour into news stories; Fighting the formula story ; Writing Leads; Message molecules (Vocabulary, grammar, Spelling), Human Interest and Depth Report; Finding and using news sources; Basics of ethics in Journalism.

GS F245 Effective Public Speaking **2 1 3**

Principles of public speaking; importance of effective listening; use of body language; characteristics of voice; ways to control stage fright; measures to develop confidence; audience analysis; modes of delivery; organization of speech; speeches for special occasion: welcome, introduction, felicitation, farewell, valedictory, inaugural; impromptu and extemporaneous speeches; meetings, group discussions, professional presentations, interviews.

(This course is extensively practice-oriented. Theoretical guidelines also will be given to the students for achieving effectiveness in public speaking. Students would be asked to prepare and deliver a number of talks and presentations. Comments and discussions will follow each presentation so as to provide the students opportunity to correct themselves. Group discussions and presentations will be recorded and projected for them to observe their organization, body language and understand the nuances of the characteristics of their voice. Evaluation components will be designed to assess the students' ability to listen actively and speak effectively. The new language laboratory will be used to enable the students to listen to speeches by eminent leaders and renowned personalities who were/are able to attract the masses with their powerful speeches. The lab would also be used to conduct group discussions through computers).

GS F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

GS F311 Introduction to Conflict Management **3 0 3**

Characteristics and dynamics of conflict, reasons for conflict; the value of conflict in social change; the different approaches to addressing and managing conflict; Examining the history and impacts of a conflict; exploring stakeholder power and relationship; assessment of options to address conflict; tools for determining the best strategy; incentive sand methods in getting stakeholders to collaborate; active listening; skills in mediation and facilitation; roles of mediator and facilitator in conflict management; dealing with emotions and difficult situations; planning and preparing for negotiations; improving negotiation skills; joint problem solving approaches; building agreements; building conflict management mechanisms and consensus-building strategies.

GS F312 Applied Philosophy **3 0 3**

Content of Philosophical Perspectives – Ethical, Logical, Epistemological and Metaphysical; Ethics and Social Dilemmas; Social Justice and Equality; Freedom of Expression; Social and Value Dimensions of Technology; Impact of Information Technology on the Quality of Life; Computer and Inter net Crime; Democratic Values and the Internet.

GS F313 Marxian Thoughts **3 0 3**

Marx and his times; basic tenets; dialectical materialism; economic determinism; doctrine of surplus value; doctrine of class struggle; different schools of Marxism; Leninism; Stalinism; Maoism; future of Marxism.

GS F321 Mass Media Content & Design **3 0 3**

Types of Corporate Communication documents; Importance of corporate communication; communication documents for stakeholders; Data collection for documents- Sources, types, methods; Analyzing and Organizing the content – preparing the drafts; Design Concepts; Design Technologies – Overview; Specific Design tools – Dreamweaver, Macromedia Director, Adobe Premier, Photoshop, Flash; Integrating Content and Design.

GS F322 Critical Analysis of Literature and Cinema **3 0 3**

Creativity and Aesthetics; An overview of Major Movements in Literature and Cinema; Interpretation of Selected Works; Cinema & Art; Understanding Drama: Theme, Character, Plot, form; Understanding Poetry: Diction, Imagery, Symbolism, Structure and Form, Personification, Apostrophe, Sound and Rhythm; Understanding fiction: Setting, Point of View, Plot and Character; Understanding Short Fiction: Meaning and message, Style and Coherence; Understanding Cinema: Plot; Character; Screenplay; Linguistic, Social, Musical codes; Cinematic Codes; Camera Work.

GS F325 Journalism **3 0 3**

Principles of reporting; the news media and public relations; ground rules for reporters; investigative reporting; specialised reporting of events, trends and activities; creating headlines; editing, copyediting; newspaper style; proof reading; the press and the law.

GS F326 Creative Thinking **2 1 3**

Creative thinking & its importance, Process of creative thinking, Road blocks to creative thinking, Developing creative thinking, Brainstorming, Bloom's Taxanomy, Assessment of creative thinking, Conceptual framework for Critical thinking, Aspects of critical thinking, Stages of critical thinking; Reasoning: Fountain head of critical thinking, Need & benefit of critical thinking, Critical thinking in decision making, Developing critical thinking in classroom, Assessment of critical thinking skills.

GS F327 Selected Reading **3 0 3**

The course is intended to nurture the students' critical thinking and to enhance their skills at information gathering and expressing. Selected readings from books in the areas of History, Science & Technology, Culture, Literature, Art, Philosophy, Psychology, Religion, Development Concepts and Trends etc. will be assigned to the students. A set of books will be identified in at least two broad areas for study and analysis. This course is designed only for students of M.Sc.(Tech.) General Studies Programme.

GS F331 Techniques in Social Research **3 0 3**

Principles of social research, research process, stages of social research, choosing the research problem, objectivity and subjectivity in social research, ethics in social research, ethical codes of practice, confidentiality and anonymity, privacy, Effects of Value in social research, constructing social explanations, descriptive studies, explanatory studies, designing a social research proposal, quantitative research, survey, sampling, SPSS, various statistical tests, qualitative research, observation: participant and non-participant, issues in conducting qualitative research studies, case studies of socio-economic, political, health, gender and developmental issues, interview as social interaction, ethnographic research, field study, hypothesis testing, analysis of data, report preparation and documentation, factors limiting application of social research, evaluation research and development of social indicators.

GS F332 Contemporary India **3 0 3**

Topics will include some or all of the following: economic process; contemporary Indian planning and industry; political processes; Contemporary Indian political scene and Indian administration: India and the contemporary world; social processes: contemporary Indian educational scene; religion and caste system; Indian science; Indian women; cultural processes; contemporary Indian art, music, dance, theatre, cinema and literature.

GS F333 Public Administration **3 0 3**

Definition, nature and scope of public administration; the chief executive; leadership qualities of an administrator; principles of organization; organization of Ministries of Home and Finance; personnel administration-bureaucracy; recruitment, promotion, conduct and discipline, employer-employee relations; administration at work-planning, policy formulation, decision making, supervision, coordination; integrity in administration; public corporations in India; financial administration in India; local administration in India.

GS F334 Global Business, Technology and Knowledge Sharing **3 0 3**

Changing corporate landscape, New knowledge industries, net-

working and interdependence, Technology: a fundamental driving force, WTO. Global Business Environment, Intellectual Property Rights (IPR), FDI, trends in India and comparison with China. Technology import and export, Technology transfer and adaptation. Need for technology intermediation, newly emerging techno-business opportunities, technology forecasting, technology assessment, technical actions. The role of small and medium enterprise's and the changing roles of enterprises. Leadership for the inter-networked business, Employment and Jobs, access and equity, quality of life, global knowledge innovation infrastructure.

GS F342 Computer Mediated Communication 3 0 3

Course description is to be developed.

GS F343 Short Film and Video Production 2 1 3

Introduction; communication media formats like audio, film, video, audio recording and editing; image composting; script writing : screenplay; equipment: video cameras, film cameras, the lens, the camera; the film stock: negatives, prints, aspect ratio, grain, gauge, speed, colour contrast, tone; handling the camera; image technology, sound technology; basic filming techniques: lights and lighting, shooting, sound recording, sound track, dubbing, voice over; visual effects, editing: familiarization with editing software, mixing and looping; final production.

GS F344 Copywriting 2 0 2

Concept of Copywriter, Setting up as a Copywriter, Copywriting Audience, Copy Writing Process, Marriage of Visual and Copy, Copy Types-Email Marketing, Direct Mail Press Release, Press Ads, Writing Leaflets and Brochures, Newsworthy Newsletters, Radio Copy, Online Copywriting, Other Types of Copy.

GS F345 Constitution of India 3 0 3

Practical, historical and legal importance of the constitution of India; evolution and features of the Constitution of India; India's political, social, and economic processes as envisaged in the Constitution; implications for democracy; institutions, aspirations, philosophy, and nature of the constitution; democratic logic of the Indian State; relationship between the individual and the State.

GS F366 Lab Project 3

GS F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

GS F491 Special Project 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

Humanities and Social Sciences

HSS F211 Introduction to Arabic 3 0 3

Recognition of Arabic alphabets; Understanding and practice of Arabic grammar; Comprehending paragraphs and reproducing it in simple Arabic; Reading and interpreting short Arabic stories, newspaper headlines; Listening and understanding radio and TV news; Vocabulary building; Using profession specific words and phrases related to engineering and business; Conversation with Arabic speaking people in different situations such as introduction and greetings, interaction with family and friends, communication during vacation and holidays, communication at the workplace, restaurant, bank, government offices, asking and answering questions during job interviews, attending phone calls, etc. (emphasis will be on Standard Arabic and Emirati dialect).

HSS F221 Readings from Drama 3 0 3

Oliver Goldsmith, John Galsworthy, T.S. Eliot, John Osborne.

HSS F222 Linguistics 3 0 3

Linguistics as a field of study and its relationship with other disciplines; nature of language; its varieties and role in society; concepts of structure, system, unit and class; theories of linguistic analysis.

HSS F223 Appreciation of Indian Music 3 0 3

The course is intended as an appreciation of Indian music; the emphasis will be upon exposing the students to musical performances, records, tapes, both vocal and instrumental; through these illustrations the consciousness in terms of the distinction between Raag and Taal etc., is expected to be derived; the course will pick up a certain number of Raags from the basic thaats and demonstrate the delineation of the Raag through Alap, through various improvisations based upon compositions; the appreciation of concepts both vocal and instrumental (Sitar and Violin) is expected to be obtained; Karnatik music will also be touched upon particularly in terms of Raags common to Hindustani Music.

HSS F224 English Skills for Academics 3 0 3

Nature and scope of English for specific academic purposes; Common core academic genres: description, narration, cause-effect, problem solution, and argumentative; Writing for specific purposes: paragraphs, essays, critiques, research; Academic English lexis: AWL and AVL; Lexical cohesion: adverbials, collocations; Publication of word lists for English for specific purposes: corpus-based study (through AntConc tools); Discourse patterns: argument & counter argument, self-referencing, adverbials; Language use: DIY activities for word, phrase, clause and text level aspects of discipline specific texts

HSS F226 Postmodernism 3 0 3

Postmodernism, The Postmodern Condition, History of Postmodernism in brief, Pluralism, Eclecticism, Polysemy, Intertextuality, Metanarratives, Language Games, Parody, Pastiche, Simulation, Postcolonialism, Commodification, Deconstruction-and New Historicism, Creativity, Critical Judgment, Ethical and Social Understanding, analysis of postmodern cultural artifacts and practices from fine art, music, theology, literature, and film alongside primary texts by the leading theorists of postmodernism.

HSS F227 Cross Cultural Skills 3 0 3

Overview of Intercultural Communication, Intercultural Communication in the Global Workplace, Technology as cultural Power and Its Social Impact, Critical Issues and challenges in Intercultural Communication, Understanding interrelatedness among Religion, Family, Culture, Gender and Race.

HSS F228 Phonetics and Spoken English 3 0 3

Speech mechanism; the English phonemes; word accent; features of connected speech; phonetic transcriptions; varieties of spoken English; spoken English in India; problems of Indian speakers; oral reading of passages including conversation; speech training.

HSS F229 Introduction to Western Music 3 0 3

A historical and cultural examination of music in Western culture from the Middle Ages to the 21st century; Listening to and understanding different genres of music; Fundamentals of Music: Rhythm, Meter and Measure; Melody and Harmony; Pitch names; Intervals; Key signatures; Chord progressions; Score reading; In-tune singing; Ear training; Making music on the electronic keyboard.

HSS F232 Introduction to Development Studies 3 0 3

History of development; meanings of development; Key development thinkers: Smith, Marx, Liszt, Keynes, Prebisch, Friedman; 20th century perspectives on development: dependency, modernization, human development, post- and anti-development theories; Models of development: ISI and neoliberalism; Themes

in comparative international development: environment, health, gender, foreign aid, social and human rights.

HSS F233 Main Trends in Indian History 3 0 3

A panoramic view of the development of Indian thought and society; evaluation of Indian life and quality from earliest times through the so-called Hindu, Muslim and British periods; the present day analysis and discussion on the basic features of Indian society, its strength and its weakness; a glimpse into future in terms of the transformation of the Indian society.

HSS F234 Main Currents of Modern History 3 0 3

Renaissance, the major revolutions of the world; rise of nationalism; growth of imperialism; world between the two world wars; super powers and the contemporary world; resurgence of Asia, protest movements in Africa and Latin America; problem of world peace.

HSS F235 Introductory Philosophy 3 0 3

An overview of some philosophical theories and issues both from India and the western world; nature and purpose of philosophy; theories of cosmology, metaphysics and epistemology; skepticism and its philosophical value; contemporary philosophy.

HSS F236 Symbolic Logic 3 0 3

A brief historical survey of the development of logic; nature and kinds of arguments; sentential connectives; symbolization of statements and arguments; truth tables, establishing validity of arguments by truth tables and different types of proofs, quantified statements; quantified arguments and their validity.

HSS F237 Contemporary Indian English Fiction 3 0 3

Indian novel in English as a global phenomenon; pioneering publications; new approaches to the art of storytelling and reworking of language introduced in Indian English fiction. Developments in contemporary Indian fiction in English from the 2000 to the present; Analysis of selected novels set in their historical, political, social and cultural contexts, and alternate view-points on contemporary India.

HSS F238 Sports and Society 3 0 3

The Sociology of Sport; Theories; Sports and Socialization; Sports and Culture; Deviance and Violence; Class, Gender, Race and Ethnicity; Sports and Education; Sports and Economy; Sports and Politics; Sports and Media; Sports and Globalization.

HSS F242 Introduction to Phonology 3 0 3

Means of communication; language differences;human speech sounds; organization and structure;deployment; historical evolution; tools and theoreticalframework; formal analysis of data; theories.

HSS F243 Introduction to Critical Pedagogy 3 0 3

Critical pedagogy; ideology and education; oppressivevs. liberatory pedagogy; practice of freedom;democratic education; hidden curriculum; power inclassroom; politics in classroom; class; religion;gender; sexuality; disability; examination and impact;mind as blank slate; awakening critical consciousness;humanistic teaching.

HSS F244 Crime and New Media 3 0 3

Biological Theories: The 'Born Criminal', Social Darwinism, Detective Fiction and the Forensic Method, Monstrous Bodies; Psychoanalytic Theories: Trauma and Perversion, Trigger Warning, Voyeurism, Spectacle of Punishment; Social Disorganization Theories: Sociopath and Vigilante, Organized Crime, Cyber Bullying and Trolling, Panopticism; Feminist Theories: Female Offender, Female Victim, Law Enforcement, Social Rights Movements.

HSS F245 Gender, Science and Technology 3 0 3

Introduction to science studies: Nature of science and technology, Modern Western science, Science study debates in Indian subcontinent; Gender, science and technology: Sex and gender, Representation of genders in science and technology, Access and retention; Feminism and science: Practice of science and gender, Feminist epistemology; Feminism and technology: Gender-technology debates, case studies.

HSS F246 Philosophy of Nāgārjuna 3 0 3

Abhidharma notions; Rejection of aggregates, elements, and conditioned entity; Desire and the desirous, agent and action, and fire and fuel; Ontological independence, prior entity, initial and final limits, intrinsic nature, and compounded phenomena; Early-Buddhist views on suffering, bondage and freedom; Action and consequence; Self and entities within substance metaphysics; Time, origin and dissolution of existents, Tathāgata, assemblage, and conjunction; Four noble truths, nirvāṇa, and the twelve links of dependent origination.

HSS F247 Social Informatics 3 0 3

Intro to Social Informatics; Evolution of Social Informatics-India and Global; Right to Information and Consent of the Networked; Critical Informatics; Infrastructure and Equitable Information Technology; Identity and Community; Hackers and Hacking; Ethics, Law, and Policy related to ICT; Big Data; Privacy and Surveillance; Artificial Intelligence and impact on Social structure, Commercialization of Social Informatics.

HSS F248 Introduction to Disability Studies 3 0 3

Critical interdisciplinary field: socio-cultural and historico-political perspectives of disability. Historical construction of ablebodiedness, normalcy, disability, abnormality. Disability-centred critique of medical technologies and psychiatric practices. Culturally different ways of knowing body-minds. Disability in relation to other bio-social differences like gender, caste, class, race and sexuality. Disability expressions: life writing, autism narratives, sign-language poetry, crip performances.

HSS F249 Politics in India 3 0 3

Institutional Setting of the State; Transformed structures of political power; Constitutionalism; Parliament; The Party System; Social Cleavages; Identity, Class, Caste and Religion in Politics; Politics and National Identity; Political Processes; Political Parties; Social Justice; Social Movements; Politics and Redistribution

HSS F250 Comics and Visual Culture 3 0 3

A historical and cultural examination of popular visual culture; case studies from comic books, manga, graphic novels, memes, and caricatures; transnational approach spanning India, Japan, and America; visual methodologies; critical theory on culture industry, political satire, patriarchy, and public morality; intersections of class, caste, gender, and racial violence in visual media.

HSS F251 Introduction to Discourse and Conversational Analysis 2 1 3

History and background of discourse analysis; relationship of discourse and society; patterns in text organization; genres and text types; stance of writers; patterns in talk and conversations; stance of speakers; databases and corpora; methodologies and tools for conversation analysis.

HSS F252 International Law 3 0 3

services; Theories of International Law: Realism, idealism, and other schools; Process of making of international laws; Role of international institutions in the making of international law; Law of treaties, ratification, reservation and withdrawal process; International courts and tribunals; State and international law,, recognition of states, statehood, sovereignty; Evolution of law of the seas and air space; High seas as global commons; Law related to freedom of navigation on high seas and airspace; Digital sovereignty and international cyber laws, data theft and breach of privacy; International environmental law; International climate change treaty; Law to protect biosphere; Legal aspects of international sanctions; Rule of law in international politics: Use and abuse.

HSS F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

HSS F311 Introduction to Videogame Studies 3 0 3

Introduction to videogames- a brief history of videogames, game studies as a multidisciplinary academic field, play and game- deconstructing videogames: narrative structures of

videogames, critiquing rules in videogames, immersion and materiality- puzzles, drama and socio-technical system of video games- Themes of videogames: violence, addiction, language, sexuality, gender, identity, communities, values and ethics- game genres: e-sports, indie games, serious games-gamification, game design; developing story, action and characters in videogames- Game market and economics, game journalism.

HSS F312 Bureaucracy **3 0 3**

Course description is to be developed.

HSS F313 Introduction to Contemporary Arts **3 0 3**

Methodologies of viewing contemporary art and its cultural, political, Philosophical and environmental underpinnings- the basic principles of Western and Eastern art - Indian art history at a glance - different mediums of artistic practice through the ages - modern art- connecting art and technology.

HSS F314 Maritime Governance and Naval Diplomacy **3 0 3**

A comprehensive idea on the growth of maritime history, evolution of maritime economies, conventional and evolving strategic concerns, responses and naval diplomacy- Maritime communities: structures, changes and influences Evolution, Growth & Development of Maritime Transportation -Maritime Mobility- Growth of Ancillary Sector- Maritime Issues & India International Port & Shipping Economy- National, Regional & International Maritime Security Paradigms- Maritime Governance

HSS F315 Society, Business and Politics **3 0 3**

Course description is to be developed.

HSS F316 Popular Literature and Culture of South Asia **3 0 3**

South Asia as a region; culture and its representation through literature and cinema; politics of representation, breaking the stereotypes; bringing in the marginalized voices; writings of women; identity formation; concept of majority and minority; commonality in spite of all the differences, violence, migration and dislocation.

HSS F317 Introduction to Globalization **3 0 3**

Main themes and concepts: Globalization, Globalism, Localization, Glocalization; Dimensions of Globalization: Social, cultural, economic, political and ideological; Processes related to Globalization: Internationalization, Westernization, Americanization, Neo- Colonialization; Relationship with issues of environment, city, consumption, media, inequality; Development; Impact and consequences of Globalization in India; Challenges and future of Globalization: Anti-Americanization and Anti-Globalization Movements.

HSS F318 Introduction to Anthropology **3 0 3**

Introduction to Social and Biological Anthropology: Human Nature, Race, Evolution; Sex, Gender, Family; Archaeology: Domestication, Agriculture, and Civilization; Cultural Anthropology: Nature of Culture, and Cultural Relativism; Nature of Language and Languages.

HSS F319 Lighting for Theatre and Films **2***

Design principles and elements of design; lighting instruments; lighting mechanics, rigging and focusing lights; color and color theory, psychology of color, color mixing; lighting paper works, lighting for play, opera, thrust, musical, proscenium, arena and films.

HSS F323 Organizational Psychology **3 0 3**

Industrial/Organizational Psychology, Hawthorne Studies, Leadership-Theories, Motivation-Concepts, Personality & Values: Strengths & Weaknesses, Employee Issues: Recruitment, Training & Development, Organizational Change & Development-Psychosocial Aspects, Organizational Culture & Climate, Work-Family Balance, Stress and its Management, Positive Organizational Psychology.

HSS F325 Cinematic Adaptation **3 0 3**

Essentials of literature; types and characteristics of literary writings: story and plot, character, theme, setting, point of view, incidents, characters, and dialogues; film history, types of adaptations; features of adaptations; importance of adaptations; trend of adaptations; process of adaptation; cinematic text; essentials of cinema: dialogues, text, screenplay, etc.; critical analysis of adaptations; current trends and challenges.

HSS F326 Humanities and Design **2 2 3**

Ideas and Designs, Thinking about New Designs, Perspectives to Design: Historical, Social, Technical and Creative Dimensions; Engineering Design and Problem Solving; Basic Concepts in Engineering Design; Design Skills, Abstraction, Identification of Patterns in Processes and Products, Application of Systematic Techniques to Problem Solving, Application and Adaptation of tools and technologies to new problems; Core Principles of Design; Elements of Design, Form and Functionality, Central Activity of Engineering Designs; Language and Interface Design, Design Thinking: Influence of Context Vs. Conflict with Context.

HSS F327 Contemporary Drama **3 0 3**

Course description is to be developed.

HSS F328 Human Resource Development **3 0 3**

The strategic role of human resources management; human resource development – concept, goal, mechanism, and design the system; manpower planning and policies; staffing process-recruitment & placement, job analysis, selection, managing employee separation, downsizing and outplacement; maintaining & developing people- training & development, developing managers, appraising performance, managing career, employee remuneration; governance- developing employee relations & communication, respective employee rights & managing discipline; trade union; managing safety & health.

HSS F329 Musicology – An Introduction **3 0 3**

Music and it's philosophy, history of music, different theories regarding the development of music, music as an exact science (mathematics), musical terminology, musical forms and their background, composers, artistes and their contributions, music of different cultures, music and film world, music therapy. Emphasis would be laid on research and knowledge gained through self-experience.

HSS F330 Appreciation of Art **3 0 3**

Visual perception and basic techniques used in art, compositional balance, space, movement form, light colour, texture, tensions, expressions lines; mainstreams of art; influence of Indian art abroad; various schools of art-Greecian, Medieval, Christian Renaissance, Baroque and Romanticism, impressionism and post impressionism, fauvism, futurism, expressionism, Dadaism and surrealism, metaphysical art, non-representational and abstract art; analysis of work of art and their evaluation.

HSS F331 Sankara's Thoughts **3 0 3**

Life and achievements of Adi Sankara; pre-Sankara Vedanta; basic concepts and theories of Advaita: Atman and Jeeva, nature, sources and validity of knowledge, Brahman and Isvara, Maya and World, Avidya, bondage and liberation; Sankara's contribution to Indian heritage.

HSS F332 Cinematic Art **3**

Cinema as an art form; elements of cinema; defining form, style types, rhyme as adopted in global cinema; new idiom in Indian cinema; experimental techniques; evolution of the language of cinema; analysis of Japanese, Swedish, American, French and Indian cinema ; theatre and cinema.

HSS F333 Comparative Religion **3 0 3**

A clear objective description of the great religions and their appeal to the spiritual aspirations of the different people of the world; a comparative non-sectarian approach to the understanding of Hinduism, Buddhism, Islam and Christianity; a final summing up bringing the unity of all religions of the world.

HSS F334 Srimad Bhagavad Gita **3 0 3**

The science of Soul; Reincarnation; Karma; Karma Yoga; Transcendental Knowledge; Action in Krishna consciousness; Dhyana Yoga; Knowledge of the Ablolute; Attaining the Supreme; The process of Transmigration; the most confidential knowledge; Bhakti Yoga – The process to go back home, back to Godhead.

HSS F335 Literary Criticism **3 0 3**

Aristotle, Dryden, Johnson, Coleridge, Arnold, Eliot.

HSS F336 Modern Fiction 3 0 3

E.M. Forster, Virginia Woolf, Joseph Conrad, Aldous Huxley, D.H. Lawrence.

HSS F337 English Literary Forms and Movements 3 0 3

This course is designed to provide a historical perspective on major forms and movements in English Literature and to develop an insight into various social, religious and other influences on their birth and growth. The course will cover the entire range of literature from renaissance and reformation to modern times.

HSS F338 Comparative Indian Literature 3 0 3

This course is intended to acquaint the students with literary achievements in Indian Languages and their home-environment and to give integrated view of Indian literature, literary selections from the best writers in the Indian languages will be studied.

HSS F339 Theatre Art-Acting and Production 3 0 3

General historical background of theatre; general knowledge of acting; its tools and exercises; voice training and practice; a study of stage; various systems of theatres; rehearsal techniques and stage management.

HSS F340 Post Colonial Literature 3 0 3

Introduction to Post colonial discourses; Post Co-lonial Concepts: Colonization, De-colonization, Linguistic colonization, Politics of representation, Orientalism, Euro-centrism, Hybridization, Select Literary Texts.

HSS F341 Performance Design 3 0 3

Study of a dramatic text and its genre, structure; plot, time, theme and its development, character;music and spectacles; conceiving scenography: basic principles of design; reading the hidden image in the text; performance and show; organizing performing space, conceiving light, music, and sound;staging the show: final production.

HSS F342 Advanced Communicative English 3 0 3

Pronunciation, Accent, Intonation, Vocabulary, Active Listening, Conversation, Group Discussion,Dynamics of Writing, Art of condensation, Dictogloss, Critical Essays, Academic Essays, Term Paper, Book Review.

HSS F343 Professional Ethics 3 0 3

Ethics, nature and purpose; ethical theories; ethics in business and management; ethics in engineering, global ethical issues.

HSS F344 Heritage of India 3 0 3

Foundations of India; India and her ancient culture; life of the people; systems of Indian philosophy; art and archaeology; languages and literature; impact on world civilization; Western influence.

HSS F345 Gandhian Thoughts 3 0 3

Sources of Gandhian thoughts, metaphysical convictions, ethical principles, ends and means; Gandhi and religion; theory of satyagraha; political thought; economic thought; social reforms; untouchability; Gandhi and Muslims; Gandhi and women; some items of constructive programme, Gandhi and Marx; his nonviolent state; Gandhism after Gandhi.

HSS F346 International Relations 3 0 3

Rise of nationalism, World War I, Interregnum; World War II and after; bi-polar politics and detente; instruments for promotion of national interest; diplomacy; propaganda and political warfare; integration of Western Europe; West Asia and world politics; panchsheel and nonalignment; major national foreign policies--USA, USSR, UK and Pakistan; disarmament; UN and World peace.

HSS F347 Introduction to Carnatic Music 3 0 3

Origins and History of Carnatic music; Basic concepts of svara, svaravalis, svarasthanas, aarohana, avarohana, sthayis; Concept of laya, tala, gati, nadai, different jaati's of taalams; Concept of raaga, Melakarta and janya; Ragalakshanam for some specific raagas; Notation of svaras, taalam; Brief biography of the Trinity, Purandaradasa, and other major composers; Concert formats and styles; Vocal or instrumental exercises including varisais, Saptataala alankaaras, Geetams, svarajati, keertanams; Listening practice.

HSS F348 Introduction to Hindustani Music 3 0 3

Origins of Hindustani music and evolution of the style; Basic concepts of melody and rhythm: Naad, Dhwani, Sangeet, Swar, Laya, Raag, Taal, Shuddh- Vikrit, Chal-Achal, Mandra-Madhya-Taar, Poorvang – Uttarang, Saptak - Ashtak, Sthayee – Antara, Aroha- Avaroha, Raag-Jati, Tal Jati, Alap-Tan, Varn, Alankar, Pakad, Bandish, Vilambit-Madhya-Drut, Matra, Theka, Vibhag, Tali, Khali, Sam. Raaga, Thaat, raag vivara; Compositions: khayals, dhrupad, taraana etc; Vocal or instrumental exercises including ten alankars, Identification of svaras, Aroh, avaroh and pakad of simple raags viz. Yaman, Bhoop, Khamaj, Des, Kafi, Bhimpalasi, Bageshri, Durga; Sargam geets, lakshan geets and madhyalay khayals; Taals including Trital, kaharva, daadra; Listening, identification of raaga from simple phrases.

HSS F349 Ecocriticism 3 0 3

Defining Ecocriticism; Interdisciplinarity; Ecosystem and Biodiversity; Ecology and Environment; Developmental Ecology; Ecocritical Concepts; Literary Ecocriticism; Application of Ecocritical Principles in Literature - tinai Criticism; Deep Ecology; Bioregionalism - Cultural Ecocriticism; Ecocinema - Debates on Anthropocentrism and Biocentrism/Ecocentrism; Food documentaries; Animal Studies; Ecophobia; Gaia Theory; Ecocriticism and Society; Ecopolitics and Activism; Ecospirituality and Ecosophy; Practical Ecocriticism.

HSS F350 Human Rights: History, Theory & Practice 3 0 3

The meaning and history of human rights; Human rights debates and controversies; Political, civil, social and economic rights; Culture and human rights; Themes - Democracy, dictatorship, and human rights; Science, technology, and human rights; Ethnicity; Gender; Children's rights and others;Evaluating the progress made and challenges in practice of human rights.

HSS F351 Social and Political Ecology 3 0 3

Environmental History and Social construction of nature; Theoretical perspectives on Natural Resource use; Ecological Development; Natural Resource Governance; Ecological Identity and Social Movement-Gender-based dimensions; Degradation and Marginalization; Conservation and Control; Ecotourism; Urban Ecology; Regional case studies.

HSS F352 Technology, Work and Society 3 0 3

Work during and after Industrial Revolution; Major theoretical contributions to the study of Work; Technology and its impact on work in the 21st century; Work and self in the service industry; Work and self among professionals and managers; Changes in Culture of Work; Domestic labor and the politics of household work; Modern distinction between work and family.

HSS F353 Philosophy of Aesthetics 3 0 3

Fundamental questions related to art, its purpose and manifestations as well as foundational problems such as, ideology, ontology, values attached, implicit/explicit meanings, connections with other disciplines, social manifestations and implications, historical contexts, mediums and representations. Important Indian and Western perspectives on aesthetics through music, literature, painting and cinema, contextualizing them in history.

HSS F354 Introduction to Islamic Economy 3 0 3

Islamic Finance and Islamic digital economy, Halal industries, Halal tourism, Islamic art and design, Islamic economy standards and certification, and Islamic information and education.

HSS F355 Dictatorship, Democracy & Development 3 0 3

Overview of the relationship between political regimes and development; how regimes matter: top-down interventions and bottom-up pressures; key concepts: democracy, dictatorship, civil society, social movements, social capital, human development; survey of academic literature to understand "democracy advantage"; country studies: Brazil, China, India; relevance and limitations of the relationship between political regime type and development.

HSS F356 Social Movements and Protest Politics 3 0 3

Need for studying social movements ; origins, forms, trajectory, outcomes of social movements ; key participants; protestors objectives, their achievements / failures ; the Civil Rights Movement ; women's movements in the US and Europe; prodemocracy movements in Brazil; Islamic movements in the Middle East; The Christian Right in the US; the Hindu nationalist movement in India ; Maoism in India; anti-corruption protests.

HSS F361 Urban Policy and Governance 3 0 3

Urban, urbanization, urbanism- the concepts; Major schools of thought in urban sociology; Patterns of urbanization- World urbanization, third world and India; Urban processes- assimilation, segregation, differentiation, suburbanization, Core-periphery, urban sprawl, primate city, right to city; Factors of urbanization- Natural growth, migration and re-classification; The constitutional and political dimensions of urbanization in India; Urban growth in post-liberalization era and informal economy in cities; Urban problems; Urban policy history in India and contemporary policy measures; Future of urbanization in India.

HSS F362 Local Governance and Participation 3 0 3

Political role of Panchayat Raj - Decentralisation below state level, Decentralised planning, Panchayati Raj Bills, Acts and Constitutional amendments, Grassroots politics; Inclusiveness and Participation - Women in Panchayati Raj, Impact of reservation in local bodies, Democracy and social capital, Local democracy and clientelism; Functional and Financial Devolution - Fiscal decentralisation to the sub-state level governments, Functional devolution to local bodies, Federalism, urban decentralisation and citizen participation, Poverty alleviation and efforts of panchayats; Challenges and Prospects of Local Government and Participation- Neighbourhood associations and local democracy, Experiment with direct democracy, Law of two-child norm in Panchayat, Beyond feminine public altruism.

HSS F363 Disaster and Development 3 0 3

Disaster and Development - Concepts and contemporary debates, How disasters impact development, How development can induce vulnerability, Role of Planning in Disaster Management; Disaster Risk Assessment - Risk and Uncertainty, Multihazard analysis, Vulnerability and Capacity analysis, Risk evaluation and decision making; Mainstreaming Disaster Risk Reduction into Development - Mainstreaming of Frameworks and tools, Policies, Plans and Regulations, Challenges: data and modelling limitation, political and economic consideration; Disaster Management Planning - Need and impact assessment, Business Continuity Plan (BCP), Response and recovery planning.

HSS F364 Political Economy of Gulf Cooperation Council States 3 0 3

Overview of Gulf History and Society: History in a nutshell; Religion, Language, Identity and Culture, Rentier State, Citizenship; Political and Social Change in the Gulf: Nationalism, Rule of Law and Political Liberalization, Gender and Participation; Media, Bureaucracy and Civil Society Groups; Economic Reforms and Governing Structure: State-Business Relations, Islamic Finance Development, Oil based Economy to Knowledge Economy, Resource Curse, Labour Market & Migration Policies; Internationalization of the Gulf: Security and Strategic Trends, Foreign Policy with International Reach, Environment, Energy, Maritime and Sustainable Policies, Challenges in transition.

HSS F365 Science of Sustainable Happiness 3 0 3

Introduction to Science of Happiness; What Determines Happiness; Happiness Model and Model of Sustainable Happiness; Power of Social Connection; Managing Stress, Hardship, and Trauma; Living in the Present, Committing to Your Goals; Compassion and Kindness; Cooperation and Reconciliation; Mindfulness; Gratitude; Mental Habits of Happiness; If You are Depressed; New Frontiers and Happiness "Fit"; Five Hows Behind Sustainable Happiness; Sustainability, Happiness and Education.

HSS F368 Asian Cinemas and Cultures 3 0 3

Introduction; The ideas of Asia; Asia as method; India andher neighbors; BRICS and ASEAN; Look East Policy;Cinema, Culture and Diplomacy; Cinema as Soft Power;Asian diaspora cinema; Indian Diaspora in the East;Cinemas from the Middle East; Iranian Cinema after theRevolution; Cinemas of & on the Israel-Palestine conflict-New Asian Metros; Thai Cinema and the global auteur;South Korean history through their Cinema; Filipino NewWave, Taiwanese New Wave; Chinese Cinemas after theCultural Revolution; Asianization of the West; India'sCine-Cultural Negotiations with her Asian Neighbors.

HSS F369 Caste and Gender in India 3 0 3

Concepts - Caste and Gender; Materialist and religioustheories; Caste Ideologies; Caste, class and genderintersections, Gender construction within castes; GradedPatriarchies; Colonial impact on caste and gender; Casteand Gender in contemporary period; Oppositional narrativesto caste and gender construction; Legal interventions.

HSS F371 Cities-Life, Issues and Conflicts 3 0 3

The origin and growth of city; Theories and paradigms of cities; Spatial, socio-economic, political and cultural perspectives of cities; Social psychology of cities; Conflicts and changes within a city; City and the environment; Globalization impact on urban development in the Indian context.

HSS F372 Introduction to Social Psychology 3 0 3

Interaction between human and social situation; social environment and people and vice versa; fundamental theories; concepts; research methods in social psychology; past and present research related to social psychology; application of social psychological concepts to understand real life situation; social perception, social cognition; group dynamics; aggression; application of social psychology in law, health, and organizational sector; impact of social networking on life.

HSS F373 Shakespeare and Popular Culture 3 0 3

Renaissance political exigencies of government and theater; Shakespeare as popular culture in renaissance England; Shakespeare adaptations; case study of hamlet; the prince's right to govern; use of political force; early modern cultural expectations of the governed; renaissance individual's reliance of fortune; Machiavelli's The Prince; Castiglione's the book of the courtier. Recent popular representations of Hamlet; cotemporary relevance; nature of artistic composition; the discursive nature of the relationship between the past the present.

HSS F374 Urban Modernity and the Renewal of Paris 3 0 3

1850s – 1870s Street level reform; hygiene; circulation of capital; Modernity and Urban planning; theoretical background of urban planning; role of Baron Haussmann; notion of any modern city; political and artistic effects of urban planning; advertising and modern consumer culture in 1850s – 1870s.

HSS F375 Business and Politics in Colonial and Post Colonial India: a historical approach 3 0 3

Introduction to Indian Economic history; Dominant paradigms; Historical origins of Indian business, Caste, community networks and diaspora in early modern India and the Indian Ocean; Workings and impact of colonial rule on the Indian economy; Industrialization in India- challenges and way forward; Bazar economy; Indian capitalism; Business and Politics; Premier business houses and their strategies. The Informal sector; Business in new India.

HSS F378 Cinemas of India: From Past to Present 3 0 3

The emergence of cinema in India; early cinematic forms in India; the studio era; the rise of language cinema in India; social and mythological as popular film genres; melodramatic mode of Indian cinema; national and regional cinemas from India; Indian cinema and modernity; realism and Indian cinema; Indian new wave; Indian documentary films; star system and cine-politics; corporatisation of Indian film industries; media convergence and Indian cinema; gender and figuration in Indian cinema; Indian cinema after digital turn; indie cinematic practices from India.

HSS F379 Introduction to Philosophy of Science 3 0 3

Introduction; Philosophy and science, Science and pseudoscience, Focal questions of philosophy of science, Philosophical roots of science; ancient and modern, Nature of scientific reasoning; deduction and induction, Problem of induction, Inference to the best explanation; arguments for and against, Induction-Probability connection; Scientific explanations; Causality, Metaphysics of science; realism and anti-realism, Scientific change and scientific revolutions; Kuhn - paradigm shift, incommensura-

bility, theory-ladenness; Philosophical problems in science; Physics – absolute space, Biology – species problem and classification, Psychology – Architecture of mind; Criticism of science; Values in science.

HSS F399 Introduction to American Literature 3 0 3

Socio-cultural and literary history of the United States since the landing of the Pilgrims from *The Mayflower* to the decisive American victory over the Axis powers in World War II. (1500-1700) Etablishment of Plymouth Plantation and the establishment of early Puritanism. (1700-1800) Influence of Enlightenment thought on American life and letters and Consequences of the Revolutionary War on literature. (1800-1865): American Literary Nationalism, the westward expansion, and the American Civil War. (1865-1914): Reconstruction period, Mexican War, imperial expansion to the Southwest, building of transcontinental railroads, the American frontier issue, industrialization and transformation of American life and their effects on the literary marketplace. (1914-1945): the two world wars, the Great Depression, Modernism and Modernity in American life and letters, Harlem Renaissance, increasing presence of science and technology in everyday American life.

HSS G511 Philosophical Foundations of Liberal Studies 3 2 5

Idea of being; modes of being; causation; metaphysicaleducation; natural education; social education;refutation of metaphysics; concept of necessity;humanism; epistemology; search for the method ofscience; Reasoning – constructing Arguments-Standards for constructing and evaluating arguments;validity, truth, and soundness; Fallacies; Project

HSS G512 Theoretical Approaches to Liberal Studies 3 2 5

Introduction to Ideologies in Social Sciences;Developmentalism, Political Culture, Sociologicalapproaches; Psychoanalysis as bridging the fields ofhumanities, natural and social sciences; Institutionsand institutionalism; Irrationalism; Environmentalism;Sociobiology; The present as post; Culture,Intellectuals and Media; Indigenous theories of change;Project

HSS N201T Intro to Photography* 3 0 3

HSS N202T Ind C Dance Bharatnatyam* 3 0 3

*Course Description is to be developed

HSS N203T Basic Arabic 3 0 3

Arabic of basic level, Recognition of Arabic alphabets with its different writing patterns, Phonetics and peculiar Arabic sounds, Familiarity with the basic vocabulary, Familiarity with profession specific words and phrases, Grammar, Sentence patterns and expressions for daily communication, Reading, writing, listening and speaking skills at initial level, Focus on modern standard Arabic and its comparison with colloquial and local dialect, exercises and practice.

HSS N301T Elements of Dance 1 1 2

Introduction to elements of dance; dance sense; dance pathway; relationship of dance with culture, society, geography and arts; dance workout, salsa, ballet, folk, classical, contemporary, musical theatre

Humanities

HUM G511 Introduction to Health Systems 3 0 3

Health facilities for SC/ST; Health Systems; Evolution of Medicine; Sociology, health and medicine; Primary health care; Health Development; Health education; Health policy in India; Issueslike euthanasia, consumer forums, child labor; Female infanticide; women's health; Role of hospitals; Advances in Public Health; Communications; Evaluation of National Health Systems; Demography; Family Planning; Psycho-social issues.

Instrumentation

INSTR F211 Electrical Machines 3 1 4

Transformer: Constructional features, equivalent circuit and phasor diagram - regulation and efficiency, parallel operation. Three phase transformer connections; Harmonic in transformers; Testing; Phase conversion; Autotransformer. D.C Machines: Construction, armature windings, armature voltage and torque equations, classification. D.C generators, performance characteristics; D.C motors - torque/speed characteristics, speed control and braking. Testing and efficiency. Induction machines: Constructional features and rotating magnetic field. Circuit model and phasor diagram. Steady state characteristics. Testing, starting and speed control. Time harmonics and space harmonics. Wound rotor induction motors, Single phase induction motors - classification and equivalent circuit. Synchronous machines: Constructional features; synchronous generators and motors; equivalent circuit and phasor diagram; power and torque characteristics and capability curves. Parallel operation. Salient pole synchronous machine - phasor diagram and determination of synchronous reactances; starting and speed control of synchronous motors. Special machinesuniversal motors, Induction generators.

INSTR F212 Electromagnetic Theory 3 0 3

Review of mathematics - scalar and vector fields, calculus of scalar and vector fields in Cartesian and curvilinear coordinates, Dirac delta function; Electrostatics - electric field, divergence & curl of electric field, electric potential, work and energ y in electrostatics, conductors, electric dipole; Electrostatics in Matter - polarization and field of a polarized object, electric displacement, linear dielectrics; Magnetostatics - Lorentz force law, Biot-Savart law, divergence & curl of magnetic field, magnetic vector potential, magnetic dipole; Magnetostatics in matter - magnetization and field of a magnetized object, the H-field, linear & non-linear magnetic media; Electrodynamics - electromotive force, electromagnetic induction, Maxwell's equations in free space, plane wave solutions of Maxwell’s equations in free space.

INSTR F214 Electronic Devices 3 0 3

Crystal structure and growth of semiconductor, electrical conduction in solids, Elementary quantum physics (Photoelectric effect, uncertainty principle, Schrodinger wave equation and tunneling), energy bands in solids, charge carriers in semiconductors, excess carriers in semiconductors, Fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, metal semiconductor junctions Bipolar junction transistors, field effect transistors (JFET, HEMT, MOSFET),Special diodes (varactor diode, solar cell, LEDs, Tunnel diode and HBT), dielectric materials and insulation (Polarization mechanisms, frequency dependence, dielectric strength and insulation breakdown).

INSTR F215 Digital Design 3 1 4

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

INSTR F216 Electronic Devices Simulation Laboratory 0 2 2

Hands on simulation experience of Electronic Devices (Diodes, BJTs, MOSFET and MOS Capacitor) using Sentarus TCAD; Simulation of electrostatics of various Electronic Devices and their effects on the device performance.

Pre-requisites:

EEE F214 / INSTR F214 / ECE F214 : Electronic Devices

INSTR F241 Microprocessors and Interfacing 3 1 4

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system. This course will have laboratory component.

INSTR F242 Control Systems 3 0 3

Modeling and classification of dynamical systems, Properties and advantages of feedback systems, time-domain analysis, frequency-domain analysis, stability and performance analysis, State space analysis, controller design.

INSTR F243 Signals & Systems 3 0 3

This course is intended to provide a comprehensive coverage of

Signals and Systems, a fundamental subject of Electrical Engineering. The topics covered are: Continuous-time and discrete time signals and systems, convolution, properties of linear time-invariant (LTI) systems, Fourier series, Fourier transform, Z transform, Laplace transform; System analysis, frequency response, analog filters, Sampling and reconstruction.

INSTR F244 Microelectronic Circuits 3 0 3

Basic microelectronic circuit analysis and design, biasing in discrete and integrated circuit amplifiers, an overview of modeling of microelectronic devices single and two transistor amplifier configurations with passive and active loads; current mirrors & current sources; single-ended and differential linear amplifiers , differential and multistage amplifiers; 2 stage CMOS OPAMP, frequency response of amplifiers; negative feedback in amplifiers, R-C frequency compensation.

INSTR F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

INSTR F311 Electronic Instrumentation & Instrumentation Technology 3 1 4

Electronic indicating, display, recording and analysis instruments, signal generators, frequency synthesizer, counters, elements of design, grounding and shielding, electronic circuits manufacturing technology, metrology, standards in quality management, instrumentation in hazardous area, industrial communication techniques.

INSTR F312 Transducers and Measurement Systems 3 0 3

Importance and types of measurement, generalized measurement system, functional elements, static & dynamic characteristics, primary sensing elements, passive transducers, active transducers, inverse transducers, fiber optic transducers, MEMS based transducers, measurement techniques for motion, seismic, pressure, flow, temperature, level, humidity, pH, viscosity; signal conditioning techniques using bridge, op-amp, instrumentation amplifier, carrier, chopper, charge, isolation amplifier, data converters, filters, modulators; data acquisition systems.

INSTR F313 Analog & Digital VLSI Design 3 0 3

Moore's Law, Y chart, MOS device models including Deep Sub-Micron effects; an overview of fabrication of CMOS circuits, parasitic capacitances, MOS scaling techniques, latch up, matching issues, common centroid geometries in layout. Digital circuit design styles for logic, arithmetic and sequential blocks design; device sizing using logical effort; timing issues (clock skew and jitter) and clock distribution techniques; estimation and minimization of energy consumption; Power delay trade-off, interconnect modelling; memory architectures, memory circuits design, sense amplifiers; an overview of testing of integrated circuits. Basic and cascaded NMOS/PMOS/CMOS gain stages, Differential amplifier and advanced OPAMP design , matching of devices, mismatch analysis, CMRR, PSRR and slew rate issues, offset voltage , advanced current mirrors; current and voltage references design, common mode feedback circuits, Frequency response, stabilty and noise issues in amplifiers; frequency compensation techniques.

INSTR F341 Analog Electronics 3 1 4

Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short; Analysis of simple operational amplifier circuits; Effects of real operational amplifier parameters on circuit performance. Linear applications of operational amplifiers: Instrumentation and Isolation amplifiers; Current and voltage sources; Active filters. Non-linear applications of operational amplifiers: Comparators; Linearization amplifiers; Logarithmic amplifiers, multifunction modules & circuits, true rms convertors, Precision and signal conditioning circuits, Waveform Generation: sinusoidal and non-sinusoidal signal generation; Wave shape converters. Timer 555 based circuits, Phase lock loop circuits & applications, IC regulators, Output stage and large signal amplifiers, Power amplifiers, Tuned amplifiers, Analog and Digital interface circuits: A/D, D/A Converters.

INSTR F342 Power Electronics 3 1 4

Need for power conversion; Power electronic converters: classifications and scope; Power semiconductor switches: diodes, SCR , GTO and transistors (BJT, MOSFET and IGBT): Ratings, static and dynamic characteristics, drive and switching aid circuits and cooling; DC to DC conversion: Buck, Boost and Buck-Boost converters: circuit configuration and analysis with different kinds of loads; Choppers: single quadrant and two quadrant operation with DC motor load and steady state analysis; Rectifiers: single phase and three phase operation, power factor, harmonics and effect of source inductance; Dual converters; Drive concept: Four quadrant drive and load characteristics, selection of motor, control and stability of electric drives, feed back control of drives; DC motor drive; Inverters: single phase and three phase bridge inverters and PWM inverters; Single phase AC voltage regulators and cycloconverter; Induction motor drive - Variable frequency operation of 3- phase induction motor, stator voltage control and V/f control methods; Non-drive application of power electronic converters: UPS, active power line conditioner, electronic ballast and induction.

INSTR F343 Industrial Instrumentation and Control 3 0 3

Importance of process control, elements of process loop, mathematical modeling, dynamic closed loop characteristics, controller principles & tuning, direct digital loop, hydraulic controllers, pneumatic controllers, electronic controllers, complex & multivariable control schemes, final control elements, P& I diagrams, PLCs, Distributed Control Systems (DCS), AI techniques: expert systems, neural networks, fuzzy logic, genetic algorithms & applications.

INSTR F366 Lab Project 3

INSTR F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

INSTR F376 Design Project 3

INSTR F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

INSTR F411 Opto-Electronic Instruments 3 0 3

Optical radiation-its emission, control and detection; optical signal processing; amplifiers and associated electronic equipments. Opto-electronic system design-calorimeters, spectrophotometers, flame photometers, fluorimeter and turbidimeters; project equipments; introduction to laser-based instruments.

INSTR F412 Analysis Instrumentation 3 0 3

Generalized configuration of an analysis instrument. Off-line analysis instruments: emission spectrometers, UV/VIS/IR absorption spectrophotometers, flame emission and atomic absorption spectrophotometers, X-ray fluorescence spectrometer and diffractometer, NMR and mass spectrometers, pH-meters, gas chromatographs, electrochemical instruments, analytical electron microscopes. On line analyzers: Sampling systems for gases and liquids, fluid density monitors, consistency and viscosity analysers, thermal conductivity gas analysers, paramagnetic oxygen analysers, chemical composition analysers, on-line instruments for measuring standard parameters, e.g. vapour pressure, distillation characteristics, cloudpoint, pour point, flash point etc. Recent developments.

INSTR F413 Advanced Process Control 3 0 3

Process identification and adaptive control; Model predictive control structures; Model-based control structures; State estimation; Synthesis of control systems-some case studies; intelligent control.

INSTR F414 Telecommunication Switching Systems & Networks 3 0 3

Intoduction, electromechanical switching, pulse dialing and DTMF dialing, stored program control, space division switching, speech digitization and transmission, time division switching, fundamentals of traffic engineering, telephone networks, signaling, data networks, layered architecture and protocols, LANs, packet switching networks, TCP/IP, ISDN, ATM networks.

INSTR F415 Digital Control **3 0 3**

Course Description is to be developed.

INSTR F419 Virtual Instrumentation **3 1 4**

Fundamentals of virtual instrumentation--- Concept of virtual instrumentation – PC based data acquisition – Typical on board DAQ card – Resolution and sampling frequency - Multiplexing of analog inputs – Single-ended and differential inputs – Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card - Use of timer-counter and analog outputs on the universal DAQ card. Concepts of graphical programming – Lab-view software – Concept of VIs and sub VI - Display types – Digital – Analog – Chart – Oscilloscopic types – Loops – Case and sequence structures - Types of data – Arrays – Formulae nodes –Local and global variables – String and file I/O., Analysis tools and simple applications :Fourier transform - Power spectrum - Correlation – Windowing and filtering tools – Simple temperature indicator – ON/OFF controller – P-I-D controller - CRO emulation - Simulation of a simple second order system.

INSTR F420 Design of Instrumentation Systems **3 0 3**

Design of transducers, signal conditioning circuits, instrument air system, control valve, control panel design, Human machine interface, Reliability, Electronic product design, Noise reduction, P&I diagrams, safety instrumentation systems, life cycle activities: requirement specifications, I&C system design and implementation, system integration, validation, operation maintenance, case studies of ISD in various sectors.

INSTR F422 Instrumentation for Petrochemical Industry **3 0 3**

Petroleum Processing: Petroleum exploration – Recovery techniques – Oil - Gas separation –Processing wet gases - refining of crude oil, Unit Operations in Petroleum Industry: Measurement in Petrochemical Industry: Parameter to be measured in refinery and petrochemical industry – Selection and maintenance of measuring instruments – Intrinsic safety of instruments Control Loops in Petrochemical Industry: Process control in refinery and petrochemical industry – Control of distillation column control of catalytic crackers and pyrolysis , Automatic control of polyethylene production – Control on vinyl chloride and PVC production.

INSTR F423 Electronic Material Design and Simulations Laboratory **1 2 3**

Reviewing the basic Theory for Crystalline Solids (Crystal group, real Space, reciprocal space), Introduction of the Concept of Density Functional Theory (Many Electron Scenario, Born-Oppenheimer Approximation, Hartree's Formulation, Hohenberg and Kohn Theorems, Energy Functional, Kohn Sham Scheme), Familiarization with Quantum Espresso (Plane Wave Basis Set, Exchange Correlation Functional, Pseudopotential, Brillouin Zone Sampling, Quantum Espresso input file format), Theoretical Calculation of Structural Properties of Materials (Unit Cells and Super Cells, Lattice Vectors, Ground-state Energy, Bond-Length and Bond Angles), Theoretical Calculation of Electronic Properties of Materials (Energy Band Profiles and Density of States, Projected Density of States), Theoretical Calculation of Optical Properties of Materials (Optical Spectrum), Introduction of Doping in Materials (Effects on Electronic and Optical Properties), Introduction of Strain in Materials (Effects on Electronic and Optical Properties) Simulation of 2D materials like Graphene and MoS2.

Pre-requisites:

EEE F214 / INSTR F214 / ECE F214 : Electronic Devices

INSTR F424 Smart Grid for Sustainable Energy **3 0 3**

Introduction to Smart grid, Renewable Power Generation and Energy Storage, Microgrid, Power System Economics and Electricity Markets, Demand Response, Various Sensing, Communication, and Control technologies, and Application of Data Science.

Pre-requisites:

EEE F242 / INSTR F242 / ECE F242 : Control Systems

INSTR F428 Energy Storage Systems **3 0 3**

Need of Energy Storage; Broad classification of Energy Storage Systems and applications; Electrochemical Energy Storage Systems; Battery Storage; Application oriented choice of Batteries; Electrical interface system design for Batteries with Renewable Energy sources; Battery Management Systems (BMS); Hydrogen Energy Storage; Its application as Fuel cell, Electrical Energy Storage; Thermal Energy Storage; Mechanical Energy Storage and their applications.

INSTR F432 Medical Instrumentation **3 0 3**

Basic components of bio-medical instruments, bio-electric signals & recording electrodes, transducers, recording and display devices. Patient care and monitoring systems, cardiovascular measurements-blood pressure, blood flow, cardiac output, heart sounds etc.; instrumentation for respiratory and nervous systems, analysis of EEG, ECG, EMG, EOG and action potentials, non- invasive diagnostic measurements - temperature, ultrasonic diagnosis, CAT scan techniques, sensory measurements-motor response, analysis of behaviour etc. biotelemetry, biofeedback, clinical laboratory instruments, X-ray diagnosis. Recent advances in biomedical instrumentation- microprocessor based systems, lasers & optical fiber based systems.

INSTR F473 Wind Electrical Systems **3 0 3**

Thermodynamics of wind energy, Types of Wind energy conversion devices, Aerodynamics of wind rotors, design of wind turbine rotor, Power -speed characteristics, torque-speed characteristics, Wind turbine control systems, Wind speed measurements , Wind speed statistics, Site and turbine selection, Induction Generators, Wound field synchronous Generator, Permanent Magnet synchronous machine, Doubly fed induction generator, Power Flow equations, Power Semiconductor devices, Converters, Inverters, power quality, Reactive power compensation, Wind diesel hybrid systems, Wind photovoltaic systems, Role of Govt. and policies for market development.

INSTR F491 Special Project **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

INSTR G611 Advanced Control Systems **3 2 5**

Review of State variable modelling of linear continuous, linear discrete and non linear control systems; Time varying systems; Time domain solution; Controllability and observability; Stability; direct method of Lyapunov; Modal control; OptimalControl System; Calculus of variation, Minimum principle, dynamic programming, search techniques, Ricatti equation, Stochastic processes and Stochastic estimation and control; Adaptive Control system.

INSTR G612 Instrumentation Systems **3 2 5**

Generalized approach to measuring systems; performance characteristics of instruments; primary sensing elements and transducers; analog and digital signal conditioning operations; microprocessors in instrumentation; applied process control instrumentation; General purpose and analytical instruments covering spectroscopic, separation, atomic absorption instruments UV-VIS-IR,GLC, HPLC, etc; Instrumentation practices in typical R&D laboratories; instrumentation case studies covering selection, quality assurance, system design, etc; Hands on experi-

ence in operation of sophisticated instrumentation systems.

INSTR G621 Industrial Automation 3 2 5

Computer control theory, sampling of continuous time signals, computer oriented mathematical models, discrete time systems, and analysis of the same, translation of analog design, state space design methods, pole-placement design based on input/output models. Adaptive control principles, implementation of digital controllers, model reference adaptive systems, self-tuning regulators, stochastic adaptive control, auto-tuning, expert controllers, learning systems and other applications.

Information Systems

IS F211 Data Structures & Algorithms 3 1 4

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Recursive Data Types, Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues); Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, Quick Sort and Randomization), Lower Bound on Complexity of Sorting Algorithms. Unordered Collections: Hash tables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Probabilistic/Randomized Data Structures (such as Bloom Filters and Splay Trees). Generalized Trees – Traversals and applications. Text Processing – Basic Algorithms and Data Structures (e.g. Tries, Huffman Coding, String search / pattern matching). External Memory Data structures (B-Trees and variants). Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees).

IS F213 Object Oriented Programming 3 1 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; overloading and overriding; static and dynamic binding; multithreaded programming; event handling and exception handling; process of object oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages. Object Oriented Design Patterns: Behavioral, Structural and Creational.

IS F214 Logic in Computer Science 3 0 3

propositional logic – syntax, semantics, satisfiability & validity, predicate or first order logic – syntax, semantics, satisfiability & validity, completeness & compactness, Undecidability & incompleteness; Godel's incompleteness theorem; SAT solvers; verification by model checking, linear-time temporal logic (LTL), & computational tree logic (CTL). Program verification using Hoare logic & proofs of correctness; Modal logic & logic programming paradigm.

IS F222 Discrete Structures for Computer Science 3 0 3

Sets & operation on sets; relations & equivalence relations; number theory; weak & strong form of mathematical induction; principle of inclusion & exclusion, pigeonhole principle; recurrence relations & generating functions; digraphs & graphs, graph isomorphism & sub-graphs, spanning trees, Euler & Hamiltonian graphs, planar graphs, chromatic numbers & graph coloring; groups; Lagrange theorem finite groups; Rings & Fields.

IS F241 Digital Electronics and Microprocesors 3 1 4

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing; examples of system design.

IS F242 Computer Organization 3 1 4

This course covers the fundamentals of computer organization and architecture. Computer system components; Interconnection structures; Instruction set architecture; Computer arithmetic; Memory system; I/O systems; Control unit design; Instruction execution and scalar pipelining; Parallel processing and Super scalar pipelining; Introduction to parallel processing architecture including multi-core systems.

IS F243 Database Systems & Application 3 1 4

Introduction to Database Management Systems; Data Independence in databases; DBMS architecture; Data Models; Relational Model; Query Languages: Relational Algebra and SQL, Database Design techniques; Normalization; Data Organization; File Systems and Indexing; Concepts of security and integrity in databases; Transaction Processing ; Query processing and optimization; DBMS based application development; internet applications XML data management; multimedia databases; Distributed Databases.

IS F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

IS F301 Principles of Programming Languages 2 0 2

The course covers features of programming languages and introduces the main programming paradigms. It covers, in detail, the semantics of the features of programming languages – Control Abstraction, Data Types and Data Abstraction, Scope and Parameter passing and Concurrency related features. It covers various aspects of runtime environments like global and local data, code, function call stacks, dynamically allocated data, runtime features for exceptions and threads. Introduction to programming paradigms. Functional paradigm – formal elements of lambda calculus, introduction to syntax of common functional programming languages and programming exercises that explore the functional paradigm. Logic programming paradigm - formal elements of logic programming and programming tasks that explore the logic paradigm. Scripting as a paradigm. Domain specific languages. Applications of the principles of programming languages –program verification, software testing and security.

IS F303 Computer Networks 3 1 4

Introduction; Need for Computer Networks; Top-down vs. Bottom-up approaches; Network Services, and Protocols; Network Reference Models and Architectures, Architecture of the Internet, Types and Applications of contemporary and emerging Networks, Application-Layer Requirements, Concepts, Services and Protocols: Protocols for Web, Email, File transfer, Name Resolution, Address Assignment / Discovery, Remote Access Services, Voice/Video over IP, Webcasting, Video-Conferencing and Telepresence, Network Management Protocols and Overlay Networks; Transport Layer Requirements, Services, Concepts and Protocols; Network Layer Requirements, Concepts, Services and Protocols, Routing vs. Layer-3 Switching; QoS; Link Layer and Physical Layer Requirements, Concepts, Services and Protocols, Logical Link and Medium Access Control concepts, Physical medium dependent function, Modes of Signaling and Communication at the lower layer; IEEE 802 architecture, Bridging versus Layer-2 Switching; VLANs, VPNs, Performance vs. Security, Emerging Trends and Best Practices related to design of computer networks and internetworks.

IS F311 Computer Graphics 3 0 3

Graphics I/O hardware; Generation of dot, lines, conics, curves, surfaces & polygons; Filling closed regions, 2D & 3D Graphics & Transformations, Windowing, Viewing & Clipping, Efficient algorithms, Solid Modeling, Color Models & Dithering, Visible surface detection, Rendering, Animation Techniques, Advanced modeling and Future directions.

IS F322 Software Testing 2 1 3

Brief description of importance of software, Life cycle model and process, Basic software testing, all definitions, Types of testing and techniques (CFG, CDG etc.), Black Box & white box Testing

Methodologies, Finite State Machine Model, State based Testing, Static Testing and analysis, Test cases, Test Data Generation, Test selection, Minimizations and Prioritization, Test adequacy criteria, Software Testing on Web Engineering, Object based Software Testing, Architecture of Testing tool, Software Test Effort Estimation, Testing behavior and process model, Qualitative analysis, Quality factors in software testing, Selection of testing tools.

IS F341 Software Engineering 3 1 4

Ethics of software Engineering (ACM/IEEE code of Ethics),Type of Software, Application of Software ,Software Life Cycle Model, Agile Modeling Requirement Engineering, Object Oriented Analysis and Design(using UML), Introduction of Web Engineering, Software Integration and Testing, Support Processes and Software Quality, Software change Management, Software Product and Process Metrics Measurement, Software Project Management ,Scheduling ,Staff Measurement, Risk Management, Componnet based Software Engineering, Quality and Reliability Model, Maturity Models , Software Reengineering, deployment models.

IS F342 Compiler Design 2 1 3

Introduction - Compilation and Execution Environments - Compilers and Interpreters – Requirements and Motivation; Front-end and Back-end of compilers/interpreters; Intermediate Representation and Intermediate Languages; Compile Time vs. Execution Time; Translators, and Assemblers; Virtual Machine - Just-in-Time Compilers. Structure of a Compiler – Phases and Passes. In-memory data - intermediate versions of code, symbol table. Lexical Analysis: Regular expressions and DFA (introduction where needed), Defining tokens using regular expressions, Designing and implementing scanners / lexical analyzers. Parsers: Context Free Languages (introduction where needed)and Recognizing CFLs. Parsing techniques – LL , LR - LR (0),LR(1), LALR) . Intermediate Representation: Parse Trees and Abstract Syntax Trees; 3-address code. Semantic Analysis. Back End Phases: Machine Independent optimizations: Loop Optimization Techniques - Loop Unrolling, Induction variable based optimization, Loop-Invariant code elimination. Procedure Call Optimization, and Dead Code Elimination. Target Code Generation : Data Flow Analysis, Register Allocation, Instruction Selection & Scheduling. Memory Management : Memory allocation support, Memory- de-allocation – Garbage Collection Techniques. Advanced Topics :Issues in compiling Object Oriented Languages, Functional Languages, Concurrent Languages, Script & Query Languages.

IS F366 Lab Project 3

IS F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

IS F376 Design Project 3

IS F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

IS F372 Operating Systems 3 0 3

Introduction to operating systems; Various approaches to design of operating systems ; Overview of hardware support for 0perating systems; Process/thread management: synchronization and mutual exclusion, inter process communication, CPU scheduling approaches ;Memory management: paging, segmentation ,virtual memory, page replacement algorithms ; File systems: design and implementation of file systems; Input /Output systems; device controllers and device drivers; Security and protection ; Case studies on design and implementation of operating system modules.

IS F462 Network Programming 3 0 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

IS F491 Special Project 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

Internet Technology & e-Business

ITEB G621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production & distribution networks; SCM in the context of JIT and MRP-II; Distribution Resource Planning; Management of dealer networks; Total Quality Control & product innovation across the supply chain; Incoming logistics & supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; mathematical programming for SCM.

Japanese

JAP N101T Beginning Japanese 3 0 3

Basic Japanese scripts (Hiragana, Katakana and Kanji); constructing words using Hiragana and Katakana and understanding their meanings; forming sentences, understanding their meanings, learning the related Kanjis; listening and reading comprehension, conversion practice, revision and additional practice through audio cassettes.

Mathematics

MATH F111 Mathematics I 3 0 3

Functions and graphs; limit and continuity; applications of derivative and integral. Conics; polar coordinates; convergence of sequences and series. Maclaurin and Taylor series. Partial derivatives. Vector calculus in R^n; vector analysis; theorems of Green, Gauss and Stokes.

MATH F112 Mathematics II 3 0 3

Complex numbers, analytic functions, Cauchy's theorems; elementary functions; series expansions; calculus of residues and applications.

Vector space; basis and dimension; linear transformation; range and kernel of a linear transformation; row reduction method and its application to linear system of equations.

MATH F113 Probability & Statistics 3 0 3

Probability spaces; conditional probability and independence;random variables and probability distributions;marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions;sum of independent random variables; law of large numbers; central limit theorem (without proof);sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

MATH F211 Mathematics III 3 0 3

Eigen-values and eigen-vectors. Inner product space and orthonormal bases. Elementary differential equations, Hypergeometric equations, Lengendre polynomials, Bessel functions; Fourier series; Sturm-Liouville problem, series solution for differential equation, systems of first order equations; Laplace transfor-

mation and application to differential equations; one dimensional wave equation, one dimensional heat equation & Laplace equation in rectangular form.

MATH F212 Optimization 3 0 3

Introduction to optimization; linear programming; simplex methods; duality and sensitivity analysis; transportation model and its variants; integer linear programming nonlinear programming; multi-objective optimization;evolutionary computation techniques.

MATH F213 Discrete Mathematics 3 0 3

Logic and methods of proof, Elementary Combinatorics, recurrence relations, Relations and digraphs, orderings, Boolean algebra and Boolean functions.

MATH F214 Elementary Real Analysis 3 0 3

Countability and uncountability of sets; real numbers; limits and continuity; compactness and connectedness in a metric space; Riemann integration; uniform convergence.

MATH F215 Algebra I 3 0 3

Groups, subgroups, a counting principle, normal subgroups and quotient groups, Cayley's theorem, automprhisms, permutation groups, and Sylow's thorems.

Rings, ring of real quaternions, ideals and quotient rings, homorphisms, Eculidean rings, polynomial rings, and polynomials over the rational field.

MATH F231 Number Theory 3 0 3

Primes and factorization; division algorithm; congruences and modular arithmetic; Chinese remainder theorem Euler phi-function and primitive roots of unity; Gauss's quadratic reciprocity law; applications to periodic decimals and periodic continued fractions.

MATH F241 Mathematical Methods 3 0 3

Integral Transforms: Fourier, Fourier sine/cosine and their inverse transforms (properties, convolution theorem and application to solve differential equation), Discrete Fourier Series, Fast Fourier transform, Calculus of Variation: Introduction, Variational problem with functionals containing first order derivatives and Euler equations, Variational problem with moving boundaries. Integral equations: Classification of integral equations, Voltera equations, Fredholm equations, Greens functions.

MATH F242 Operations Research 3 0 3

Introduction to Data Processing; Files and File Structures; Indexing Techniques; Sorting, Searching and Merging Techniques; Introduction to Database Management Systems; Design of Information Systems; Emerging trends in Data Processing.

MATH F243 Graphs and Networks 3 0 3

Basic concepts of graphs and digraphs behind electrical communication and other networks behind social, economic and empirical structures; connectivity, reachability and vulnerability; trees, tournaments and matroids; planarity; routing and matching problems; representations; various algorithms; applications.

MATH F244 Measure and Integration 3 0 3

Lebesgue measure and integration in real numbers, Convergence and Convergence theorems, absolutely continuous functions, differentiability and integrability, theory of square integrable functions, and abstract spaces.

MATH F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

MATH F311 Introduction to Topology 3 0 3

Metric Spaces; Topological Spaces – subspaces, Continuity and homoeomorphism, Quotient spaces and product spaces; separation Axioms; Urysohn's Lemma and Tietze extension Theorem; Connectedness; Compactness, Tychonoff's Theorem, Locally Compact Spaces; Homotopy and the fundamental group.

MATH F312 Ordinary Differential Equations 3 0 3

Existence and uniqueness theorems; properties of linear systems; behaviour of solutions of nth order equations; asymptotic behaviour of linear systems; stability of linear and weakly nonlinear systems; conditions for boundedness and the number of zeros of the nontrivial solutions of second order equations; stability by Liapunov's direct method; autonomous and nonautonomous systems.

MATH F313 Numerical Analysis 3 0 3

Solution of non-linear algebraic equation; interpolation and approximation; numerical differentiation and quadrature; solution of ordinary differential equations; systems of linear equations; matrix inversion; eigenvalue and eigenvector problems; round off and conditioning.

MATH F314 Algebra II 3 0 3

Dual spaces, modules, fields, finite fields, extension of fields: algebraic extension, separable and inseparable extension, normal extension, sptitting fields, Galois extension, and Galois group.

The algebra of linear transformations, characteristic roots and characteristic vectors, canonical forms: triangular form, nilpotent form, and Jordan form.

MATH F315 Introduction to Statistical Inference 3 0 3

Parametric point estimation; Unbiasedness; Consistency; Uniform minimum variance unbiased estimator; Method of moments; Maximum likelihood estimation and its properties; Lower bounds for the variance of an estimator; Sufficiency; Factorization theorem; Best equivariant estimators; Tests of hypotheses; Neyman-Pearson lemma; uniformly most powerful (UMP) tests; Likelihood ratio tests; Chi-square tests; Methods for finding confidence intervals.

MATH F316 Matrix Theory and Linear Estimation 3 1 4

Revision of linear algebra and allied concepts; Generalized inverse; Singular value decomposition their applications; Majorization, Principal components, Canonical correlations; Generalized inverses, Linear model, Estimability; Residual sum of squares; Schur complements, Multivariate normal distribution, quadratic forms and Cochran's theorem; One-way and two-way classifications, general linear hypothesis, Multiple correlation and regression models; Block designs and optimality: reduced form of normal equations, c-Matrix.

MATH F317 Sampling Theory 3 1 4

Advantages of the sampling method; Principal steps in a sample survey; Role of sampling theory; Probability sampling; Bias and its effects. Simple random sample: definitions and notation; Properties of the estimates; Variances of the estimates; Finite population correction; Estimation of the standard error from a sample; Confidence limits; Validity of the normal approximation; Effect of non-normality on the estimated variance. Sampling for proportions and percentages. Stratified sampling: Estimation of gain due to stratification; Ratio and regression methods of estimation; Unbiased ratio type estimators; Optimality of ratio estimate. Cluster sampling, Two stage sampling, Double sampling.

MATH F341 Introduction to Functional Analysis 3 0 3

Banach spaces; fundamental theorems of functional analysis; Hilbert space; elementary operator theory; spectral theory for self-adjoint operators.

MATH F342 Differential Geometry 3 0 3

Curve in the plane and 3D-space; Curvature of curves; Surfaces in 3D-space; First Fundamental form; Curvature of Surfaces; Gaussian and mean Curvatures; Theorema Egreguim; Geodesics; Gauss-Bonnet Theorem.

MATH F343 Partial Differential Equations 3 0 3

Non linear equations of first order, Charpits Method, Method of Characteristics; Elliptic, parabolic and hyperbolic partial differential equations of order 2, maximum principle, Duhamels principle, Greens function, Laplace transform & fourier transform technique, solutions satisfying given conditions, partial differential equations in engineering & science.

MATH F344 Mathematical Fluid Dynamics 3 0 3

Introduction to the Fluid Dynamics and Fundamental Concepts, Langrange and Eulerian Descriptions, Continuum hypothesis,

Conservation of Mass based on different approaches, Equation of Continuity in different Coordinates,Potential Flow, Laplace Equation, one-,two- and three-dimensional flow, Conservation of Linear Momentum,Euler's Equation,Bernoulli's equation, Constitutive equations for Newtonian Fluid, Navier-Stokes Equations, First Law of Thermodynamics, Reynolds number, Exact Solution of Navier-Stocks Equation, Boundary Layer Approximations, Setting up the Boundary-Layer Equations, Limit Equation For the Flat Plate, Discussion of Blasius' Equation, Description of Flow Past a Circular Cylinder, Decay of a Laminar Shear Layer.

MATH F353 Statistical Inference and Applications 3 0 3

Review of elements of probability and statistical methods, Classical Decision theory including parametric and non-parametric methods for testing of hypotheses, Analysis of Variance: One way and two way classifications, Design of experiments: Analysis of Completely randomized design, Randomized block design and Latin square design with one or more missing values, Statistical Quality control for variables and measurements.

MATH F354 Complex Analysis 3 0 3

A rigorous treatment of the theory of analytic functions of complex variables including Cauchy's theorems; maximum modulus theorem; the principles of argument; Jensen's formula; Mittag Lefler theorem; Weierstrass canonical products and analytic continuation.

MATH F366 Lab Project 3

MATH F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

MATH F376 Design Project 3

MATH F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

MATH F378 Advanced Probability Theory 3 0 3

Measure theoretic probability and probability space, Law of large numbers and independence, convergence, Central limit theorems, Higher dimensional limit theorems, Random walks and their properties, Martingale and their properties, Martingale convergence theorem, Radon-Nikodym derivative, Doob's inequality, Backward martingales, Markov chain and their properties, finite state ergodicity, recurrence and transience.

MATH F420 Mathematical Modeling 3 0 4

Elementary mathematical models; Role of mathematics in problem solving; Concepts of mathematical modeling; Pitfalls in modelling; System approach; formulation, Analyses of models; Sensitivity analysis, Simulation approach. One or more of the interrelated topics will be covered from the following: optimal harvesting models, Environmental models, traffic flow models, biofluid flow models, socio-economic models, financial models, stochastic models, etc. providing a fertile ground for interdisciplinary courses. The selection of topics will depend upon the circumstances and mutual interest of the current students and faculty

MATH F421 Combinatorial Mathematics 3 0 3

Advanced theory of permutations and combinations; elementary counting functions; theory of partitions; theorems on choice including Ramsey's theorem; the mobius function; permutation groups; Polya's theorem and Debrauijn's generalisation; graphical enumeration problems.

MATH F422 Numerical Methodology for Partial Differential Equations 3 1 4

Classification of PDEs, nature of well-posed problems, interpretation of PDEs by characteristics and physical basis, appropriate boundary/initial conditions. Numerical methods for PDEs: Finite difference approximations to partial derivatives, Explicit and implicit schemes, Richardson Extrapolation Convergence, Stability and Consistency of Elliptic, Parabolic and Hyperbolic PDEs. Introduction to finite volume method, Computational experiments based on the algorithms.

MATH F423 Introduction to Algebraic Topology 3 0 3

Homotopy; Fundamental group and Computation; Covering Spaces; Universal Covering Spaces; Simplicial Complexes; Simplicial Homology and Computation.

MATH F424 Applied Stochastic Process 3 1 4

Definition and examples of Stochastic Processes (SPs), classification of random processes according to state space and parameter space, types of SPs, elementary problems; Stationary Process: Weakly stationary and strongly stationary processes, moving average and autoregressive processes; Martingales: definition and examples of martingales; Markov Chains: Transition probability, classification of states and chains, stability of Markov chains, irreducibility, stationary distribution ergodic theorem; Continuous-time Markov Chains (CTMCs): Poisson process, birth-death process and their applications; Continuous time and continuous state space: Brownian motion, Wiener process and applications; Renewal processes in discrete and continuous time; Renewal reward process; Branching Processes; Galton-Watson branching process and its properties.

MATH F425 Numerical Linear Algebra 3 1 4

Matrix algebra, conditioning, condition number, vector and matrix norms, perturbation theory of linear systems, stability of numerical algorithms, Cholesky decomposition, floating point arithmetic and its error analysis, singular value decomposition (SVD), algebraic and geometric properties of SVD, least square solutions, Moore Penrose inverse, Rank deficient least squares problems, Sensitivity analysis of SVD and least-squares problems, Householder matrices and transformation, QR method, Iterative methods with iterative refinement, Krylov subspace method, Arnoldi iteration, Low rank approximations.

Pre-requisite: MATH F112 Mathematics II

MATH F426 Mathematical Theory of Finite Element Methods 3 1 4

Hilbert spaces, Sobolev Spaces, Variational formulation of elliptic boundary value problems, Lax-Milgram theorem, Error estimates, Construction of FE spaces, Polynomial approximations, interpolation errors, Aubin-Nitsche duality argument, Parabolic initial and boundary value problems: Semi-discrete and fully discrete schemes, error estimates.

MATH F427 Statistical Simulation and Data Analysis 3 1 4

Review of probability concepts; Pseudorandom number generation; Generating discrete random variables – Poisson and binomial random variables; Generating continuous random variables: Polar method for generating normal random variables; Discrete event simulation approach – single-server and two-servers queueing system, inventory model; Statistical analysis of simulated data – bootstrapping technique for estimating mean square errors; Several ways of variance reduction; Concepts of stratified sampling; Statistical goodness of fit tests – two sample problem; Markov chain Monte Carlo methods; The Hastings–Metropolis algorithm; Gibbs sampler; Continuous time Markov chains and a queueing loss model; Simulated annealing; Methods of data analysis.

MATH F428 Time Series Analysis and Forecasting 3 1 4

The course reviews Extrapolative and Decomposition Models, Introduction to Box–Jenkins Time Series Analysis, ARIMA Models, which remains the most commonly used statistical technique in Time Series Analysis. The remainder of the course considers various practical aspects of the principles behind modern forecasting techniques. A one-hour lab will be conducted every week. Students will learn how to explore and analyze different types of Time Series data using R programming.

MATH F431 Distribution Theory 3 0 3

C-infinity functions, distributions and their derivatives; support, convolution and regularization; distributions of finite order; multiplication of distributions; Fourier transforms of distributions; temperate distributions and their Fourier transforms; fundamental solutions.

MATH F432 Applied Statistical Methods 3 0 3

Review of estimation and testing of hypotheses; Simple and multiple regression methodology through method of least squares, Multicollinearity and residual analysis, Categorical data handling through logistic regression; Multivariate data analysis by Hoteling T^2, Mahalanobis D^2, discriminant analysis, cluster analysis and factor analysis; Data handling and forecasting time series data by various components time series methodology; Statistical Quality Control of variables and attributes control charts; Non parametric data handling through Kruskal walls test, Mann Whitney and KS two sample test.

MATH F441 Discrete Mathematical Structures 3 0 3

One or more of the interrelated topics will be covered from the following: graphs, designs, codes, shift register sequences, groups, fields, Boolean algebras, analysis of algorithms, Fast Fourier Transform etc. providing a fertile ground for interaction between mathematics and modern areas of computer science. The selection of the topics will depend upon the circumstance and current interest of faculty.

MATH F444 Numerical Solutions of Ordinary Differen- 3 0 3 tial Equations

Introduction to ODEs, Numerical Techniques for One Step Methods, Convergence and Absolute Stability, Numerical techniques for Linear Multi-Step Methods, Zero Stability, Consistency, Convergence, Predictor-Corrector methods, Absolute Stability of Predictor-Corrector methods, Stiff ODEs and its numerical methods, Finite Difference Methods to Linear and Nonlinear Boundary Value Problems, Stability and Convergence Analysis, Differential Algebraic Equations, Numerical techniques for Differential Algebraic Equations, Introduction to One dimensional Finite Element Methods, Comparison between Finite Difference Methods and Finite Element Methods, Variational formulation, Finite Element Approximation, Approximation Errors, Convergence of solution, Order of Convergence.

MATH F445 Mathematical Fluid Dynamics 3 0 3

Introduction to the Fluid Dynamics and Fundamental Concepts, Lagrange and Eulerian Descriptions, Continuum hypothesis, Conservation of Mass based on different approaches, Equation of Continuity in different Coordinates, Potential Flow, Laplace Equation, one-, two- and three-dimensional flow, Conservation of Linear Momentum, Euler's Equation, Bernoulli's equation, Constitutive equations for Newtonian Fluid, Navier-Stokes Equations, First Law of Thermodynamics, Reynolds number, Exact Solution of Navier-Stokes Equation, Boundary Layer Approximations, Setting up the Boundary-Layer Equations, Limit Equation For the Flat Plate, Discussion of Blasius' Equation, Description of Flow Past a Circular Cylinder , Decay of a Laminar Shear Layer

MATH F456 Cosmology 3 0 3

History of cosmological ideas, Observational overview of the universe, Expansion of the universe, Newtonian gravity, Friedman equation, the fluid and acceleration equations, Geometry of the universe, Infinite and observable universe, Big bang, Simple cosmological models, Hubble law, redshift, Observational parameters, the cosmological constant, the age of the universe, weighing the universe, dark matter, CMB, the early universe, Nucleosynthesis, Inflationary universe, Initial singularity, standard cosmological model, general relativistic cosmology, classic cosmology, neutrino cosmology, baryogensis, structure of the universe.

MATH F471 Nonlinear Optimization 3 0 3

Introduction; convexity and cones; Kuhun Tucker theory; unconstrained and constrained optimization; gradient methods; polynomial optimization; penalty function; generalized convex functions; duality in nonlinear programming; optimality criterion for generalised convex functions; fractional programming.

MATH F481 Commutative Algebra 3 0 3

Modules; direct sums and products; finitely generated modules, exact sequences; tensor product of modules; rings and modules of fractions; localization; Noetherian modules and primary decompositions; integral dependence and valuation theory; integrally discrete valuation rings and Dedekind domains; fractional ideals.

MATH F491 Special Projects 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

MATH F492 Wavelet analysis and applications 3 1 4

Haar wavelet bases, Multiresolution analysis, Orthonormal wavelets from MRA, Orthonormal spline wavelets, Fast wavelet transforms, Biorthogonal wavelet bases, Compactly supported wavelets, The Daubechies scaling functions, Coding signals by wavelet transform, Filter banks, Condition number of a matrix , Wavelet Galerkin method.

MATH G511 Design and Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

MATH G512 Selected Topics in Advanced Mathemat- 5 ics for Engineering Situations

The topics may include mathematical theory of probability and stochastic processes, Graph theoretical techniques; information theory; pattern recognition; fuzzy sets.

MATH G521 Applied Functional Analysis 5

MATH G531 Number Theory 5

MATH G541 Advanced Methods in Discrete Mathematics 5

Course description for the above courses are to be developed.

MATH G611 Algebraic Number Theory 5

Localization, Galois extensions, Dedekind rings, discrete valuation rings; completion, unramified extensions, ramified extensions; the different and discriminant; cyclotomic fields, roots of unity, quadratic fields, relations in ideal classes; the unit theorem, Minkowski's constant, Zeta function.

MATH G612 Riemann Surfaces 5

Compact Riemann surfaces, algebraic functions, analytic continuations, branched coverings, study of line bundles, Riemann-Roch theorem, Serre duality theorem.

MATH G621 Fibre Bundles 5

Differential manifolds, tangent bundle, vector bundles, principal bundles, functorial properties, the Milnor construction, homotopy classification, Grassmannians, universal bundles, characteristic classes, introduction to K-theory.

MATH G622 Algebraic Geometry 5

Study of varieties, introduction to complex varieties, some ideas on schemes, complete varieties, cohomology of coherent sheaves.

MATH G632 Lie Groups and Lie Algebras 5

Lie groups: basic definitions, one parameter sub-groups, maximal tori, representation theory; Lie algebras: basic definitions, solvable and nilpotent lie algebras, cartan subalgebras, roots and weights, simple lie algebras, classification theorem universal enveloping algebras, PBW theorem.

MATH G642 Complex Manifolds **5**

Manifolds and vector bundles: manifolds, vector bundles, & operator & almost complex manifolds; sheaf theory: Sheaf cohomology & Cech cohomology; differential geometry: Hermitian differential geometry, canonical connection & curvature of Hermitian holomorphic bundles, Chern classes of bundles.

Master of Business Administration

MBA G501 Managerial Economics **3 0 3**

The firm and it's environment, Introduction to basic principles & methodology, Revenue of the firm, Demand analysis & estimation, Economic forecasting; Production, cost and profit maximization, Production analysis, Cost of production, Profit analysis of the firm; Markets and behavior of the firm (Perfect competition, Monopoly, Monopolistic competition, oligopoly), Factor markets & profit maximizing employment of variable inputs, Games, information and strategy, pricing and profit analysis; Sectoral Economics.

MBA G502 Business Structure & Processes **3***

Fundamental concepts, development of management theory, business forms, (proprietorship etc.); review of managerial functions (planning, organizing, staffing, leading and controlling); business processes, structure and systems, socio-economic interface.

MBA G503 Managerial Skills **2***

The role of manager, team building and goal setting, basics of supervision, leadership, decision making, negotiation skills and techniques, how managers communicate, how to interview, process of induction, training and development, delegation, how to appraise employees, how to manage time, use of committees, how to handle meetings, how to handle complaints.

MBA G504 Legal and Economic Environment of Business **4***

Indian contracts act, sale of goods act, negotiable instruments act, companies act, corporate tax laws, consumer protection and unfair trade practices act, FEMA, Industrial policy, macroeconomic environment, fiscal and monetary policy, overview of Indian economy, economic indicators.

MBA G505 Management Framework & Functions **2 0 2**

Overview of management, its role and range of applications, building blocks and interrelations, core concepts, functional and strategic areas, quantitative tools and techniques, issues and approaches to problem solving, developing professional perceptions and attitudes.

MBA G506 Negotiation Skills and Techniques **2 0 2**

Overview, Negotiation styles, Negotiation process, Tactics in Negotiation, Handling conflicts in negotiation, Best Alternative to a Negotiated Agreement, Communication - Key to Effective Negotiating, Non-verbal communication in Negotiations, Emotions: dealing with others and ourselves, International negotiations, Cross Cultural Issues in Negotiations, Power in negotiation, Workplace Negotiations, Turning Negotiation into a Corporate Capability, Do's and Don'ts of Negotiations, Negotiating over the telephone/ Electronic media, Ethics in negotiation, Negotiation-Exercise.

MBA G507 International Financial Markets & Services **3 0 3**

Currency futures, options and swaps; interest rate determination and asset pricing in face of volatile nominal and real exchange rates; international portfolio management; treasury risk management and performance measurement; major international stock exchanges: New York; ISE London; Tokyo; trading and settlement practices; listing of Indian derivatives on Brussles stock exchange; arranging foreign collaboration; floating India funds; syndication of Euro-dollar loans.

MBA G508 Functions and Working of Stock Exchanges **3 0 3**

Stock exchanges in India: regulations governing formation and working; trading and settlement procedures; review of the working of stock exchanges in India. National stock market system; OTCEI; listing requirements. requirements for membership of stock exchange; responsibilities of stock brokers in regard to contracts and accounts, duties and responsibilities to stock exchange, public and members interset; securitiescontracts act, by-laws and regulations; SEBI guidelines; trading in stock exchanges; insider trading: SEBI guidelines; dealings in debentures; rating of debentures; trading in government securities; potential for trading in derivatives.

MBA G509 Investment Banking and Financial Services **3 0 3**

Merchant banking function- perspectives; organization of merchant banking function; managing new issues; negotiating terms with financial institutions, brokers, investors and under writers; pricing of further issues- SEBI guidelines; syndication of loans from banks; preparation of loan dossiers and application for financial assistance; negotiations; public deposits to finance working capital; agencies mobilizing public deposits; regulations governing raising of public deposits; cost of public deposits, factoring, forfeiting , structured finance, securitization and personal finance like house loan, personal loan and other individual loans, non-fund based services -credit rating, business advisory services, mergers, de-mergers and acquisition, asset management and insurance commodities services and wealth management.

MBA G510 Human Resource Management **4**

Introduction to Human Resource Management, Employment Laws, The Manager's Role in Strategic Human Resource Management, Job Analysis, HR Metrics, Human Resource Planning and Recruiting, Testing and Selection, Interviewing Candidates, Training and Developing Employees, Performance Management & Appraisal, Talent Management, Strategic Pay Plans, Pay for Performance and Employees Relations; Employee Relations & Employees safety & health; Managing Global Human Resource & HR in Entrepreneurial Firms; Futuristic trends in HRM; HRM in Indian Context.

MBA G511 Organisational Behaviour **4**

Evolution and relevance; perception emotions and learning in an organisational set up; attitudes and values, groups and group processes, leadership, power and politics, organizational change, resistance and development, managing conflict.

MBA G512 Manufacturing Strategy **4**

Corporate strategy; Missing links in manufacturing strategy; Audit approach; Restructuring; Manufacturing strategy process in practice; Formulation as a process; Operating strategies; Methodology framework; Lean production; Competitive priorities; Strategic value of response time and product variety; Flexibility in context of manufacturing strategy; Manufacturing focus; Business process reengineering; Theory of constraints; Link between strategy and organizational culture; Evolution of manufacturing systems; Operations management strategic perspective.

MBA G513 Quantitative Methods **4**

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, time series and forecasting, index numbers, decision theory, linear programming, transportation and assignment problems, queuing theory, network problems, simulation; application of statistical software (SYSTAT, SPSS, SIMULA8, etc.) and spreadsheets.

MBA G514 Technology Management **3 0 3**

Concept of technology, nature of technological change, economics of technology, corporate technology strategy, analysis for technology strategy, adoption and management of new technology, accounting for technology, appropriate technologies, transfer of technology, influence of government policies on technology, technology, management for sustainable development.

MBA G515 Financial and Management Accounting **4**

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

MBA G516 Corporate Finance and Taxation 4

Role and environment of managerial finance, time value of money (NPV, IRR), project feasibility, budgeting, long term investment decisions, long term financing decisions (LT & ST), capital structure, dividend decisions, short term financing decisions, working capital management, principles of corporate taxation, income tax, capital gains tax, tax laws and provisions, financial engineering.

MBA G517 Business and Society 4

Corporate social responsibility, business ethics, policies, codes, standards, ethics and decision making, environmental and social issues, workplace diversity, fostering ethics at work (whistle blower policy); business and social etiquette, internet and online behaviour, etiquette and office electronics.

MBA G518 Marketing 4

Definition, marketing research and forecasting demand, creating customer value, satisfaction and loyalty, analysing consumer and business markets, market segmentation, brand equity, brand positioning, product and pricing strategies, managing services, managing value networks and channels, integrated marketing communications, international marketing.

MBA G519 Production and Operations Management 4

Product & service design, plant location, aggregate planning, capacity, process, layout, sequencing & scheduling, line balancing, maintenance, quality (control, assurance, management), statistical quality control, queuing theory, project management. CPM, PERT.

MBA G520 Business Policy and Strategic Management 4

Mission, vision, strategic intent, hierarchical levels of strategy, PEST analysis, SWOT analysis, industry analysis, organisational analysis, BCG matrix, GE matrix, core competencies, five force theory, value chain, competitive advantage, generic strategies, diversification, strategy implementation and control.

MBA G521 Supply Chain Management 4

Purchase/procurement, stores, material handling systems, inventory analysis, inventory models, disposals, make or buy, outsourcing; vendor selection, development, and relations; Material requirements planning, manufacturing resources planning, ERP, JIT, inbound and outbound logistics, warehousing, transportation, packaging.

MBA G522 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability.

MBA G523 Project Management 4

Concepts and techniques of project formulation, evaluation and implemention; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

MBA G524 International Business 3 0 3

Global Trade Protection, Cultural Environment, Legal Aspects, International Monetary System, Overseas Business Options, MNCs, Regional Analysis, Screening and Segmentation, International Marketing Research, International Marketing Strategy, Export Policy and Institutional Infrastructure, Export Finance, Export Payments, Exchange Transactions, Product Planning; Positioning and Management, Distribution Policy; Management and Agreements, International Pricing and Promotion, Organizing for Overseas Markets.

MBA G525 R&D Management 3 0 3

Distinctive need and particular structure for management of R&D systems; the close relationship between R&D objectives and innovation and precise time targets; micro considerations like economics and cost, science policy, criteria of choice, various issues connected with availability, transfer and marketing of technology; micro considerations in planning, organisation, project selection, formulation and management, R&D cost estimating and budgeting human resources availability, evaluation and measurement of performance, control problems; mission-oriented research; technology missions enunciated by Indian Government.

MBA G526 Database Management Systems 4

Introduction to data bases and management; data files and structures; hierarchical, relational, network models; distributed data bases; query processing and query optimization, query languages; concepts of security and protection; case study of a data base system.

MBA G527 e-Business and Internet Marketing 4

e-business evolution & opportunities; categories of e-business; e-business models; network infrastructure & web based tools for e-business; e-business risks & risks management; network security and firewall; cryptography and authentication; billing/payment systems; regulatory environment of e-business; ERP/SCM/CRM and web based marketing; business intelligence & intelligent systems; data warehousing and data mining; implementing e-business systems & change management. Case studies and projects in e-business areas; emerging e-business scenarios.

MBA G528 Internet Security and Cyber Laws 4

Examination of issues related to network and information security, security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

MBA G529 Recent Advances in ETM 4

Course description is to be developed.

MBA G530 Project Appraisal 3 0 3

Criteria for selection of a project; factor intensity; commercial profitability; national economic-profitability; limitations of market prices; estimation of shadow prices; linkup project appraisal to national objectives; McGaughey and Thorbeck approach; Little-Mirrlees method; UNIDO guidelines approach; limitations of the conventional project appraisal; towards a new framework for project appraisal.

MBA G531 Managerial Communication 2*

Business communication basics; issue interpretation, reformulation and summation; interviews, questionnaires and forms; presentation techniques; technology and communication; business correspondence; business documents; group communication and meetings; employment communication.

MBA G532 Risk Management and Insurance 3 0 3

Introduction to risk; types of risk; risk measurement; risk management techniques; risk avoidance, loss control, loss financing, risk retention, risk transfer, internal risk reduction through diversification etc.; insurance business and operations; insurance pricing; insurance v/s hedging; life, health and income risk; property and liability risk – commercial and personal; social insurance; insurance regulation.

MBA G533 Advertising and Sales Promotion 3 0 3

The communication process and models of persuasive communication; advertising research; advertising campaign components; advertising campaign planning; advertising/media scene; media concepts; media planning & strategy; advertising campaign planning, execution and evaluation; advertising agencies; sales promotion types and techniques; sales promotion strategy; measuring the effectiveness of the promotional program; regulations of advertising and promotion; Extending marketing communication to social communication, personal selling, international advertising, interactive advertising, advertising laws, social, ethical and moral issues.

MBA G534 Introduction to Business Sustainabiligy 3 0 3

Evolution of the Concept of sustainable development, Dimensions of sustainable development, Issues and Trends in business sustainability, Business Sustainability, Sustainable Consumption and Production, Industrial Environment Management, Finance of sustainability, Setting Goals and Measuring Progress towards sus-

tainability

MBA G535 Cross Cultural Management 3 0 3

The Critical Role of Culture in Management, The Various Dimensions of Culture, The Impact of Culture On Management Functions Like Communication, Negotiation, Motivation, Leadership and Human Resource Management, Formulating and Implementing Strategy for International and Global Operations, Managing Global Teams, International Assignment and Expatriate Management, Skills and Competencies for Global Managers, International Business Etiquette and Uniqueness of Indian Culture and Management.

MBA G536 Strategic Financial Management 3 0 3

Company Value and the Manager's Mission: Introduction to Valuation, Why Value Value? The Value Manager, Cash Is King and Value-Based Management. Approach to Valuation - A Practitioner's Guide: Frameworks for Valuation. Valuation Methods: Discounted, Relative and Contingent Claim. Analyzing Historical Performance. Forecasting Performance. Estimation of Discount Rates. Estimation of Cash Flows. Estimation of Growth Rates. Valuation Models: Dividend-Discount Models, Free-Cash-Flow-To-Equity Discount Models, Free-Cash-Flow-to-firm Approach, Price / Earnings Ratio, Price/Book Value Ratio and Price/Sales Ratio. Measuring and Managing the Company Value: Company Value vs. Shareholders Wealth Maximization - TSR. Economic Value Added, Market Value Added and Cash Value Added. Wealth Creator by the Indian Corporates. Analyzing the Company Performance - Application of Balanced Scorecard (BSC). Applying Valuation: Multibusiness Valuation. Mergers, Acquisition , and Joint Ventures.

MBA G537 Security Analysis and Portfolio Management 3 0 3

Introduction to investment and securities; profile of financial assets; new issue market or primary market, initial public offerings (IPO); secondary market; framework of risk & return; fundamental analysis- economy, industry; company analysis; stock evaluation models; multiple holding period and multiple growth rate; bond analysis and bond management strategies; technical analysis; efficient market theory; portfolio management; Markowitz model; Sharpe's Single Index model; capital asset pricing model; financial derivatives-options & futures.

MBA G538 Marketing Models 3 0 3

Introduction to Marketing Models, Understanding the consumer behavior models, Developing models for optimal pricing decisions, Product definitions and classifications, Modeling the effects of Advertising, media selection and scheduling, Understanding Distribution problem, strategy, location, Learning New Product Planning, Innovation Diffusion process, Understanding Marketing planning Strategy Decision, Decision and Implementation.

MBA G539 Six Sigma 3 1 4

Voice of business/customer, Basic concepts of quality management, Quality function deployment, Developing Six sigma project charter, Measurement system analysis, Gauge repeatability and reproducibility, (R & R), Measuring base line performance, sigma short term, sigma long-term, sigma goal and entitlement, Validating the measurement systems, Cause-effect(CE) diagrams, charts hypothesis testing, Pugh matrix, Design of experiments, Design of Experiments, Analysis of Variance (ANOVA), Evolutionary Operation (EVOP); Fractional, Full and Orthogonal Experiments, Regression model building, Taguchi methods for robust design, Six Sigma sustainability, Process capability analysis, Process Capability (Cp), Process Capability Index (Cpk), Process Performance (Pp), Process Performance Index (Ppk), Combing the power of lean and six sigma.

MBA G540 Sports Marketing 3 0 3

Understanding scope of sport marketing, Strategic sport marketing planning process, Sport consumer decision making process, Carrying out research in sport, Strategic pricing process in sport, Facility planning and marketing channels for sporting goods and services, Understanding market segmentation from viewpoint of customer and player, Branding and promotion decisions, Tactics for higher sponsorships, Licensing venue and event marketing, Advertising strategy in sports, Global sports marketing, and Public relations in sports.

MBA G541 Operations Strategy 3 0 3

Operations Strategy, Operations Performance, Capacity Strategy, Purchasing and Supply Strategy, Process Technology Strategy, Improvement Strategy, Product and Service Development and Organization, Process of Operations Strategy-formulation, implementation, Monitoring and Control etc.

MBA G542 Consumer Behaviour 3 0 3

Concepts and characteristics of modern consumer behaviour; marketers' and consumers' views of consumer behaviour; market segmentation of consumers; consumer motivation; personality, values and involvement; consumers' perception, learning and attitudes, external influences on consumer behaviour-social, cultural, and situational; influences of sales persons and advertising on consumer behaviour; consumer decision process.

MBA G543 Leading Modern Organizations 3 0 3

Evolving role of management in organizations and functional areas, Importance of leadership in modern day organizations, Various models and theories of leadership, Understanding leadership from four perspectives : Self-assessment of Individual Leadership through models of personal growth and effectiveness; Team Leadership: importance of motivation, building trust, managing crisis and communicating effectively for creating high performing teams: Organizational Leadership: Inspiring innovation and change, enabling changes effectively, ethical leadership and; understanding the situational factors of effective leadership in the Global Context, Ethical Leadership.

MBA G544 Organizational Theory & Behaviour 3 0 3

Organizational Behaviour; Diversity in Organizations, Attitude and Job Satisfaction, Emotions and Moods, Personality & Values, Perception and individual Decision Making, Basic Motivation: Concepts & Applications, Foundations of group behavior & Understanding work teams, Organizational communication, Transactional analysis and Managerial Interpersonal Relations, Power and politics, Conflict management.

Organizational Structure, Organizational Design, Organizational culture, Organizational change, Positive organizational behavior, Ethics in organization.

MBA G545 Management Science 3 0 3

Management Science Approach to Problem Solving, Model Formulation and Graphical Solution, Computer Solution and Sensitivity Analysis, Modelling and Applications, The Simplex Method, Transportation Problem and its variants; Assignment Problem and its variants, Integer Programming and its Location; Goal Programming (GP); Loading and Machine scheduling; Distribution Problems; Waiting Lines and Queuing Theory Models, Simulation Modeling; Applications in Workforce Planning, Marketing, Investment, Healthcare Systems, Education and other business cases and applications.

MBA G546 Business Statistics 3 0 3

Randomness and Probability; Random Variables and Probability Models; Theoretical Probability Distributions; Sampling and Sampling Distributions; Estimation; Testing of Hypothesis in Case of Large and Small Samples; Chi – Square Test; F – Distribution and Analysis of Variance (ANOVA); Regression Analysis; Time Series Analysis; Index Numbers, Business Case Problems and applications.

MBA G547 Accounting for Managers 3 0 3

Basics of accounting concepts and practices, collecting, recording and reporting accounting information: journal entries, ledger and trial balance, preparation of final accounts, financial statement analysis — ratio analysis, Indian Accounting Standards, taxation – direct, indirect and GST etc. and their implications on financial reporting, management accounting tools and techniques: introduction to cost concepts, understanding the nature and importance of various cost components, introduction to various control systems in an organization: preparation & analysis of budget as a tool for management control system, preparation of cost sheet and standard costing. Ethical Issues in Corporate governance.

MBA G548 Strategic Marketing 3 0 3

Viewing marketing as a value creation process, Using a framework to analyze market opportunities Analysis, Situational Analysis, Understanding the buying-decision process of consumers, Selecting the target market and positioning the product, Developing an integrated marketing program, Designing products and services that deliver meaningful customer value, Using the "augmented" product as an antidote to commoditization , Capturing created value for the firm, Shifting from cost-based to value-based pricing, Planning the budget and media mix for marketing communications, Designing and managing the distribution channel, Positioning the internet as an effective online sales tool, Redefining strategy for the digital world, Understanding how digital and social media marketing contribute to a sustainable business strategy, Creating a strategic marketing plan, Anticipating and adapting to change, Ethical issues in marketing.

MBA G549 Introduction to Systems & Sustainability 3 0 3

Introduction to system, Open and closed system, Socio-ecological system, Systems for Sustainability, Sustainable development – evolution, approaches, interpretations, Climate change – Law policy & opportunities, Business (corporate) sustainability, triple bottom line, CSR, Social Accounting, Social Investment, Impact Assessment, Sustainability and Profitability, Sustainable production and consumption, zero emission in industries, Sustainability benchmarking and indicators, Sustainability reporting.

MBA G550 Critical and Design Thinking 3 0 3

Learning about thinking, deductive, inductive and abductive thinking, Convergent and Divergent thinking, Lateral thinking, Adverbial thinking, Parallel thinking; Creativity and Innovation, Problem definition, Theory of Constraints, 5 Why's method, Principles of Design Thinking, enabling design thinking in teams, application of design thinking; Systems principle, Holistic thinking, Learning Organization, Integrative thinking.

MBA G551 Internetworking Technologies 3 0 3

Introduction to internetworking concepts; the internet architecture; goals and key issues related to internetworking technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security; case studies.

MBA G552 Total Productive Maintenance 4

Outline of TPM; TPM – Challenging limits; Maximizing equipment effectiveness; Organizing for TPM implementation; TPM implementation and stabilization; TPM small group activities; the PM prize for outstanding TPM plants.

MBA G553 Organizational Change and Development 3 0 3

Business Organisation: The Domain of Change; Concept of Change; Perspectives on Organizational Change; Models of Change; Organizational Resistance to Change; Organizational Change and Change Agents; Strategic Management of Change; Organizational Diagnosis; Organizational Development (OD); Organizational Transformation (OT); Role of Change Agents and Leadership; Manager as Catalyst of Change; Implementing Organizational Change; Organizational Culture and Change; Learning Organization: The Ultimate Objective of Change Management.

MBA G554 Innovative Leadership 3 0 3

Leadership for innovation, Stimulating Bottom-Up innovation, Steering innovation Top-down, Appointing an Innovation Conductor, Leadership Imperative for Innovation Strategy, Leading development of new products, Leading the creation of totally new product/service, Innovation leaders as pragmatic architect, Leading improved customer solutions, Building an innovative leadership environment, Attracting, developing and keeping Innovative Leaders.

MBA G555 International Human Resource Management 3 0 3

Enduring context of International Human Resource Management (IHRM), Context of Cross-border Alliances and SMEs, Staffing International Operations for Sustained Global Growth, Recruiting and Selecting Staff for International Assignments, International Training and Development, International Compensation, Re-entry and Career Issues (Expatriation Issues), IHRM in the Host Country Context, International Industrial Relations ,Performance Management, IHRM Trends: Complexity, Challenges and Choices in the Future.

MBA G556 Performance Management 3 0 3

Overview of Performance Appraisal & Management, Performance Management in the Organizational Context, systems & processes ; Goal Setting, Approaches to Performance Appraisal, Performance Appraisal Techniques, Data Gathering, Observing, and Documenting, The Performance Appraisal Meeting, Feedback, Performance Diagnosis and Improvement, Linkage to Rewards & Compensation, Training & Development Requirements, Potential Appraisal & Career Progression, issues: Problems, Role of HR, Training the appraisers, Performance Appraisal in India.

MBA G557 Economic Environment of Business 3 0 3

Introduction to Business Environment, Role of Government in policy formulation, Mercantile laws: Indian Contract Act 1872, Indian Sales of Goods Act 1930, Macro Economic Concepts: Consumption, Savings, Investment, Economic Growth, Industrial policy, Introduction to the financial markets, Money supply and Banking system, National Income, Implications of Fiscal policy and Monetary policy for Business.

MBA G558 Operations and Supply Chain Management 3 0 3

Strategic importance of Operations, Forecasting, Product planning, Management of Quality, Statistical Process Control, Process Strategy, Layout planning, Production Scheduling, Inventory Management, MRP, Supply chain Management: An Overview, Supply chain strategy, Supply chain performance measurement, Distribution networks, Order management and customer service, Sales and Operations Planning, Transportation, Digital Supply chain, IoT and Blockchain, Sustainability in Supply chain, Ethical supply chain.

MBA G559 Corporate Finance 3 0 3

Basics of financial management, time value of money, valuation of securities, risk return and opportunity cost of capital, capital budgeting, WACC and company valuation, capital financing decisions – capital structure, working capital management, dividend decisions, Aspects of Mergers & Acquisitions, Risk Management, International Financing. Ethical versus legal standards in finance, Limited Liability, its Effects and Legal Responses, Insider Dealing and Market Abuse, Regulatory Competition and Regulatory Arbitrage.

MBA G560 Marketing Research & Metrics 3 0 3

Elements of marketing research process viz. Problem Definition, Development of an approach to the Problem, Research Design formulation, Exploratory, Descriptive and experimental, Fieldwork & Data collection, Data preparation & Analysis, univariate, bivariate and multivariate statistical techniques, Report preparation and Presentation. Marketing metrics. Nonfinancial metrics: Brand awareness, Test drive, Churn, Customer satisfaction (CSAT) and Take rate; Financial metrics: Profit, Net present value (NPV), Internal rate of return (IRR), Payback, Customer lifetime value (CLTV), Cost per click (CPC), Transaction conversion rate (TCR), Return on ad dollars spent (ROA), Bounce Rate and Word of mouth (WOM).

MBA G561 Business Analytics 3 0 3

Decision Making using Business Analytics; Business Analytics in Practice; Advanced Data Visualization; Data Dashboards, Predictive and Prescriptive Spreadsheet Models; Cluster Analysis; Text Mining; Logistic Regression; k-Nearest Neighbors; Classification and Regression Trees; Building Good Spreadsheet Models: What-If Analysis; Auditing Spreadsheet Models; Risk Analysis; Simulation Modelling; Application of optimization models: Capital Budgeting; Bank Location; Product Design and Market Share Optimization; A Location Problem; Markowitz Portfolio

Model; Forecasting Adoption of a New Product; Big Data: Statistical Inference and Practical Significance; Case Problems, Data Governance & Ethics.

MBA G562 Services Marketing 3 0 3

Distinctive elements, system: relationships with customers; positioning; managing customer portfolio, demand management, service delivery process, pricing; promotion; operating strategy; quality, productivity, human resource management; internationalization of services; services marketing in future.

MBA G563 Industrial Marketing 3 0 3

Market/consumer orientation, marketing in industrial context, industrial market behaviour, organisational buying and buying behaviour, business forecasting and planning, product planning, new product development, pricing, distribution, management of communications, advertising & personal selling, management of sales force, corporate strategy and industrial marketing.

MBA G564 Decision Making 3 0 3

Decision Analysis, Decisions under certainty and under uncertainty, Behavioral Decision Making, Framing of Decisions and Psychology of Choice, Common Errors, Paradoxes, Anomalies and Traps, Game theory- simple, two - player and bi- matrix games, Concepts of dominance, equilibrium and iterated dominance, Negotiation Analysis, Joint and Collaborative Decisions.

MBA G565 Information & Knowledge Management Systems 3 0 3

Information systems, organization and strategy; Ethical and social issues in information systems; IT infrastructure, emerging technologies, tools and portals for information and knowledge management; Creating, accumulating and applying knowledge in a learning organization; Building information systems in a learning organization; Information and knowledge management systems in digital economy; Managing projects; Future of information and knowledge management systems in the modern era of business.

MBA G566 Strategic Management 3 0 3

Overview of strategy, Crafting Strategy, company's strategy and its business model; Environmental Scanning, General Environment, Task Environment, STEEP analysis, Industry analysis; Resource based view of firm, Core competence, Distinctive competence, Competitive Advantage, Sustainable competitive advantage, Value Chain analysis; Strategy Formulation; Corporate strategy, business strategy, functional strategy; Strategy Implementation; Strategy Evaluation; Advanced Topics of strategic management: Blue Ocean Strategy, Ethical Issues and conduct.

MBA G567 Technology Innovation & Entrepreneurship 3 0 3

Technology & Innovation; Role of technology & entrepreneurship in addressing societal needs/problems, creation of economic activities and wealth; Understanding Technology innovation cycle; Timing factor; Technology-price relationship; Understanding of technology life cycle; Technology planning & Roadmap; Types of innovation; Disruptive innovation and innovation for base of the pyramid; Process and key elements of entrepreneurship: Entrepreneurial opportunity recognition and feasibility analysis; Developing B-Plan; innovating Business Model, Legal Aspects and financing.

MBA G568 International Business Strategy & Operations 3 0 3

Introduction to International Business, International Market, Cultural environment, Legal, political, economic and monetary aspects facing IB, Governments influence on trade via policies and instruments, Trade theory, Global Trade Protection and the Institutional Background, Global foreign exchange markets, trading process and benefits to IB, Determination of exchange rates, forex arrangements, role of IMF, forecasting and IB benefits, IB Strategy for sustainable value creation and profitability, Multinational corporation, Types of global strategies: integration & responsiveness, Export and import strategies: global & Indian context, Export - Import Procedures, Country evaluation and selection, Marketing globally & use of digital technologies, Global supply chain management, theory of FDI, Multinational Finance function, India specific analysis: Export Incentives, assistance, ECGC, export finance, role of banks and other institutions, Emerging market enterprise strategies.

MBA G571 Management Information Systems 3 0 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

MBA G574 Retail Management Systems 3 0 3

Retailing history and theories, basic retail management process, retail industry in Indian and abroad, shopper behavior in retailing, retailing formats and location related issues, category management, supply chain management in retail, retail buying, store layout and design, point of purchase communication, retail pricing strategy, building store loyalty and technology in retailing. Case studies and projects in retailing, specially focusing on Indian scenarios.

MBA G575 Financial Engineering 3 0 3

Introduction; Review of Markets, Players, and Conventions; Cash Flow Engineering with Forward Contracts; Engineering Simple Interest Rate Derivatives; Swap Engineering; Report Market Strategies; Dynamic Replication Methods and Synthetics; Mechanics of Options; Options Engineering with Applications; Pricing Tools; Applications of Fundamental Theorem of Finance; Fixed Income Engineering; Tools for Volatility Engineering: Volatility Swaps and Volatility Trading; Engineering of Equity Instruments: Pricing and Replication, computational methods such as Monte Carlo Simulation.

MBA G576 Digital Marketing 3 0 3

Fundamentals of e-Business and Internet Marketing, e-Business Models and Frameworks, Digital Marketing Strategy, Online Public Relations, Search Engine Optimization and Marketing, Content Marketing, E-Mail Marketing, Social Media Marketing, Mobile Marketing, Optimizing Customer and User Experience, Web Analytics.

MBA G577 Supply Chain Analytics 3 1 4

Introduction to supply chain analytics, Data understanding and data preparation, Supply chain performance , Descriptive analytics, Predictive analytics and setting up the problem, Supply chain forecasting, studying holt, winter and ARIMA models, Supply chain Network Planning, Multi echelon network optimization, Supply chain sales and operations planning, Supply chain segmentation, Vehicle routing problems, Supervised and Unsupervised learning, Use of Bayesian networks in supply chain, Simulation and SC models, Supply chain risk management.

MBA G578 Game Theory and Business Strategy 3 0 3

Psychology and philosophy of games of strategy; Non-cooperative, One-time, Static Games with Complete Information; Finitely, Infinitely Repeated, Static Games with Complete Information; Mixed Pure Strategies; Games with imperfect competition; Games with perfect competition and monopoly; Strategic Trade Policy; Dynamic Games with Complete and Perfect Information; Bargaining; Pure Strategies with Uncertain Payoffs; Auctions.

MBA G579 Management Practice 3*

This course is intended to make student explore a business problem and offer insights for the solution using management frameworks, tools & methodology under the guidance of faculty member(s). This may include research work. The student will submit the report after completion.

MBA G581 Expert Systems 4

The object of this course is to study in details the features of expert systems and their role in the scientific world of today and tomorrow. It concentrates on the tools available to the knowledge engineer, expert systems, building techniques, and the difficulties which may be encountered during the development of an expert system.

MBA G582 Creating & Leading Entrepreneurial Or- 3 0 3 ganizations

Fundamentals of entrepreneurship; elements of leadership; identifying business opportunities; market study and research; business plans; finance, issues in raising finance; venture capitalist evaluation of business plans, technical aspects for the project, corporate strategies for growth; legal aspect to entrepreneurship, people skills, marketing and branding; creativity and communication.

MBA G583 Marketing Research 3 0 3

An examination of the concepts and practical methodology used in marketing research. An overview of marketing research process, with emphasis on research design; data instrument design; questionnaire formulation; sampling plans; data collection methods -interviewing, panels; data analysis and use of computer based information systems for marketing intelligence. Also Time-series & Regression based models of sales forecasting, control and evaluation of marketing function and survey methodology are covered.

Emphasis will be on cases and research projects.

MBA G586 Product and Brand Management 3 0 3

Scope of product Policy Decisions; Product-Market strategy; Product Life Cycle and Strategy; Managing Product Deletion; Product Associations; Branding including aspects of brand name selection; Brand Equity and its utilization for marketing decision making; Brand Extension: use for brand names for launching new products; New product development process; Idea Generation and Screening; Concept Development and Evaluation; Product Design and Testing; Market planning; Testing the market plan; Marketing research process; Adoption and Diffusion of products; Organizing for new and existing product.

MBA G588 Services Management System 3 0 3

Understanding Services, the Service Sector today, Designing the Service Enterprise, Technological Issues, Structuring Service Operations, Processes Management, Staffing for Services, Functions of Services Management System, Client Relationships, Measuring and Reporting Services.

MBA G589 Enterprise Resource Planning 3 0 3

Introduction to ERP; Re-engineering and ERP systems; ERP planning, design, and implementation; ERP systems – sales and marketing; ERP systems – accounting and finance; ERP systems – production and materials management; ERP systems – human resources; Managing and ERP project; Supply chain management and e-Market place.

MBA G593 Business Analysis and Valuation 3 0 3

Theory of finance, value maximization, stakeholder theory, and corporate objective function: value creation – ways and means, business analysis: The techniques of strategy and competitive analysis, value chain analysis for competitive advantages, business valuation – approaches and methods, the dark side of valuation: strategic investment decisions.

MBA G622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documention in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

MBA in Business Analytics

MPBA G501 Managerial Economics 3 0 3

The firm and it's environment, Introduction to basic principles & methodology, Revenue of the firm, Demand analysis & estimation, Economic forecasting; Production, cost and profit maximization, Production analysis, Cost of production, Profit analysis of the firm; Markets and behavior of the firm (Perfect competition, Monopoly, Monopolistic competition, oligopoly), Factor markets & profit maximizing employment of variable inputs, Games, information and strategy, pricing and profit analysis; Sectoral Economics.

Equivalent: MBA G501

MPBA G502 Financial Statement Analysis & Reporting 3*

Financial Statement Analysis and reporting depicts the financial health of any company and helps the companies to augment their financial resources and management of generated funds efficiently. The course provides an overview of the preparation of financial statements and understanding, financial analysis of statements, and the significance of financial reporting.

MPBA G503 Marketing Management 3 0 3

Definition, marketing research and forecasting demand, creating customer value, satisfaction and loyalty, analysing consumer and business markets, market segmentation, brand equity, brand positioning, product and pricing strategies, managing services, managing value networks and channels, integrated marketing communications, international marketing.

MPBA G504 Managing People & Organization 3 0 3

Fundamental concepts and principles of management as applied to a variety of organizations; elementary study of managerial roles, styles, activities and decision making; relationship with organizational effectiveness; basic concepts relating to planning activities, manpower development; basic concepts relating to organizational behaviour.

MPBA G505 Statistics & Basic Econometrics 3*

Probability and Probability Distributions, Characteristics of Probability Distributions, Some Important Probability Distributions, statistical inference, estimation and hypothesis testing; ANOVA, MANOVA, MANCOVA, the linear regression model (two-variable model, multiple regression, functional forms, dummy variables); regression analysis in practice (model selection criteria and tests, multicollinearity, heteroskedasticity, autocorrelation), simultaneous-equations models. Statistical package 'R' will be used in this course.

MPBA G506 Data Management and Warehousing 3*

The database environment and the development process, Modelling data in organizations, Entity-Relationship diagrams, logical database design, and relational model, physical database design and performance, Structured Query Language (SQL), Database application architectures, Foundations of Data warehousing, Data quality and integration, Big Data analytics, Data, and database administration.

MPBA G507 Programming for Analytics 3*

Variables & data types, operators, conditional statements, iteration statements, functions, Objects, and classes for Python; Data structures – vectors, matrices, lists, tuples, dictionaries, data frames, Packages: using existing packages and creating new packages, Data loading: from CSV, MS Excel, JSON & SQL databases Data wrangling: describing, summarizing, manipulating, and handling missing values of data in data frames; perform an operation such as delete values, find unique values, drop duplicate values, grouping, and performing loop operations over columns or rows; merging data frames; handling categorical data; handling time-series data, handling text data, web scraping, and handling images. Basics of version control using Github. Primary languages are R and Python.

MPBA G508 Strategic Management 3 0 3

Overview of strategy, Crafting Strategy, company's strategy and its business model; Environmental Scanning, General Environment, Task Environment, STEEP analysis, Industry analysis; Resource based view of firm, Core competence, Distinctive competence, Competitive Advantage, Sustainable competitive advantage, Value Chain analysis; Strategy Formulation; Corporate strategy, business strategy, functional strategy; Strategy Implementation; Strategy Evaluation; Advanced Topics of strategic management: Blue Ocean Strategy, Ethical Issues and conduct.

Equvalent: MBA G566

MPBA G509 Corporate Finance 3*

Basics of financial management, time value of money, valuation of securities, risk return and opportunity cost of capital, capital budgeting, WACC and company valuation, capital financing decisions – capital structure, working capital management, dividend decisions, Aspects of Mergers & Acquisitions, Risk Management, International Financing. Ethical versus legal standards in finance, Limited Liability, its Effects and Legal Responses, Insider Dealing and Market Abuse, Regulatory Competition and Regulatory Arbitrage.

Equvalent: MBA G559

MPBA G510 Operations & Supply Chain Management 3*

Strategic importance of Operations, Forecasting, Product planning, Management of Quality, Statistical Process Control, Process Strategy, Layout planning, Production Scheduling, Inventory Management, MRP, Supply chain Management: An Overview, Supply chain strategy, Supply chain performance measurement, Distribution networks, Order management and customer service, Sales and Operations Planning, Transportation, Digital Supply chain, IoT and Blockchain, Sustainability in Supply chain, Ethical supply chain.

Equvalent: MBA G558

MPBA G511 Data Visualization, Ethics and Data Privacy 3*

Data Visualization Tools:R, Rstudio; RMarkdown; Organising data for visualization; choosing right visualization; visualization in practice: continuous variables, categorical variables, time-varying variables, visualizing statistical summaries, spatial data with maps, dimension reduction, three dimensions, networks, and interactive visualizations. Primary packages for visualization: ggplot2 & shiny. Secondary packages: Matplotlib, and Plotly. Introduction to Ethics, Intellectual Property, Information Privacy, Privacy, and the Government, Computer and Network Security, Professional Ethics.

MPBA G512 Time Series Analysis and Forecasting 3*

Extrapolative and Decomposition Models, Introduction to Box–Jenkins Time Series Analysis, ARIMA Models, Estimation and Diagnosis, Metadiagnosis and Forecasting, Intervention Analysis, Autoregressive Error Models-The Nature of Serial Correlation of Error, Sources of Autoregressive Error, Autoregressive Models with Serially Correlated Errors, Tests for Serial Correlation of Error, Corrective Algorithms for Regression Models with Autocorrelated Error, Forecasting with Autocorrelated Error Models, Models with Stochastic Variance- ARCH and GARCH Models, A Review of Model and Forecast Evaluation. The course necessarily involves the use of statistical software and programming languages.

MPBA G513 Predictive Analytics 3*

An Introduction Predictive Analytics, Exploratory Data Analysis, Dimension-Reduction Methods, Preparing the Data for modeling, Decision Trees, Support Vector Machines, Regression Analysis Techniques, Naïve Bayes and Bayesian Networks, Clustering, Association Rules, Boosting and Begging algorithms, Enhancing Model Performance. The course necessarily involves the use of statistical software and programming languages.

MPBA G514 Deep Learning for Business 3*

Introduction to deep learning, and example applications of deep learning algorithms to solve business problems; Basics of neural networks; Applying linear regression and logistic regression using neural networks; Deep neural networks: concepts and hands-on applications; Model Building & Hyper- parameters tuning, Convolution Neural Networks (CNN), Recurrent Neural Networks, Deep reinforcement learning; Long Short Term Memory (LSTM); Generative Adversarial Networks (GANs); Challenges & limitations of deep learning algorithms

MPBA G515 Prescriptive Analytics with Mathematical Programming 3*

Linear Programming, Duality Theory, Sensitivity Analysis, Network Models, Integer Programs, Stochastic Optimization, Sequential Decision Making, Non-Linear and multi-Objective Optimization, Local Search and Meta-heuristics, Large-Scale Optimization, Monte Carlo simulation. The course necessarily involves the use of statistical software and programming languages.

MPBA G516 Advanced Spreadsheet & Macro Programming for Business 3*

Variables, Arrays, Constants, and Data Types, Modules, Functions, and Subroutines, Programming Basics, The Excel Object Model, Using Excel to Interact with Other Office Programs, Working with Databases, API Calls, Class Modules, Animation, Converting Labels to Numbers and Numbers to Labels, Transposing a Range of Cells, Adding Formula Details into Comments, Replacing Characters in a String, Auto Totaling a Matrix of Numbers, Coloring Alternate Rows and Columns of the Spreadsheet, Globally Changing a Range of Values, Searching Multiple Sheets and Workbooks, Brighten Up Your Comments, An Alternative to Message Boxes, Working with Shapes, Turning Your VBA Code into an Add-In.

MPBA G517 Big Data Analytics 3*

Hardware trends for data storage and computation, Big data in private and government sectors, Evolution of tools to handle big data, Apache Spark: for big data processing & engineering, Spark's Resilient Distributed Datasets (RDDs), Transformations and actions in Spark, Exploring big datasets using spark, Application of machine learning algorithms on big datasets through Spark, Application of deep learning algorithms on big datasets through Spark, Handling huge textual datasets and application of deep learning algorithms through Spark, Challenges.

MPBA G518 Bayesian Analysis 3*

Distributions; likelihoods, priors; intuition of building Bayesian models; Basics of Markov Similatuions, building posterior distributions from MCMC simulations; single-parameter models, Multi-parameter models, Hierarchical Models; Generalised Linear Models, Model checking and comparison of models. The course necessarily involves the use of statistical software and programming languages.

MPBA G519 Natural Language Processing for Business 3*

Natural language processing and its neighbors, Themes in Natural language processing, Types of textual data, Preparing textual data for analysis, Regular expressions and patterns matching, term frequency times inverse document frequency, Word to vector representations (word embeddings), and feature engineering, Text classification or Topic Modeling, Text to knowledge conversion: Knowledge graph construction, N- grams, and analysis of word networks in text, logical semantics, predicate argument semantics.

MPBA G520 Analytics for Supply Chain 3*

Supply chain performance, Descriptive analytics, Supply chain forecasting, studying holt, winter and ARIMA models, Supply chain segmentation. Single period and multi-period inventory modeling, Multi-echelon inventory models, Network flow models, Distribution planning, Sales, & Operations planning, Vehicle routing problems, Simulation in supply chain risk assessment.

MPBA G521 Supply Chain Finance 3*

Financial flexibility, Supply chain, and finance link, SCOR model, Financial measures, Trade finance tools, operational hedging, enterprise risk management (ERM), supply chain risk management (SCRM), integrated risk management (IRM), supply chain finance (SCF), and financial management of supply chain strategies.

MPBA G522 Discrete Event Simulation 3*

Introduction to Simulation, Simulation Examples, General Principles, Simulation Software, Statistical Models in Simulation, Queueing Models, Random-Number Generation, Input Modeling, Verification and Validation of Simulation Models, Output Analysis for a Single Model, Some Simulation Applications.

MPBA G523 IT Project Management 3*

Project lifecycle, Scope of work, scope statement, scope creep, project planning, work breakdown structure, project network method, CPM, PERT, project cost estimation, function method, cocomo model, project crashing, project scheduling, time-phased budgeting, project monitoring and control, earned value

method, agile project management.

MPBA G524 Marketing Analytics 3*

Introduction to marketing analytics, Pricing of Single and Bundled Products, Forecasting (Bass Diffusion Model, Copernican Principle), Demand Analysis (Conjoint Analysis, Logistic Regression, Discrete Choice Analysis), Seasonality, Neural Networks to Predict Sales, Customer Life-time Value, Allocation of Marketing Resources, Market Segmentation (Cluster Analysis, Collaborative Filtering, Classification Tree), Market Basket Analysis, Optimizing Direct Mail Campaigns, Allocating Retail Space and Sales Resource, Measuring Effectiveness of Advertising (Adstock Model), Media Selection Models (Linear Media Allocation Model, Monte Carlo Media Allocation Simulation), Online Advertising, Klout Score, Tipping Point, Watt's Model for Viral Marketing, Text Mining.

MPBA G525 Digital Analytics 3*

Understanding web analytics; Finding data for web analytics; Web analytics tools; Discovering bots; Knowing website visitors; Clickstream analytics; Identifying most important webpages; Key performance indicators; Increasing website visibility; Deciding online advertising strategy; Fine-tuning website; Competitive intelligence analysis; Understanding Social Media; Foundations of social, mobile and video analytics; Creating Value with Social Media Analytics; Analytics-Business Alignment; Capturing Value with Network Analytics, Text Analytics and Actions Analytics; Social Media Analytics Capabilities; Social Media Security, Privacy & Ethics. The course necessarily involves the use of statistical software and programming languages.

MPBA G526 Pricing Analytics 3*

This course provides an introduction to both the theory and the practice of revenue management and pricing, Fundamentals of price theory, Segmentation and price differentiation, Break- even analysis, Price sensitivity and willingness-to-pay, Empirical estimations of price-response functions, Price optimization, Markdown optimization, The hedonic pricing model, Revenue Management, Big Data and pricing analytics, Monte Carlo simulation for pricing decisions, Conjoint analysis for pricing decisions. The course necessarily involves the use of statistical software and programming languages.

MPBA G527 Retail Analytics 3*

Retail business's business intelligence environment, retail processes, methods, and technologies, retail information systems, retail consumers, data-driven tools and theoretical analytical models, analytical tools for retail, statistical methods in econometrics and machine learning like -single and multivariate linear regressions, logistic regressions, and classification trees, merchandising analytics, customer analytics, managing in-store environment & operations, inventory, sales and its trends, loyalty marketing and 'retail data reporting & visualization'. The course necessarily involves the use of statistical software and programming languages.

MPBA G528 Customer Engagement and Analytics 3*

Customer acquisition: RFM scoring, Customer characteristics, Company-interaction variables, Clickstream data, Linear regression model, logit/probit model, transaction usage clustering, Probability models. Customer development: Regression model, logistic regression model, Markov decision process, Structural equation model. Customer retention: Dependence between customer value, customer engagement and churn probability, Non-parametric models. The course necessarily involves the use of statistical software and programming languages.

MPBA G529 Marketing Research & Metrics 3*

Elements of marketing research process viz. Problem Definition, Development of an approach to the Problem, Research Design formulation, Exploratory, Descriptive and experimental, Fieldwork & Data collection, Data preparation & Analysis, univariate, bivariate and multivariate statistical techniques, Report preparation and Presentation. Marketing metrics. Nonfinancial metrics: Brand awareness, Test drive, Churn, Customer satisfaction (CSAT) and Take rate; Financial metrics: Profit, Net present value (NPV), Internal rate of return (IRR), Payback, Customer lifetime value (CLTV), Cost per click (CPC), Transaction conversion rate (TCR), Return on ad dollars spent (ROA), Bounce Rate and Word of mouth (WOM).

Equvalent: MBA G560

MPBA G530 Financial Analytics 3*

Financial Statistics, data exploration using fundamentals, returns evaluation, gauging market sentiment, prediction using fundamentals, forecasting financial time-series, portfolio analytics: Sharpe ratio, Markowitz mean-variance optimization, portfolio allocation using regularization, portfolio strategies, dynamic portfolio selection, portfolio tracking, and rebalancing, Simulating Trading Strategies. Market structure, mechanics of algorithmic, taxonomy of data used in algorithmic trading, market microstructure, high-frequency data, computational resources and algorithms for high-frequency trading.

MPBA G531 Financial Derivatives and Analysis 3*

Futures and Forward Contracts: Futures Markets, Currency Futures, and Forward Contracts, Equity Index Futures, Interest Rate and Bond Futures and Forward Contracts, Fundamental of Options Trading, Option Strategies, Option Hedging, Option Pricing, The Binomial Option Pricing, The Black_Scholes Option Pricing Model, Pricing Non-Stock Options and Future Options, Pricing Bond and Interest Rate Options, Financial Swap, Credit Default and Currency Swaps.

MPBA G532 Financial Modelling and Valuation 3*

Introduction to valuation, the role of financial statements, steps in business valuation, different approaches to valuation, strategy analysis, accounting analysis, financial analysis, prospective analysis, deal analysis, credit analysis, and corporate governance.

MPBA G533 Financial Technology 3*

Introduction to FinTech landscape, Blockchain technologies, Crypto-assets and their ecosystem, FinTech Business Plans, FinTech Start-ups, Technology Stack Evaluation to develop fintech products, Payments, Lending, FinTech in Incumbents, InsureTech, AI in Finance, Regulations in FinTech, Risks in fintech, Identify opportunities in emerging internet and finance sectors and develop a fintech product, Evaluation of the market potential of fintech-startup, fund-raising for fintech start-ups, Cryptocurrencies disruption in venture capital funding.

MPBA G534 People Analytics 3*

Introduction to People Analytics, HR Business Processes and HR Analytics, People Analytics and Data, Descriptive Analytics: Data Visualization in HR using Excel and Tableau, Predictive Analytics: Application of GLM procedures using MS Excel and R Commander, Predictive Analytics: Application of Supervised and Unsupervised Learning, Text Analytics: Applications in Orange

MPBA G535 Strategy Analytics 3*

Creating competitive advantage through Data; Role of analytics in strategic management; Drawing insights from data for environmental scanning; Analytics concepts for strategy formulation & prioritization; optimization tools & techniques for strategy implementation; Metrics for strategy evaluation & control; Designing intelligent information System for key stakeholders; Solving real-life case problems using analytical tools.

MPBA G536 Knowledge Management and Digital Strategy 3*

This course introduces the models and definitions of Knowledge Management, The information management cycle, Policies, tools, and techniques for knowledge management, Digital Trends: Big data, business analytics, and artificial intelligence. Knowledge management strategy, Digital strategy and business models of technology companies, Role of social media strategy in supporting knowledge flows, Enablers and barriers in knowledge sharing and knowledge transfer, Learning Organisations, Communities of Practice, Artificial Intelligence (AI) ethics, and the future of professions.

MPBA G537 Data Structures and Algorithmic Thinking 2 1 3

Recursion and backtracking, Linked List and Arrays, Stack and Queues, Trees, Priority Queues, Maps and Hash Tables, Disjoint Sets, Graphs, Text Processing

Pre-requisite: MPBA G507 Programming for Analytics

MPBA G538 Critical Product Management 3*

Purpose and role of a PM, PM: Myth vs. Reality; Telling Your Product Story; Deeper Dive into Product Build, UX research, UX Design Sprints, User Experimentation (A/B Testing), PM - UX Partnership, Technical savviness to give directions to and mentor Engineering, Writing PRFAQ and/or PRD; Data Experimentation & Measurement Programs; Ensuring a successful product, GTM strategy, Naming, Pricing, Launch; Stages: Private Preview, Limited Preview, General Availability (or as known as alpha, beta, general release); Having difficult conversations and prioritizations: Build the Product Roadmap; Strategy: Short term vs. Long term; Analytics: From Vision to Metrics to Insights (North Star, Counter Metrics, Guardrail Metrics), Adding color to analytics; Soft skills.

Mechanical Engineering

ME F110 Workshop Practice 0 4 2

Laboratory exercises for different manufacturing processes like machining on lathe, drilling, grinding, milling and shaper; sand moulding and casting; metal forming; joining processes like arc welding, gas welding, brazing and soldering; carpentry; fitting; use of metrology equipments in measurement; demonstrations on CNC machines and CNC part programming.

ME F112 Workshop Practice 1 1 2

Engineering materials, casting, forming, machining, joining, powder metallurgy, additive manufacturing, plastic processing, various other manufacturing processes and related laboratory exercises.

ME F211 Mechanics of Solids 3 0 3

Fundamental principles of mechanics, introduction of mechanics of deformable bodies, force and moment transmitted by slender members (2D truss, frame, beam), stress and strain, stress-strain-temperature relations, torsion of circular member, stress and deflection due to bending, buckling of columns, theories of failure.

ME F212 Fluid Mechanics 3 0 3

Fluid statics, fundamental of mass, momentum and energy transfer, control volume approach and integral equations, differential analysis of mass, momentum and energy transfer, solutions for one-dimensional steady-state situations, viscous and inviscid flow, dimensional analysis, compressible fluid flow.

ME F213 Materials Science & Engineering 2 0 2

Introduction, Structure of Materials (Metal and Ceramics), Dislocations, heat treatment of steel and strengthening Mechanisms of Metals, Phase diagrams, Iron-carbide phase diagram, Phase transformation in Metals, Mechanical and thermal properties of Metals, Polymers (Structure, processes and properties), powder metallurgy.

ME F214 Applied Thermodynamics 3 0 3

Availability and irreversibility, thermodynamic relations, gas and vapor cycles, combined power generation cycles, gas mixtures, refrigeration cycles, psychometrics and heat load calculations, gas turbine cycles , compressors, boilers and accessories

ME F215 Mechanical Engineering Laboratory 0 2 2

The course shall aim to train the student in the skill of operation of instruments and equipments. Testing of mechanical properties like tensile testing, hardness, impact, bending of beams, spring testing, basic fluid mechanics experiments like measurements of pressure, temperature, viscosity, flow measurement, basic electrical & electronics like experiments on diodes, rectifiers, OPAMPS, dc motors, transformers, induction and synchronous motors.

ME F216 Materials Science and Engineering 2 1 3

Introduction, structure of materials (metals, ceramics, and polymers), crystalline structure imperfections, amorphous and semi-crystalline materials, correlation of structure to properties, phase diagrams & phase transformation, solidification, diffusion and heat treatment, mechanical behaviour of material. Composites, advanced-smart materials, and functional materials, criteria for material selection, economic environmental, and societal issues. Experiments related to materials testing and characterization such as tensile, torsion, hardness, impact, non-destructive testing, XRD, SEM, etc.

Equivalent: MF F216

ME F217 Applied Thermodynamics 3 1 4

Thermodynamics relations, gas and vapour cycles, combined power generation cycles, gas mixtures, refrigeration cycles, psychometrics and heat load calculations, gas turbine cycles, compressors, boilers, and accessories; Experiments related to applied thermodynamics and fluid mechanics courses.

ME F218 Advanced Mechanics of Solids 2 0 2

3D stress, strain, and generalized Hooke's law, energy methods, torsion of noncircular members, shear center and asymmetrical bending, curved beams, and thick cylinders.

ME F219 Manufacturing Processes 3 1 4

Metal casting: different types of casting processes, casting analysis, and defects. Metal forming process analysis and defects. Welding, brazing, and soldering process and defects. Machining processes and analysis, machine tools, and cutting tool geometry. Polymer processing, metrology, and instrumentation: limits, fits, and tolerances. Related laboratory experiments.

ME F220 Heat Transfer 3 1 4

Fundamental concepts of heat transfer, steady-state and unsteady-state heat conduction, analytical and empirical relations for forced and free convection heat transfer, heat exchanger analysis and design, heat transfer by radiation, boiling, and condensation, introduction to mass transfer; associated laboratory.

ME F221 Mechanisms and Machines 3 0 3

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, synthesis of planar mechanism, cam design, kinematics of gears, gear trains, dynamics of machines: static force analysis, dynamic force analysis (planar), dynamics of reciprocating engines, balancing, flywheels, gyroscopes, introduction to spatial & compliant mechanism, exposure to modeling and simulation tools.

Equivalent: MF F221

ME F241 Machine Design & Drawing 3 1 4

Fundamentals and principles of Design. Design and selection of Machine elements such as shafts, Screw fasteners, Welded joints, Springs, Brakes & Clutches, Bearings & Gears. Fundamentals of Machine Drawing; practices for Orthographic drawing of machine parts, sectional view, assembly drawing & exploded view.

ME F242 IC Engines 2 0 2

Working cycles and operation of two stroke, four stroke SI and CI engine cycles. Ignition, combustion, alternative fuels, emission and their control.

ME F243 Production Techniques I 2 1 3

Metal casting methods, patterns and molding, different types of casting processes, injection molding, die casting and casting defects. Casting analysis. Metal forming, different bulk metal forming processes like rolling, extrusion, forging and wire drawing. Metal forming process analysis and forming defects. Welding, brazing and soldering, different techniques and welding defects. Welding analysis. Simple description of various machining operations, machine tools and cutting tool geometry. Limits & Fits and Metrology. Fabrication project.

ME F244 Kinematics & Dynamics of Machinery 3 0 3

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, Synthesis of mechanisms (Planer), cam design, Kinematics of gears (spur, helical, bevel and worm), gear trains, Dynamics of machines: static force analysis, dynamic force analysis (planar),dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes.

ME F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels.

These courses must coterminate with project reports.

ME F311 Heat Transfer **3 1 4**

Fundamental concepts of heat transfer; steady state and unsteady- state heat conduction; analytical and empirical relations for forced and free convection heat transfer; heat exchanger analysis and design, heat transfer by radiation; associated laboratory.

ME F312 Advanced Mechanics of Solids **3 0 3**

Generalized Hooke's law; Energy methods; torsion of non-circular members; shear center and asymmetrical bending; curved beams; thick cylinders; plates and shells; contact stress.

ME F313 Production Techniques II **3 1 4**

Metal cutting theory. Analysis, economics and quality control of metal cutting, laboratory exercises in metal cutting and fabrication project. Different machine tools their description and operation. Non-traditional machining processes. Micro-manufacturing technologies. Introduction to computer aided manufacturing (CAM), CNC machines and CNC part programming.

ME F314 Design of Machine Elements **3 0 3**

Design methodology, fundamental principles, materials, design for static failure, design for fatigue failure, design and selection of machine elements such as shafts, screw fasteners, welded joints, springs, belt drive, brakes & clutches, bearings & gears.

Equivalent: MF F314

ME F315 Advanced Manufacturing Processes **2 1 3**

Unconventional manufacturing processes and analysis, micro-manufacturing technologies, introduction to computer-aided manufacturing, CNC machines, CNC part programming, additive manufacturing, modeling & simulation of manufacturing processes, surface technologies. Related laboratory exercises and fabrication project.

ME F316 Manufacturing Management **2 0 2**

Introduction to manufacturing systems, forecasting, life cycle concepts, facility location and layout planning, aggregate and batch production planning, scheduling, inventory control, material requirement planning, and enterprise resource planning, just-in-time and lean manufacturing, total quality management, supply chain management and Industry 4.0.

ME F317 Engines, Motors, and Mobility **2 0 2**

Introduction - injection & ignition systems, lubrication, and cooling, measurement, and testing, emissions and control; fuel-air cycles; actual cycles; conventional fuels; combustion; alternate fuels; modern mobility solutions; electric and hybrid vehicles; comparisons of conventional vehicles with electric vehicles in terms of advantages, disadvantages, and applications.

ME F318 Computer-Aided Design **1 2 3**

Mathematical modeling of parametric curves, surfaces and solids. Geometric transformations, isometric transformations including translation, scaling, reflection, and rotation using specialized solid modeling packages. CAD/CAM data exchange. Introduction to FEM & FEA practice on a specialized CAE package. Modeling and simulation based practical exercises related to geometric modeling, finite element analysis, and machine drawing such as orthographic drawing, sectional view, assembly drawing & exploded view.

ME F319 Vibrations and Control **3 0 3**

Small oscillations of linear dynamical systems, free and forced vibrations of single and multi-degree-of-freedom systems, normal modes and orthogonality relations, generalized coordinates, and Lagrange's equations, matrix formulation, eigen-value problem, and numerical solutions, transient response of one-dimensional systems. Introduction to continuous system, vibration measurement and analysis, closed loop control, conventional and non-conventional control strategies, transfer function, dynamic response, and stability criteria, state space approach and exposure to simulation tools.

ME F320 Engineering Optimization **3 0 3**

Formulation of optimization problems, classical optimization techniques, nonlinear optimization methods for problems with and without constraints, simplex method, duality and sensitivity concepts, revised simplex methods, transportation models, travelling-salesman models, assignment models, network models, integer programming, genetic algorithm and other evolutionary optimization techniques, goal programming and multi-objective optimization. Use of application softwares in solving optimization problems.

Equivalent: MF F320

ME F321 Data Mining in Mechanical Sciences **2 1 3**

Introduction to data mining, clustering, classification & association, sequence analysis, regressions method, decision trees, machine learning, neural networks, SVM for engineering and manufacturing applications, data mining for product design, applications of data mining in production, planning and scheduling, data mining for defect identification, process and quality control, application of data mining in maintenance, data analysis for machine and manufacturing process monitoring, introduction to cyber physical systems, introduction to big data handling and big data analytics.

ME F323 Energy Storage Technologies **3 0 3**

Introduction, necessity of energy storage, classification, principles, challenges, comparison and applications of energy storage technologies. Mechanical energy storage: Flywheel, compressed air and pumped hydro energy storage. Thermal energy storage: Sensible heat, cryogenic storage, phase change materials, latent heat enthalpy, charging and discharging, thermochemical energy storage, sorption and desorption reactions. Electrochemical energy storage: Lead-acid batteries, ionic batteries, fuel cells, flow batteries, super-capacitors. Chemical energy storage: Hydrogen storage methods, power-to-gas and synthetic fuels. Challenges and solutions through different energy storage technologies.

ME F427 Continuum Mechanics **3 1 4**

Introduction to tensors, tensor algebra and tensor calculus. Kinematics of deformation (displacement, velocity, deformation gradient, material and spatial field descriptions, description of local deformation, linearized kinematics, kinematic rates), left & right Cauchy-Green deformation tensor, Cauchy-Lagrangian strain tensor. Traction and stress (first Piola-Kirchhoff stress, second Piola-Kirchhoff stress, Biot stress etc). Mechanical conservation and balance laws (conservation of mass, conservation of linear momentum, conservation of angular momentum, conservation of energy, work done by stresses and the principle of virtual work, BVP, IVP, calculus of variation). Constitutive relations (constraints on constitutive relations, frame indifference, objectivity, material symmetry, constitutive models for linearly elastic, hyperelastic solids and fluid flows).

ME F428 Smart Materials **3 1 4**

Overview of smart materials. Piezoelectric materials (Ceramics and polymers), Electro and Magneto-Rheological Fluids, Shape Memory Alloys (SMA) – One way and two-way SMAs, Magnetic Shape Memory Alloys (M-SMA), Fiber optic sensors, Miscellaneous smart materials – Magnetostrictive, electrostrictive materials and others. Basic modelling of smart materials, Dynamics and control knowledge for smart materials. Applications in the field of civil, mechanical, aerospace, biomedical, energy industry such as sensors and actuators, vibration control and damping, structural health monitoring. Intelligent devices based on smart materials.

Pre-requisites: ME F216 or MF F216 or CHE F243

ME F429 Micro-Nanoscale Heat Transport **3 1 4**

Introduction to energy carriers at micro/nanoscale, energy levels at micro/nanoscale, energy transport by waves and particles, energy quantization, energy states in solids, scattering and heat generation processes, statistical thermodynamics, micro/nanoscale heat transport: Phonon specific heat, thermal conductance, thermal conductivity, convection and radiation, entropy of energy states. Classical laws, Boltzmann transport equation, deviation from classical laws at micro/nanoscale, phonon-phonon transport, electron-phonon transport. Applications of micro/nanoscale heat transport: micro heat exchanger, micro heat pipes, thermoelectric devices, microchannel heat sinks, microelectronics, nanomaterials, nanoencapsulated heat storage materials, nanofluids, nanoscale thin films and nanosensors.

Pre-requisites: ME F220 OR CHE F241

ME F340 Introduction to Sports Engineering 3 0 3

The course essentially prepares engineering students to utilize their existing technical knowhow for sports applications. The specific topics will include, working with human and human movement patterns, qualitative and quantitative techniques for analysis of human movement. Sports performance measure and analysis. Anthropomorphy, Ergonomics and Task design. Computer application in sports, computerized performance measure. Sports surface and its impact on sports performance, surface testing methods. Sports and training equipment case study, business around sports.

ME F341 Prime Movers & Fluid Machines 2 1 3

Theoretical analysis of energy and momentum transfer between fluid and rotor; principles of axial, mixed and radial flow compressors, turbines and pumps; design considerations; cascade aerodynamics and performance limitations; applications to power plant systems; model similitude for turbo-machines; Introduction to fluid power system, laboratory exercises in testing reciprocating machines, rotary machines and fluid power system.

ME F342 Computer Aided Design 3 1 4

CAD software and CAD hardware. Mathematical modeling of parametric curves, surfaces and solids, and their computer simulation on spreadsheets and using specialized solid modeling packages. CAD/CAM data exchange. Introduction to finite element analysis and FEM practice on a specialized CAE package. Rapid prototyping. Students will be required to do several assignments and one CAD project.

ME F343 Mechanical Vibrations 3 0 3

Small oscillations of linear dynamical systems, free and forced vibrations of single and multi-degree-of-freedom systems, normal modes and orthogonality relations, generalized co-ordinates and Lagrange's equations, matrix formulation, eigenvalue problem and numerical solutions, transient response of one-dimensional systems, approximate energy methods, continuous system, vibration of string, rods, bars and beams. Introduction to control systems.

ME F344 Engineering Optimization 2 0 2

Linear programming methods, simplex method, transportation model and its variants, queuing systems, PERT/CPM, Optimal problem formulation, engineering optimization problems, single variable optimization algorithms, multivariable optimization algorithms, constrained optimization algorithms.

ME F366 Lab Project 3

ME F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ME F376 Design Project 3

ME F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ME F411 Fluid Power Systems 3 1 4

Introduction to Fluid power, advantages of fluid power, applications, Introduction to Pneumatics, Air preparation and Components, Pneumatics Circuits and Applications, Electro pneumatics, Electrical Controls for fluid power circuits, , Physical properties of hydraulic fluids, Energy and Power in Hydraulic Systems, Frictional Losses in Hydraulic Pipelines, Hydraulic Pumps, Hydraulic Cylinders and Cushioning Devices, Hydraulic Motors, Hydraulic Valves, Hydraulic Circuit Design and Analysis, Ancillary Hydraulic Devices, Hydraulic Conductions and Fittings, Maintenance of Hydraulic Systems, Use of PLC programming for interfacing pneumatics and Hydraulic Circuits.

ME F412 Production Planning and Control 3 0 3

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

ME F413 Nonlinear Vibrations 3 0 3

Introduction, sources of nonlinearity, examples, qualitative analysis: phase plane, singular points, stability of singular points, Forced response, Perturbation methods: straightforward expansion, the method of multiple scales, harmonic balance, method of averaging, Nonlinear normal modes, Nonlinear Multiple-DOF Systems, Bifurcations, Centre manifold reduction, Flouquet Theory, Chaos Theory, Melnikov Criterion, Applications to vehicle dynamics, structures and microsystems etc. Use of softwares for simulations and numerical solutions.

ME F414 Fuel Cell Science and Technology 3*

Introduction to fuel cell, types, advantages and applications;Fuel cell thermodynamics, electrochemistry, chargetransport, heat and mass transport; Fuel cell modelling andsimulation. In-situ, ex-situ experimental characterizationtechniques viz. polarization curve, electrochemicalimpedance spectroscopy, current density mapping etc.Polymer electrolyte membrane fuel cell including directliquid fuel cell; Other fuel cells viz. SOFC, AFC, MCFC,PAFC, biological fuel cells etc. and recent development.

ME F415 Gas Dynamics 3 0 3

Introduction to Gas Dynamics, Basic equations of compressible flow, Wave propagation, Steady one-dimensional flow (Varying-area adiabatic flow), Normal shock waves, Oblique shock and expansion waves, Prandtl-Meyer Flow, Flow with Friction and Heat Transfer, Potential equation for compressible flow, Similarity rule.

ME F416 Reverse Engineering and Rapid Prototyping 3 0 3

Introduction to reverse engineering, methodologies and techniques for reverse engineering, reverse engineering hardware and software, selecting reverse engineering system, introduction to rapid prototyping, relationship between reverse engineering and rapid prototyping. Reverse engineering in automotive engineering, aerospace engineering, medical device industry. Legal aspects and barriers for reverse engineering. Project work.

ME F417 Advanced Metal Forming 3 0 3

The stress and strain tensors in macroscopic plasticity and failure criteria for metal forming, effective stress and effective strain, flow rules for plastic deformation and principle of normality. Work hardening, determination of work hardening exponent. Plastic instability and effect of inhomogeneity on uniform strain. Strain rate and temperature effects on plastic deformation and flow stress, super-plasticity, temperature rise during metal forming. Ideal work and redundant work. Slab, upper-bound, slip-line field and finite element methods of analysis of various bulk and sheet metal forming processes. Bulk and sheet metal formability tests and forming limit diagram. Sheet metal properties and plastic anisotropy.

ME F418 Rocket and Spacecraft Propulsion 3 0 3

Thrust and specific impulse. Compressible flows. Detailed analysis of liquid, solid and hybrid propulsion systems. Includes propellants, injection systems, combustion and chemical equilibrium, thrust chambers, nozzles and plumes. Electro-thermal thrusters. Plasmas and electromagnetic thrusters.

ME F419 Total Product Integration Engineering 3 0 3

Quality design across global supply chain. Robust product architecture for market variety and technology advances. Product development risk management.

ME F420 Power Plant Engineering 3 0 3

Classification of power plants. Components and layout of; thermal, nuclear, hydro electric power plants. Site selection for various power plants. Combined cycle power plants. Magneto Hydro Dynamics (MHD) systems. Economics of power generation, economic loading of power stations. Load curve analysis; load factor, diversity factor. Power plant instrumentation and controls.

ME F423 Micro Fluidics and its Application 4*

Introduction to microfluidics, scaling in microfluidics, theoretical microfluidics, Philosophy of Computational Fluid Dynamics,

Concepts of discretization, fabrication techniques for microfluidic devices, microvalves, micropumps, microflow sensors, microfluidics for life sciences: micromixers, microneedles, microfilters, microseparators, microreactors, modeling and simulation on CAD tool.

ME F424 Energy Management 3 0 3

World and Indian energy scenario; energy policy;energy management principles; energy conservation;energy auditing; analysis; formulation of energymanagement options; economic evaluation,implementation & control; energy conservationtechniques – conservation in energy intensiveindustries; choice of fuels and stoichiometry, steamgeneration, distribution systems, and electricalsystems; integrated resource planning; demandsidemanagement; cogeneration; total energy schemes;thermal insulation; energy storage; economicevaluation of conservation technologies; analysis oftypical applications.

ME F425 Additive Manufacturing 3 0 3

Introduction to Additive Manufacturing (AM),generalized AM process and process chain, differentmaterials used in AM, Use of multiple materials,multifunctional and graded materials in AM, Role ofsolidification rate. Various AM processes and theirmechanics of operation. Vat polymerization processes,stereolithography. Powder based AM processesinvolving sintering and melting, selective lasersintering, direct metal laser sintering, selective lasermelting, other polymer, ceramic, metal and alloyK-4powder based AM processes. Extrusion based AMprocesses, fused deposition modelling (FDM). Sheetlamination processes, laminated object manufacturing(LOM). Micro- and nano-additive manufacturingprocesses; Modelling in Additive ManufacturingTransport phenomena models: temperature and fluidflow, molten pool formation, Various case studies -modelling of fusion based AM process, powder bedmelting based process, droplet based printing process;Applications of Additive Manufacturing in Aerospace,Automotive, Electronics industries and Biomedicalapplications.

ME F426 Industry 4.0 in Manufacturing 3 0 3

Limitations of existing manufacturing systems,industrial revolution 4.0 for manufacturing, vision andstrategy, organization and structure, models andstandards, drivers and enablers, smart products, smartprocess, smart production, smart factories, smartnetworked industries, smart supply chain, lean andI4.0. I4.0 navigators: sensors, actuators, data analytics,connectivity, and AI. Economic evaluation of existingsystem for I4.0. Limitations of I4.0. Case studies.

ME F432 Computer Aided Manufacturing 2 1 3

Introduction, features of NC machine tools, NC part programming, CAM system devices, interpolators for manufacturing systems, control loops of NC systems, computerized numerical control, adaptive control systems, CAD to CAM, CAPP, industrial robots, computer aided production planning & control, computer aided inspection and quality control, CIM systems.

ME F433 Solar Thermal Process Engineering 3 1 4

Fundamentals of solar energy, earth-sun angles, solar spectrum, solar radiation, measurement and estimation of solar energy on horizontal and tilted surface, conversion routes and technologies, Standards and Performance Testing, thermal utilization of solar energy, modes of heat transfer and equations for performance calculations of systems- conduction, convection and radiation of heat, Flat plate collectors, solar concentrator systems, geometric optics, tracking methods, thermal analysis, energy storage, materials and properties, solar process loads and system calculations for time dependent loads, Life cycle cost analysis and economic analysis for various applications of solar thermal processes, solar water heating, space heating and cooling in Buildings, Industrial process heating, solar air-conditioning and refrigeration, Use of Simulation tools for performance simulation and Project Assignments, solar thermal power generation, Role of Govt., policies and plans.

ME F441 Automotive Vehicles 3 0 3

Internal combustion engines; vehicle performance; analysis and design of vehicle components. Experimental or theoretical investigation of problems selected from the field of automotive vehicles.

ME F443 Quality Control, Assurance and Reliability 3 0 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

ME F451 Mechanical Equipment Design 3 0 3

Design analysis for additional machine elements; retainment of bearings and design of machine housing; introduction to techniques of optimisation reliability and value analysis; exercises in detail design; design solutions to meet specified functional requirements.

ME F452 Composite Materials & Design 3 0 3

Introduction to composites, concepts of reinforcement, strengthening mechanisms, fibrous reinforcements, matrix materials, micro-mechanical aspects of composites, manufacturing methods, composite production design methods-design of tensile members, pressure vessels, storage tanks, and other chemical process equipment made of FRP, design of joints, damage of composites by impact, FRP grids, recent development in manufacturing of composites and technologies.

ME F461 Refrigeration and Air conditioning 3 0 3

Principles, thermodynamic analysis, load estimates and design of various refrigeration and air conditioning systems for comfort and industrial applications. Theoretical or experimental investigation of refrigeration and air-conditioning problems.

ME F472 Precision Engineering 3 0 3

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and microfinishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerancing.

ME F481 Project Appraisal 3 0 3

Course Description is to be developed.

ME F482 Combustion 3 0 3

Fuels, Combustion, Adiabatic Flame Temperature, Chemical Kinetics, Chain Reactions, Conservation Equations for Reacting Flows, Laminar and Turbulent Premixed Flames, Diffusion Flames, Droplet and Particle Combustion, Emissions, Applications.

ME F483 Wind Energy 3 0 3

Historic development of wind energy technology, basic principles of wind energy conversion, different types of wind machines and their performances, wind rotor aerodynamics and its application in the turbine design, statistical methods of measurement and analysis of wind spectra for energy use, developing models for estimating the wind energy potential of a prospective site, Constructional features of various systems and sub-systems of a Wind Energy Conversion System(WECS), Features of wind farms, performance models of WECS, Optimal matching of WECS, environmental aspects of wind energy conversion, Economics of wind energy conversion.

ME F484 Automotive Technology 3 0 3

Automotive vehicle: layout, operating systems, components, materials and production processes; Power unit: IC engine, working principles, performance, systems and the associated parts; Mechanical unit: transmission, drive train, steering, chassis, suspension, brakes, wheels and tyres; Electric unit: battery, charging, starter and lighting; Electronic control unit: application of electronics and computers, sensors, actuators and on-board diagnostics; Latest Trends: advanced combustion systems and hybrid/fuel-cell/electrical power systems, alternate fuels and the

emissions.

ME F485 Numerical Techniques for Fluid Flow and Heat Transfer **3 0 3**

Introduction to CFD,Partial Differential Equation (PDE): Physical classifications, Mathematical Classifications, Well posed problem. Basic of Discretization Methods: Finite difference method, Truncation error, consistency, error and stability analysis, convergence, various discretization schemes. Introduction commercial software: OpenFOAM or Fluent. Application of numerical methods to selected model equations: Wave equation, Heat equation, Laplace's equations. Solution of Navier-Stokes equation for incompressible flows.

ME F491 Special Project **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

ME G511 Mechanisms & Robotics **2 3 5**

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

ME G512 Finite Element Methods **5**

Fundamental concepts, matrix algebra and gaussian limination, one-dimensional problems, trusses, two-dimensional problems using constant strain triangles, axisymmetric solids subjected to axisymmetric loading, two-dimensional isoparametric elements and numerical integration, beams and frames, three-dimensional problems in stress analysis, scalar field problems, dynamic considerations, pre-processing and post processing.

ME G513 Heating and Cooling of Buildings **3 2 5**

Introduction to HVAC design, basic scientific principles, climatic conditions, building heat transmission surfaces, infiltration and ventilation, heating loads, heat gains and cooling loads, HVAC psychometrics, codes and standards for HVAC systems design, acoustics and vibration, human comfort, air distribution, duct system design, fans and central air systems, air system heating and cooling, air cleaning and filtration, introduction to electrical systems, controls for air distribution systems.

ME G514 Turbomachinery **3 2 5**

Introduction, thermodynamics, gas turbine plants, steam turbine plants, fluid dynamics, dimensional analysis and performance parameters, flow through cascades, axial turbine stages, high temperature turbine stages, axial compressor stages, centrifugal compressor stages, radial turbine stages, axial fans and propellers, centrifugal fans and blowers, and wind turbines.

ME G515 Computational Fluid Dynamics **3 2 5**

Philosophy of computational fluid dynamics (CFD), governing equations of fluid dynamics, mathematical behavior of partial differential equations, basics of the numerics : basic aspects of discretization, grids with appropriate transformations, and simple CFD techniques, applications, numerical solutions of quasi-one-dimensional nozzle flows, numerical solution of a two-dimensional supersonic flow, incompressible couette flow, and supersonic flow over a flat plate, advanced topics in CFD.

ME G516 Energy Systems Engineering **5**

Basic concepts of energy conversion, generation of electrical and thermal energy, transmission and distribution of electrical energy, load management, detailed analysis of utilization of thermal energy in : boilers, furnaces, compressors, heat transfer equipments, and HVAC systems, energy audit, waste heat recovery systems, cogeneration, demand side management, and management and organization of energy saving projects.

ME G521 Mechanical System Design **3 2 5**

Concept of system design; modeling of structural and kinematic systems, and determination of system characteristics; reliability of systems; design of machine elements for specified reliability; concepts of optimization; techniques of design optimization for linear and non-linear problems.

ME G532 Machine Tool Engineering **3 2 5**

Design principles of machine tools; stiffness and rigidity of separate construction elements and their combined behaviour under load; design of stepped and stepless drives; electrical, mechanical and hydraulic drives; design of bearings and sideways; machine tool controls; machine tool dynamics; recent developments in machine tool design.

ME G533 Conduction and Radiation Heat Transfer **5***

Conduction: Steady and unsteady problems and their solutions in cartesian, cylindrical and spherical coordinates. Separation of variables. Duhamel's theorem. Laplace transform. Problems involving change of phase. Inverse heat conduction, Microscale heat transfer, Radiation: Radiative exchange among black and grey and spectral surfaces, Shape factors. Applications to cavities and enclosures. Integral equations approach. Radiation from gases, vapours and flames.

ME G534 Convective Heat and Mass Transfer **5***

Conservation equations, boundary layers, free convection, forced convection. Heat transfer in laminar and turbulent, internal as well as external flows, mixed convection. Combined convection and radiation. Boiling and Condensation. Molecular diffusion in fluids, mass transfer coefficient. Simultaneous heat and mass transfer; Applications.

ME G535 Advanced Engineering Mathematics **3 2 5**

Boundary value problems; wave equations; nonlinear partial differential equations; calculus of variations; Eigen value problems; iteration problems including forward and inverse iteration schemes – Graham Schmidt deflation – simultaneous iteration method – subspace iteration – Lanczo's algorithm – estimation of core and time requirements.

ME G536 Thermal Equipment Design **5**

Course description is to be developed.

ME G537 Cryogenic Engineering **5**

Introduction to cryogenics and its applications, properties of cryogenic fluids, properties of materials at cryogenic temperature, gas-Liquefaction and refrigeration systems, gas separation, cryocoolers, cryogenic insulations, vacuum technology, instrumentation in cryogenics, safety in cryogenics.

ME G538 Toyota Production System **3 2 5**

Birth of Toyota production system, house of Toyota production system, stability, standardization, just-in-time,jidoka, involvement, hoshin planning, Toyota culture, Toyota way, Case Studies.

ME G539 Computer Integrated Manufacturing **3 2 5**

Computer Modeling for mass property analysis. Computer Numerical Control. Computer-aided Manufacturing, operation of CNC machine tools. Design of manufacturing work cells, Automated Manufacturing and Programmable Controller.

ME G542 Advanced welding techniques **3 2 5**

A detailed overview of Friction welding, Explosive welding, ultrasonic welding, and hybrid welding process; working principle and applications; Heat distribution, metal flow in a liquid and semi-solid state; alloying element segregation, macro and microstructure in different weld zones; Selection of welding characteristics for underwater, extreme hot or cold, and in space conditions; Thermal modeling and simulations; governing transport phenomena equations, boundary conditions for individual welding processes; Estimation of the cooling rate, G/R ratio, and grain growth in weld zones.

ME G611 Computer Aided Analysis and Design 2 3 5

The course aims at developing complete self reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

ME G612Plastics Engineering 3 2 5

General properties of Plastics, Mechanical Behavior of Plastics, Processing of Plastics like Extrusion, injection moulding, thermoforming, calendaring, rotational moulding, compression moulding, transfer moulding, analysis of polymer melt flow, rheological models for polymer melt flow, analysis of heat transfer during polymer processing, elastic behavior of polymer melts, testing methods of polymers like DSC, TGA, DMA, XRD etc. FRP composites, Properties of FRP composites in longitudinal and transverse directions, volume and weight fraction relationships of fibers, failure mechanisms, mechanical properties and fiber orientation effects, processing of composite materials, advancement of composite materials in applications like wind mill blades, bullet proof jackets, etc.

ME G613 Advanced Finite Element Modelling & Analysis 3 2 5

Linear bending, modal and stability analysis of structures; incremental-iterative solution methods for nonlinear static and dynamic problems; nonlinear analysis considering geometric nonlinearity; elastoplastic analysis; alternative numerical approaches; industrial case studies on thermal analysis, coupled field analysis; fluid flow analysis; fatigue, creep and fracture, crash analysis, composite structures, shape optimization

Pre-requisite: CE F435 **OR** CE G619 **OR** ME G512

ME G621 Fluid Dynamics 2 3 5

Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory;flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

ME G631 Advanced Heat Transfer 3 2 5

Heat conduction with unsteady boundary conditions; recent advances in natural and forced convection; condensation and boiling phenomena; heat transfer in high speed flows; liquid metal heat transfer, radioactive metal heat-transfer between surfaces in absorbing media; complex problems involving simultaneous conduction, convection and radiation.

ME G641 Theory of Elasticity and Plasticity 3 2 5

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.

Microelectronics

MEL G512 Optoelectronic Devices, Circuits and Systems 3 2 5

Physics of optical radiation and principles of calculation in radiation physics & optics, fundamental laws of photometry. Interaction between optical radiation and matter. Radiation sources. Parameters of IR detectors and junction photodetectors, parameters common to emitters and receiver, radiation measurements, optoelectronic components, optoelectronic integrated devices, photodetector circuits, methods of modulation and optoelectronic system design and applications.

MEL G514 Nanoelectronic Memories and Technology 3 2 5

Introduction to memory devices in SRAM, DRAM and 3DNAND Flash, circuit and device considerations, device fabrication techniques and scaling avenues, memory array addressing, readout circuits, device characterization, reliability characterization. Non-volatile memory cell structures like (1T-1C 6T, 4T, 1T-1R, 0T-1R, 1S-1R, floating gate FLASH, SONOS, NROM), and memory organization (open bit-line, folded bit-line, NAND, NOR, cross-point etc.), new memory devices and concepts including (e.g. magnetic tunnel junction memory (MRAM, SST-RAM), ferroelectric memory (FRAM), phase change memory (PCM), metal oxide resistive switching memory (RRAM), nanoconductive bridge memory (CBRAM)

Pre-requisites:

EEE F214: Electronic Devices OR EEE F313: Analog and Digital VLSI design OR MEL G621: VLSI Design OR MEL G631: Physics and Modelling of Microelectronic Devices

MEL G531 Testable Design and Fault Tolerant Computing 3 2 5

Fault: types, modelling and simulation; testing methodologies, coverage, economics and quality; test vector generation: design for testability, built-in self tests; fault tolerant computing; fault tolerant software.

MEL G532 Digital Signal Processing 3 2 5

Introduction; design of analog filters; design of digital filters (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

MEL G611 IC Fabrication Technology 3 2 5

Material properties; crystal growth and doping; diffusion; oxidation; epitaxy; ion implantation; deposition of films using CVD, LPCVD and sputtering techniques; wet and dry etching and cleaning; lithographic process; device and circuit fabrication; process modeling and simulation.

MEL G612 Integrated Electronics Systems Design 2 2 4

General architectural features of 8/16/32 bit microprocessors, programmers model of 8086, assembly language programming, hardware design around 8086, bus based systems design, system design around IBM PC, design of real-time systems, ASIC's development tools.

MEL G621 VLSI Design 3 2 5

Introduction to NMOS and CMOS circuits; NMOS and CMOS processing technology; CMOS circuits and logic design; circuit characterization and performance estimation; structured design and testing; symbolic layout systems; CMOS subsystem design; system case studies.

MEL G622 Introduction to Artificial Neural Networks 2 2 4

Fundamentals and definitions; Perceptrons, backpropagation and counterpropagation Networks; Statistical methods for network training; Hopfield nets; Associative memories; Optical neural networks; Applications of neural networks in speech processing, computer networks and visual processing.

MEL G623 Advanced VLSI Design 5

Deep submicron device behavior and models, Interconnect modeling for parasitic estimation, Clock signals and system timing--Digital phase locked loop design, memory and array structures, Input/output circuits design, ASIC technology, FPGA technology, High speed arithmetic circuits design,-Parallel prefix computation, Logical effort in circuit design, Low power VLSI circuits-Adiabatic logic circuits, Multi threshold circuits, Digital BICMOS circuits, Design of VLSI systems.

MEL G624 Advanced VLSI Architectures 5

Instruction set design and architecture of programmable DSP architectures; dedicated DSP architectures for filters and FFTs; DSP transformation and their use in DSP architecture design; Application Specific Instruction set Processor; superscalar and VLIW architectures.

MEL G625 Advanced Analog and Mixed Signal Design 5*

Mixed signal blocks design issues,, design of high resolution, high speed Comparators,, design of Active Mixers-balanced/ unbalanced,, Data Converters Architectures, CMOS multipliers , dividers and modulators , filters-active/ passive/ switched capacitor, Signal Conditioning and sensor associated circuits, Frequency Synthesizers, Phase Locked Loop, Power Management Circuits, Integrated Voltage Regulators, Energy Harvesting Circuits,, Analog Testing, Analog layouts, noise issues, emerging trends.

MEL G626 VLSI Test and Testability 5

Fault models and types; automated test generation for combinational logic; test generation for sequential logic; need for adding testability logic; design for testability; Adhoc DFT methods; structured DFT; test generation for delay fault; issues in analog circuit testing and testability.

MEL G631 Physics and Modelling of Microelectronic Devices 3 2 5

Physics and properties of semiconductor - a review; pn junction diode; bipolar transistor; metal-semiconductor contacts; JFET and MESFET; MOSFET and scaling; CCD and photonic devices.

MEL G632 Analog IC Design 3 2 5

Basic Analog IC Design Issues, Analog Layouts, MOS Switch--Charge Injection, Current And Voltage Biasing and Reference Generation Circuits,Common Mode Feedback Circuit, Replica Bias, Design, Analysis and Synthesis of Single StageAmplifiers, Differential Amplifiers, Operational Amplifiers and Operational Transconductance Amplifier Design, Low Power OPAMP , OPAMP/ OTA design in Subthreshold Operation region, Frequency Compensation, Current Mode Analog Circuit Design, Noise- Analysis and Estimation In Amplifiers, emerging trends.

MEL G641 CAD for IC Design 3 2 5

Introduction to VLSI design methodologies and supporting CAD tool environment; overview of `C', data structure, graphics and CIF; concepts, structures and algorithms of some of the following CAD tools; schematic editors; layout editors; module generators; silicon compilers; placement and routing tools; behavioural, functional, logic and circuit simulators; aids for test generation and testing.

MEL G642 VLSI Architectures 2 2 4

Overview of CISC processor architectures; Instruction set architecture of CISC processor; hardware flow-charting methods; implementing microprocessor logic from hard-ware flowcharts; RISC instruction set architecture; Pipelined execution of RISC instructions; pipeline execution unit design; control hazards; design of memory hierarchy.

Manufacturing Engineering

MF F211 Mechanics of Solids 3 0 3

Fundamental principles of mechanics, introduction of mechanics of deformable bodies, force and moment transmitted by slender members (2D truss, frame, beam), stress and strain, stress-strain-temperature relations, torsion of circular member, stress and deflection due to bending, buckling of columns, theories of failure.

MF F212 Fluid Mechanics 3 0 3

Fluid statics, fundamental of mass, momentum and energy transfer, control volume approach and integral equations, differential analysis of mass, momentum and energy transfer, solutions for one-dimensional steady-state situations, viscous and inviscid flow, dimensional analysis, compressible fluid flow.

MF F213 Materials Science & Engineering 2 0 2

Lattice structure and dislocations, binary phase diagrams , iron-ironcarbide phase diagram, heat treatment of steel, Phase transformation in Metals, Metallurgical techniques for property enhancement, Mechanical and thermal properties of Metals, and polymers, powder metallurgy. Material standards.

MF F214 Applied Thermodynamics 3 0 3

Availability and irreversibility, thermodynamic relations,Compressible flow, Ideal gas and vapour cycles, combined power generation cycles, gas mixtures, refrigeration cycles, psychrometrics and Introduction to heat load calculations, gas turbine cycles , compressors, boilers and accessories.

MF F215 Mechanical Engineering Laboratory 0 2 2

The course shall aim to train the student in the skill of operation of instruments and equipments related to Mechanical Engineering. Testing of mechanical properties like tensile testing, hardness, impact, bending of beams, spring testing, basic fluid mechanics experiments like measurements of pressure, temperature, viscosity, flow measurement, basic electrical & electronics like experiments on diodes, rectifiers, OPAMPS, dc motors, transformers, induction and synchronous motors.

MF F216 Materials Science and Engineering 2 1 3

Introduction, structure of materials (metals, ceramics, and polymers), crystalline structure imperfections, amorphous and semi-crystalline materials, correlation of structure to properties, phase diagrams & phase transformation, solidification, diffusion and heat treatment, mechanical behaviour of material. Composites, advanced-smart materials, and functional materials, criteria for material selection, economic environmental, and societal issues. Experiments related to materials testing and characterization such as tensile, torsion, hardness, impact, non-destructive testing, XRD, SEM, etc.

Equivalent: ME F216

MF F217 Machine Drawing 0 2 2

Fundamentals of machine drawing and dimensioning practice using conventional software, orthographic drawing of machine parts, sectional view, assembly drawing, exploded view, pictorial view, BOM, materials assignment and graphic rendering.

MF F218 Transport Phenomena in Manufacturing 3 1 4

Transport phenomena and its importance in manufacturing engineering, fundamentals of fluid mechanics, fluid statics, fluids in motion, heat and mass transfer theories, conservation laws for transport phenomena and solution methodologies, important solutions and correlations in transport phenomena, radiation heat transfer and special topics relevant to manufacturing such as heat transfer with phase change, simultaneous heat and mass transfer etc.

MF F219 Operations Management 3 0 3

Introduction to operations management, product planning, forecasting, facilities location and layout, process planning and design, performance measures and capacity planning, scheduling and controlling, material requirements planning and Just-in-time systems, inventory control, Introduction to Industry 4.0 and other advancements in operations management, case studies and software application.

MF F220 Metrology and Quality Assurance 2 1 3

Importance of metrology, calibration, limits fits and tolerances, design of gauges, linear and angular measurement, inspection of surface quality, features inspection, coordinate measuring systems, application of vision, interferometry, laser, and other non-contact measuring systems, various case studies on measurement systems used for automated production systems; quality management: practices, tools and standards, statistical techniques in quality control, statistical process control using control charts, control charts for attributes, and variables, process capability analysis, measurement system analysis, acceptance sampling plan, reliability assessment of systems and use of commercial software for SQC

MF F221 Mechanisms and Machines 3 0 3

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, synthesis of planar mechanism, cam design, kinematics of gears, gear trains, dynamics of machines: static force analysis, dynamic force analysis (planar), dynamics of reciprocating engines, balancing, flywheels, gyroscopes, introduction to spatial & compliant mechanism, exposure to modeling and simulation tools.

Equivalent: ME F221

MF F222 Casting, Forming and Welding 3 1 4

Pattern, mould and gating system design; casting processes, defects and inspection. Mechanics of forming processes; forming operations, friction and lubrication, forming defects. Principles of solid phase welding and liquid phase welding, soldering, brazing and adhesive bonding; newer welding processes, welding and additive manufacturing, weld defects and inspection; plastic processing and powder metallurgy.

MF F241 Machine Design & Drawing 3 1 4

Fundamentals and principles of Design. Design and selection of Machine elements such as shafts, Screw fasteners, Welded joints, Springs, Brakes & Clutches, Bearings & Gears, Fundamentals of machine drawing; practices for orthographic drawing of machine parts, sectional view, assembly drawing & exploded view.

MF F242 Manufacturing Management 2 0 2

Introduction, product planning, forecasting, facilities location, process planning and design, layout of facilities, performance measures and capacity planning, planning and scheduling, material requirements planning and Just-in-time systems, inventory control, human resource management, financial management, marketing management, customer relationship management.

MF F243 Manufacturing Processes 2 1 3

Foundry practices and Metal casting methods, Plastic working of metals, Welding and cutting, Machining Processes and machine tools. Nonconventional manufacturing processes, Finishing and Cleaning processes, Limits & Fits. Production quality control, Manufacturing and environment.

MF F244 Kinematics & Dynamics of Machinery 3 0 3

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, cam design, gear trains, synthesis of linkages. Dynamics of machines: static force analysis, dynamic force analysis (planar), dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes, free and forced vibrations.

MF F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

MF F311 Mechatronics & Automation 2 1 3

Mechatronics design approaches, interfacing, instrumentation and control systems, modeling of mechanical and electromechanical systems, sensors and actuators, introduction to automation, pneumatics and hydraulics in automation, pneumatic circuits for automation, PLC programming and interfacing with pneumatic and hydraulic systems, introduction to MEMS, modeling and simulation of MEMS, CNC machines, automated material handling, introduction to FMS.

MF F312 Tool and Fixture Design 3 0 3

Tool-design methods, tool making practices, tooling materials and heat treatment, design of cutting tools, gages and gage design, locating and clamping methods, design of drill jigs, design of fixtures, design of sheet metal blanking and piercing dies, design of sheet metal bending, forming and drawing dies, using plastics as tooling materials, tool design for numerically controlled machine tools and automatic screw machines.

MF F313 Metal Forming and Machining 3 1 4

Plastic deformation of metals and related properties, metal forming processes, Yield conditions and stress-strain relations, Theory of slip lines, upper and lower bound theorems, Analysis of various hot & cold metal forming processes, Mechanics of machining processes and analysis, thermal aspects and cutting fluids, grinding and finishing operations, non conventional machining processes.

MF F314 Design of Machine Elements 3 0 3

Design methodology, fundamental principles, materials, design for static failure, design for fatigue failure, design and selection of machine elements such as shafts, screw fasteners, welded joints, springs, belt drive, brakes & clutches, bearings & gears.

Equivalent: ME F314

MF F315 Automation and Control 3 1 4

Types of automation and its elements, sensors and signal conditioning, actuators; analog and digital systems, microprocessor / microcontroller systems, Arduino and other microcontrollers, communication systems, PLC, various case studies on mechatronic systems. Modelling of system behavior, stability analysis using control theory, transfer function approach, frequency response analysis (Nyquist and Bode plot), feedback control systems, various types of linear controller, tuning algorithms. Force and motion controllers, state space approach, exposure to the modelling and simulation tools.

MF F316 Machining and Machine Tools 3 1 4

Significance of machining and machine tools, cutting tool geometry and materials, mechanics of machining processes, cutting fluids and their properties; abrasive machining processes and analysis, economics of machining, regulation of speed and feed rates in machine tools, design of machine tool structures, guideways, spindles; design of cutting tools for various machine tools; jigs and fixtures.

MF F317 Computer Aided Design and Manufacturing 2 1 3

Overview of CAD/CAM, principles of computer aided design, computer graphics fundamentals, 2D and 3D transformations and projections, plane curves, space curves, synthetic curves, analytical and parametric surfaces, synthetic surfaces, solid modeling basics, constructive solid geometry (CSG), sweeping; constructional aspects of computer controlled machines, CAM system devices, programming of computer controlled machines, CAD to CAM, virtual manufacturing, computer aided process planning, computer aided production planning and control, computer aided inspection, CIM.

MF F318 Nontraditional Manufacturing Processes 3 0 3

Mechanism and mechanics of cutting, process parametric analysis, process capabilities, applications and limitations of various nontraditional manufacturing processes (AJM, AFM, WJM, USM, MAF, MRF, EDM, WEDM, PAM, LBM, EBM, FIBM, ECM, ECG, ESD, etc.); introduction to micro and nanofabrication, micro forming, micro-joining, characterization of micro-machined structures, additive manufacturing: algorithm, technologies and processes such as SLA, FDM, SLS, LOM, DMLS, LENS, etc.; rapid tooling; reverse engineering.

MF F319 Supply Chain Management 3 0 3

Cycle view and decision phases of supply chain, strategic fit & scope, supply chain logistical and cross functional drivers, metrics of supply chain drivers, designing the distribution network, planning demand and supply in supply chain, planning and managing cycle inventory, safety inventory and optimum product availability in a supply chain, transportation, sourcing and sustainability.

MF F320 Engineering Optimization 3 0 3

Formulation of optimization problems, classical optimization techniques, nonlinear optimization methods for problems with and without constraints, simplex method, duality and sensitivity concepts, revised simplex methods, transportation models, travelling-salesman models, assignment models, network models, integer programming, genetic algorithm and other evolutionary optimization techniques, goal programming and multi-objective optimization. Use of application softwares in solving optimization problems.

Equivalent: ME F320

MF F321 Procurement Management 3 0 3

Procurement scope and development, strategic procurement and supply chain management, outsourcing, quality management, lead time and time compression, sourcing strategies and relationships, price and total cost of ownership, negotiations, project procurement, procurement of commodities, capital procurement, retail procurement and efficient response, services procurement, e-procurement systems, sustainability, performance measurement, case studies.

MF F341 Design of Machine Tools 3 0 3

Determination of machining forces and power in turning, milling, grinding, drilling and shaper. Kinematics of machine tools and design of gearboxes, step-less regulation. Design of machine tool guide ways, beds, tables and columns. Design of power screws, spindle units and built-in inspection units. Bearings and lubrication in machine tools. Electric and hydraulic systems of machine tools. Introduction to dynamic analysis and vibrations in machine tools. Micro-displacement in machine tools, Design of CNC machines.

MF F342 Computer Aided Design 3 1 4

CAD software and CAD hardware. Mathematical modeling of parametric curves, surfaces and solids, and their computer simulation on spreadsheets and using specialized solid modeling packages. CAD/CAM data exchange. Introduction to finite element analysis and FEM practice on a specialized CAE package. Rapid prototyping. Hands-on in assignments and CAD project.

MF F343 Casting and Welding 3 1 4

Casting processes, Pattern and Mould design, metal melting and handling, metallurgical aspects of casting, Metal flow and heat transfer, analysis of casting defects. Injection moulding of plastics Gas cutting and welding processes including its physics, chemistry and metallurgy, power source characteristics, different welding techniques, selection of welding processes, destructive and non destructive testing of weldments welding standards and codes, analysis of welded joints, brazing and soldering.

MF F344 Engineering Optimization 2 0 2

Linear programming methods, simplex method, transportation model and its variants, queuing systems, PERT/CPM, Optimal problem formulation, engineering optimization problems, single variable optimization algorithms, multivariable optimization algorithms, constrained optimization algorithms.

MF F366 Lab Project 3

MF F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

MF F376 Design Project 3

MF F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

MF F411 Fluid Power Systems 3 1 4

Introduction to Fluid power, advantages of fluid power, applications, Introduction to Pneumatics, Air preparation and Components, Pneumatics Circuits and Applications, Electro pneumatics, Electrical Controls for fluid power circuits, , Physical properties of hydraulic fluids, Energy and Power in Hydraulic Systems, Frictional Losses in Hydraulic Pipelines, Hydraulic Pumps, Hydraulic Cylinders and Cushioning Devices, Hydraulic Motors, Hydraulic Valves, Hydraulic Circuit Design and Analysis, Ancillary Hydraulic Devices, Hydraulic Conductions and Fittings, Maintenance of Hydraulic Systems, Use of PLC programming for interfacing pneumatics and Hydraulic Circuits.

MF F412 Automotive Systems 3 0 3

Frame, suspension, springs and wheels, clutch and gear box, propeller shaft, universal joint, final drive, differential and rear axle, front axle and steering mechanism, brakes, automotive air conditioning, electrical vehicles, automotive electrical systems, automotive electronics systems.

MF F413 Mechanical Vibrations and Acoustics 3 0 3

Introduction, single degree-of-freedom systems: free and forced vibration problems, concept of resonance and damping, vibration isolation, multi-degree-of-freedom systems: modeling of multi-degree-of freedom systems, eigen value problem and calculation of normal modes of a system, forced response using modal superposition techniques, introduction to acoustics - terminology used in acoustics and definitive of fundamental quantities 1D wave, equation (plane waves) & 3D wave equation, formulation and fundamental solution to the equations, measurement of noise & vibration – vibration measurement principles.

MF F414 Manufacturing Excellence 3 0 3

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility.

MF F415 Noise Engineering 3 0 3

Fundamentals of vibrations, vibrations of strings and bars, vibrations of membranes and plates, acoustic wave equation, acoustic energy and sound intensity, propagation of sound, concept of acoustic impedance, sound power transmission, transmission loss, human response and ratings, various measures of sound, weighting filters, loudness, indices of loudness, acoustic radiation from spherical source and piston source, acoustic sensors, measuring techniques and instruments, octave filtering, sound intensity measurement, intensity mapping, different types of measurement environment and uses, response of beam subjected to an acoustic plane wave, transmission loss of panels, sound absorption coefficient, noise control measures in building, reverberation time and auditorium design, industrial noise control, noise in machinery, traffic noise, vehicle noise, design of silencers and mufflers, active noise control, duct noise control and cabin noise control, practicals on noise measurements in different situations.

MF F416 Work System Design 3 0 3

Introduction to work systems design, productivity and work study, method study: process analysis, man-machine analysis, operation analysis and micro-motion study, introduction to ergonomics and principles of motion economy, work measurement: stop watch time study, work sampling, standard data and predetermined motion time systems, job enlargement and job enrichment, incentive schemes.

MF F418 Lean Manufacturing 3 0 3

Fundamentals of continuous improvement, value added and waste elimination, elements of lean production: small lot production, setup time reduction, maintaining and improving equipment, pull production systems, focused factories and group technologies, work cells and cellular manufacturing, standard operations, quality of design, systems for eliminating defects, simplified production planning and control systems: scheduling for smooth flow, synchronizing and balancing process, planning and control in pull production, beyond the production systems: managing the supply chain, activity based costing, performance measurement.

MF F421 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production & distribution networks; SCM in the context of JIT and MRP-II; Distribution Resource Planning; Management of dealer networks; Total Quality Control & product innovation across the supply chain; Incoming logistics & supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; mathematical programming for SCM.

MF F422 Supply Chain Modelling and Empirical Anal- 3 1 4 ysis

Contexts, issues and challenges in supply chain modelling and empirical analysis, buyer-supplier relationship, cultural implications, Primary and secondary data collection, questionnaire design, Model development and analysis with Statistical Packages such as SMARTPLS3, SPSS, Hugin and AMOS, Value Stream Mapping, Life Cycle Modelling, Model development and analysis with OpenLCA and EVSM, cost benefit analysis, Digital supply chain and Performance modelling, case studies

MF F442 Advances in Materials Science 3 0 3

Deformation of materials, deformation at high temperatures and creep, recovery, recrystallization and grain growth, fracture of materials and fatigue failure, deterioration of materials, corrosion and oxidation, surface properties, surface energy and tribology, polymers and fibre reinforced polymeric composites, mechanical testings, nondestructive testing techniques.

MF F453 Industrial Relations 3 0 3

Introduction to human resources management; planning and organising human resources; leadership and motivation; job satisfaction and morale; employee communication; audit and control;

procurement of personnel; performance appraisal; human resource development; wage and salary administration; job change; discipline; labour welfare; trade unions and collective bargaining; industrial disputes; worker participation in management.

MF F463 Maintenance and Safety 3 0 3

Objectives, functions, and types of maintenance; defects due to wear; lubrication and surfacing techniques to reduce wear; maintenance of different equipments and their elements; spares planning; overhauling; TPM; safety and safety management; environmental safety; chemical safety; occupational health management; control of major industrial hazards; managing emergencies; employee participation in safety; HRD for maintenance and safety.

MF F471 Instrumentation and Control 3 0 3

Measurement systems, transducers, feedback control, components: electrical, hydraulic,pneumatic; Signal conditioning and processing, controllers, display, recording, direct digital control, programmable logic controllers, PC based instrumentation.

MF F472 Precision Engineering 3 0 3

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and microfinishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerancing.

MF F473 Product Design and Development 3 0 3

Introduction to product design and development, product development planning and process tools, technical and business concerns, understanding customer needs, function modeling, benchmarking and engineering specifications, product architecture, concept generation, concept selection, concept embodiment, modeling of product metrics, design for X, physical prototypes, physical models and experimentation, robust design.

MF F474 Product Design and Development Projects 3

The course will essentially deal with the practice of product design and development. The student will involve in the design and development of different products. He will be guided by the instructor/resource person. The effort must culminate with a product along with the project report.

MF F485 Sustainable Manufacturing 3 0 3

Overview of sustainable manufacturing, 6R, WEEE, triple bottom concept of environment, economy and society, driver for, barriers to and stakeholders of sustainable manufacturing and their modelling, performance measures of sustainable manufacturing, evaluation of manufacturing systems based on environmental factors, eco-innovation and design for environment, recycling, remanufacturing, reuse, strategic and operational evaluation of technologies using life cycle management, environmental impact assessment models, end-of-life strategies, reverse logistics, sustainable product service systems, green factories.

MF F491 Special Project 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

Management

MGTS F211 Principles of Management 3 0 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

MGTS F311 Marketing 3 0 3

Marketing Management: An Introduction; Strategic Marketing and marketing Plan; The Marketing Environment; Market research; Building Customer satisfaction, Value and retention; Analyzing Consumer Markets; Industrial buyer behaviour; Segmenting and Targeting the Market; Analyzing Competition; Creating and managing brand equity; Positioning and differentiating the market offering; Product strategy; Services marketing; Pricing strategies and programmes; Designing and Managing Marketing channels; Integrated marketing communications; Marketing mix and strategy.

MGTS F313 Product and Brand Management 3 0 3

Scope of product Policy Decisions; Product-Market strategy; Product Life Cycle and Strategy; Managing Product Deletion; Product Associations; Branding including aspects of brand name selection; Brand Equity and its utilization for marketing decision making; Brand Extension: use for brand names for launching new products; Managing new product development: New product development process; Idea Generation and Screening; Concept Development and Evaluation; Product Design and Testing; Market planning; Testing the market plan; Marketing research process; Adoption and Diffusion of products; Organizing for a new and existing product.

MGTS F314 Essentials of Financial Management 3 0 3

Overview and introduction to financial management, Basic principles of financial management, Introduction to financial markets, Key financial statements, Financial statements analysis (horizontal, vertical, and ratio analysis), Time value of money and its applications, Bond valuation, Stock valuation, Introduction to risk and return, Types of risk, Introduction to Risk Management, Break even analysis, Cost of capital (basic concepts, relevance and importance to business decisions), CAPM model, Weighted Average cost of capital (WACC), Capital budgeting, Financial forecasting, Sensitivity Analysis, Scenario Analysis, Working capital management, Capital structure and dividend policy, Introduction to corporate governance, Introduction to derivatives, international finance.

MGTS F315 Foundations of Business Analytics 3 0 3

Introduction to Business Analytics, Analytics on Spreadsheet, Visualizing and Exploring Data, Descriptive Statistical Measures, Probability Distribution and Data Modelling, Sampling and Estimation, Statistical Inference, Trending and Regression Analysis, Forecasting Techniques, Introduction to Data Mining, Spreadsheet Modelling and Analysis, Monte Carlo Simulation and Risk Analysis, Linear Optimization, Integer Optimization, Decision Analysis.

MGTS F316 Managerial and Leadership Skills 3 0 3

Role of a Manager and a Leader; Ethics and Integrity; Trust & Commitment; Emotional Intelligence; Networking Skills; Decision Making; Vision and setting goals; Team Building; Delegation; Basics of Supervision; Communication Skills - Effect speaking, Listening, Presentation, Persuasion; How to Handle Meetings; Negotiation Skills & Techniques; Interviewing Skills; Process of Induction; Training and Development; Mentoring & Coaching, How to Appraise Employees; Managing Change; Grievance Handling; Time management; Work Life Balance; Stress Management.

MGTS F351 Organisational Behaviour 3 0 3

A new perspective of management; conceptual model of organization behavior; the individualprocesses- personality, work attitude, perception, attribution, motivation, learning and reinforcement, work stress and stress management; the dynamics of organizational behavior- group dynamics, power & politics, conflict & negotiation, leadership process & styles, communication; the organizational processes- decision making, job design; organizational theory and design, organizational culture, managing cul-

tural diversity; organizational change & development.

MGTS F433 Advertising and Sales Promotion 3 0 3

The communication process and models of persuasive communication; advertising research; advertising campaign components; advertising campaign planning; advertising/media scene; media concepts; media planning & strategy; advertising campaign planning, execution and evaluation; advertising agencies; sales promotion types and techniques; sales promotion strategy; measuring the effectiveness of the promotional program; regulations of advertising and promotion; Extending marketing communication to social communication, personal selling, international advertising, interactive advertising, advertising laws, social, ethical and moral issues.

MGTS G511 Advanced Marketing Theories and Advertisement 5

Strategic planning, theory and methods with emphasis on customer, competitor industry and environmental analysis and its application to strategy development and choice. Marketing communication through advertising and related mass media and promotion campaigns and its influence on market and other organisation. Globalisation and marketing aspects.

MGTS G513 Public Programme Evaluation 5

Value judgements & public choice, social welfare-Paretion Welfare Economics; market system, income distribution and government & the market. social cost benefit Analysis (SCBA):SCBA and public sector investment planning, efficiency pricing & the rational of new methodology, problems of pricing comparative advantage, social pricing; the application SCBA: economic pricing of factor of production, social pricing, distribution & public sector; management values of public sector undertakings.

MGTS G521 Business Policy-Structure and Organisation 5

Frame-work of business dynamics; missions; objective and goals; social aspects of business policy; environmental analysis; the dynamic setting of business policy; internal analysis of resources - strength and weaknesses; strategic planning choice, implementation and evaluation; functional policies; orientation in special cases - MNC's high-tech companies, non-profit organisations etc.

MGTS G531 Recent Advances in Organisation Behaviour Theory 5

Emerging challenges of human resource management- a futuristic perspective; unified global theory of management; empowerment; employeeship; entrepreneurship; organisation diagnosis and development; social system and organisational culture-both in the national and global context interpersonal and group dynamics; employee attitudes; leadership and decision making; motivating employees; quality of work life and socio - technical systems; dealing with subordinates, boss, peers, problem employees.

MGTS G541 Management Information and Decision Support Systems 5

Data & information; characteristics of information; components of management information systems; information flows; design and maintenance of management information systems; decision support systems.

MGTS G551 Frontiers in Financial Management 5

MGTS G561 Institutional Finance and Project Appraisal 5

Mobilization of funds internally, externally, financial institutions and international financial institutions, financial and monetary framework of international financial management, foreign exchange markets and negotiations, project definition, preparation of feasibility assessment and selection, project reporting, conventional project appraisal - limitations, towards a new framework.

Public Health

MPH G510 Biostatistics & Computers in Public Health 5

Introduction to data classification, analysis and probability; statistical inference – estimation and hypothesis testing; linear regression and correlation; design of experiments; analysis of variance; non parametric procedures & tests; statistical quality control; experimental design in clinical trials and validation; basic techniques in optimization.

Introduction to computer and its component, operating systems; principles and use of standard software packages having application in drug design, development, analysis, etc; principles of software creation; processing concepts, flow charting and algorithms, programming constructs, programming languages, program development sequence; information systems; need, significance concepts, their analysis, design and implementation; software life cycle with special reference to software planning and maintenance.

MPH G512 Environmental & Occupational Health 4

Introduction to environmental health and its importance; pollution from water, air, automobile, chemicals used in agricultural sector and their implication on health and environment; techniques for studying, monitoring and controlling pollution; handling and disposal of domestic industrial and bio-medical refuse, incineration of waste materials; methods of vector control; effect of low frequency electromagnetic radiation and nuclear radiation on public health, occupational health hazards; disaster management.

MPH G513 Public Health & Diseases 4

Tropical diseases – their geography, identification, treatment methods, medicines, design of standard protocols and immunization processes including planning and execution; infections due to ticks and mites; bacterial, parasitic and viral infections-types and their classification, host–parasite relationships, their mode of proliferation, mechanisms of infestation, carriers, preventive methods and processes; understanding the public health problems related TB, AIDS, leprosy, GI infections and other communicable diseases.

MPH G515 Communication in Health Care 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; research papers, interpersonal communication; business correspondence; use of modern communication aids and mass media; behavioral change communication; design, management & evaluation of IEC.

MPH G521 Health Care Management 4

Basis of organizational culture and management techniques for efficient administration of health delivery; general principles of HR, materials and operation management; understanding the organizational culture that exists in public, private and non-Govt. sector agencies; management information system.

MPH G522 Preventive Nutrition & Health Promotion 4

Basic concepts; nutritional requirements of essential nutrients, proteins, fats, carbohydrates, vitamins and minerals; balanced diet; nutritional problems in public health; nutritional factors in selected diseases; assessment of nutritional status; nutritional surveillance; mal-nutrition; special nutritional programme.

MPH G523 Epidemic & Disaster Management 4

Disaster management; impact and response; relief phase; disaster mitigation in health sector; disaster preparedness; policy development; man-made disasters; international agencies providing health based humanitarian assistance; and strategies for disaster management.

MPH G531 Health Economics & Financial Management 4

Concepts & methods of economic analysis related to health system; organization and policy; demand and supply of scarce resource for health care; health financing & population coverage; determinants of cost & utilization; health insurance; cost-benefit analysis; costing for decision making; fundamentals of accounting; financial statement analysis; budget process & budgetary control; capital investment decision.

MPH G535 Family & Community Health Measures 4

Community-level indicators (CLI) measure aspects of the physical, legal, social and economic environment that reflect and are likely to influence the attitudes and behavior of individuals and community members. They also measure an important step in

community-based health promotion interventions, Topics like, rural health services and health sector reforms from community perspective.

MPH G537 Law & Ethics in Public Health 3

Various Acts/ legislations/ rules pertaining to public health and related fields like, drug & pharmaceuticals, medical practice, PNDT, CPCSEA, IHEC, Regulations related to waste disposal.

MPH G538 Telemedicine 3

Advancing the use of digital telecommunications technology for the purpose of improving health care delivery to rural and underserved remote populations. Service areas include clinical services, educational programs, and research and development to provide high quality specialty care in participating rural communities and evaluation of the clinical utility and cost impact of telemedicine. Topic included will be Introduction to Telemedicine, Telehealth, Telemedicine Services, Telemedicine Systems and Telecommunications, Telemedicine Applications, Benefits and Drawbacks of Telemedicine, Information Sources, Advancing Telemedicine, etc.

MPH G539 Inter-sectoral co-ordination in Health Services 3

Roles of public, private, government, non-government sectors in providing health services, Public works department, Sanitation, Waste disposal and management, Water and air pollution monitoring and control, Deforestation, Urbanization and rural development, Employment and occupational health hazards, Training of administrators and enforcement agency staff, Public awareness programs, etc.

MPH G540 Role of Voluntary bodies/ NGO's in Public Health 3

Civil society organizations, Red Cross, Red Crescent movement and nongovernmental organizations in fund raising, international and local humanitarian responses, partnerships and collaborations with civil society, Operations in remote areas and marginalized groups; Role of indigenous voluntary bodies, Functioning of NGOs, WHO in preparedness and response efforts and Needs-based deployment of available resources, Effective health services coordination, etc.

MPH G613 Health Systems and Society 2

Introduction to health systems; functions of health systems; managing health systems; problems of health systems management; Major environmental health problems including quality of water, waste disposal food production and processing, vector control etc. Air pollution and its controlling, Hazards of radiation, municipal and other wastes, Occupational health hazards.

MPH G661 Research Methodology I 5

Course description is same as given under SKILL G661.

MPH G665 Hospital Operations Management 3

Operation Management aspects connected with outpatient ward, casualty, operation theatres, diagnostic laboratories, pathology laboratories, pharmacy diet and nutrition, blood bank, laundry, medical records, security, scheduling and deployment of doctors, nurses and other staff, accounts among others. The course will involve on site visits in a hospital, discussions and presentations on the practical aspects of hospital operations management.

MPH G681 Strategic Management 3

Concepts of Strategic Planning; Environment Analysis; Internal and External; Resource Analysis; Organizational Structure and Linkage with Strategies, Formulation, Implementation and Control of Strategic Plan; Communicating Strategic Plan; Case studies.

MPH G692 Epidemiology 2

Introduction to the principles and methods of epidemiology. Epidemiology of some illustrative infectious diseases (of bacterial, rickettsial and viral origins), sexually transmitted diseases, chronic diseases such as cancer, cardiovascular diseases, neurological disorders etc. Use of biostatistics in epidemiology.

Manufacturing Systems Engineering

MSE G511 Mechatronics 3 2 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

MSE G512 Manufacturing Planning and Control 4

Introduction, operations and manufacturing strategy for competitive advantage, product design and planning, forecasting product demand, facilities location, process selection and design, capacity planning, layout of facilities, job design and work measurement, aggregate planning, master manufacturing schedules, material requirements planning for dependent demand, short-term schedules and shop floor control, independent demand inventory systems, logistics and supply chain management, just-in-time systems, maintenance and reliability, quality management, managing projects, strategies for manufacturing excellence.

MSE G513 Maintenance Engineering 3 1 4

Introduction, maintenance systems, methods and tools of maintenance analysis, eliability and safety, maintainability, supportability, design for maintenance, maintenance integration, computerized maintenance management systems, TPM, world-class maintenance systems, and maintenance effectiveness and performance evaluation.

MSE G514 Leadership and Managing Change 3 1 4

Individuals as leaders, team leadership and organizational leadership. Introduction to managing change, management of change : organisational structure, culture, recruitment, performance management, human resource development, reward management, employee relations and involvement, downsizing, and evaluating and promoting.

MSE G521 World-Class Manufacturing 3 2 5

The world-class manufacturing challenge, developing a world-class manufacturing strategy, just-in-time, total quality, total employee envolvement, world-class information systems, managing the change, methods and procedures; improved brainstorming methods, using the check-total quality - the first steps, getting people involved, monitoring world-class performance.

MSE G531 Concurrent Engineering 3 2 5

Introduction of concurrent engineering and need, concurrent engineering tools, advances in design and manufacturing engineering, design for manufacture, design for assembly, rapid prototyping, simulation, concurrent approaches to design, manufacturing and other aspects of engineering.

Materials Science and Technology

MST F331 Materials Characterization 3 1 4

Thermal properties of Materials and Characterization, Electrical Characterization: Temperature dependent DC conductivity in materials, impedance spectroscopy, Characterization instruments like impedance analyzer, Optical Characterization: UV-Visible spectroscopy, FTIR spectroscopy, optical microscopy, Confocal microscopy, Mechanical Characterization: Time dependent and time independent mechanical behavior of materials, Dynamic Mechanical Analysis, Instruments:Universal testing machine, Fatigue machine, Izod and charpy impact testers, Hardness indenters, Abrasion tester, Physical Characterization: Microstructure Characterization, Characterization instruments: SEM, TEM, X-ray diffractometer, AFM, Rheological Characterization: Linear and non-linear visco-elastic behavior of materials. Magnetic Characterization: Basics of diamagnetism, ferromagnetism and paramagnetism, anti ferromagnetism and ferrimagnetism, hysteresis and anisotropy, AC susceptibility and SQUID magnetometer.

MST F332 Materials Processing 3 0 3

Processing of metals: electrometallurgy, hydrometallurgy, pyrometallurgy, extraction, and refining, Powder processing of metals and ceramics: Powder handling, compaction and forming techniques. Drying, burnout, densification, sintering, and grain growth in powder compacts. Crystal growth, epitaxial growth,

Deposition of thin films – Plasma Laser deposition, metal organic chemical vapour deposition, Production of carbon-based materials: Controlled pyrolysis, electro-spinning.

Processing of plastics and fiber reinforced plastics: Processing by using techniques such as extrusion, injection molding, compression molding, SMC, pultrusion and filament winding.

MST F333 Introduction to Biomaterials 3 0 3

Proteins, polysaccharides, oils and fats, fibers and biopolymers, structure and characterization of biomaterials, isolation and processing of biomaterials, development of polymers and composites from biomaterials, structure-property relationships (thermal, mechanical, biocompatibility, biodegradation etc.). Value-added products developed by using biomaterials, adhesives, bioplastics, composites for insulation and construction applications, biomedical applications such as, dental implants, sutures etc.,

MST F334 Materials for Catalytic applications 3 0 3

Classification of different industrial catalysis technology; Classification of solid catalysts; Synthesis of bulk and nanomaterials; Chemical properties of energy-relevant materials environmental catalytic materials at the nanoscale.; Metals and metallic alloys supported on oxide-based catalytic materials; Metal-support interaction; Structure sensitivity of catalytic reactions; Reaction mechanisms in catalysis on metal supported catalysts; Porous materials for catalyst supports; Oxide non-stoichiometry - structural defects; Semiconductor character - photocatalysts; Acidic and Basic oxide catalysts; Lewis and Brønsted acidity in oxides; Hydrotalcites - precursors for base oxides; Sulfide based catalysts.

MST F335 Coating and Thin film technology 3 0 3

Coating composition, pigments, binders, solvents, additives, Industrial process of making coatings, Rheology and mechanical properties of coatings, coatings in building and automotive sector, Introduction and formation of thin films by processes such as CVD, PVD, electrochemical deposition, thermal sprays, etc. Characterization of thin films such as coating hardness, thickness, assessment of friction & wear, roughness using nanoscale tests. Applications such as in defense, solar energy, consumer goods and implant materials.

MST F336 Glass Technology 3 0 3

Introduction to glass, glass transition, principles of glass formation and molecular structure of glass. Structural basis for glass formation. Characterization of properties of Glass. Glass making: Raw materials and mixing methods, batch wetting and compaction techniques. Glass batch melting reactions and principles. Glass technology and commercial glasses: Press and blow, Individual selection machines, molds, and container design. Surface treatments and chemical durability. Flat glass forming and fabrication. Fabrication processes: chemical strengthening, annealing, tempering, and laminating. Strengthening of glass by physical and chemical means. Gorilla glass. Fiber glass manufacturing methods and products for application in insulation, filtration, polymer reinforcement and textiles.

MST F337 Materials for Energy Applications 3 0 3

Overview of conventional and non- conventional energy resources, Silicon based Photovoltaic Solar cells, Photovoltaic thin films, Lightweight composites for wind turbine blades, Metals and ceramics used in thermal power plants, Ceramics for Energy storage and conversion, Ceramics and Composites for Nuclear energy, Photoelectrochemical Cells for hydrogen generation, Functional materials for Hydrogen storage, Functional Materials for fuel cells, Membrane electrode assemblies for fuel cells including DMFC's, Novel materials for Solid oxide fuel cells (SOFC) systems.

MST F338 Metals and Alloys 3 0 3

Introduction, classification of Ferrous metals, Non-ferrous metals such as Titanium, Aluminium, Magnesium, Copper and their alloys, Structure-property relationship, Phase diagrams and Phase kinetics, processing and applications of metals and alloys, degradation of metals, Applications in transportation, chemical and medical sectors.

MST F339 Polymer Materials 3 0 3

Polymerization techniques; classification of polymers; mechanism and kinetics of formation of polymers; Theoretical and experimental techniques for determination of different types of molecular weights and molecular weight distributions; polymer solution viscosity; melting and glass transitions, rheology; polymerization techniques used in industry, polymer solution thermodynamics; viscoelastic behaviour; degradation and stability; polymer processing and applications. Engineering thermoplastics, additives, blends, polymer composites and Biopolymers. Applications in automobile, biomedical and electronic and other industries.

MST G511 Nondestructive Testing Techniques 3 2 5

Ultrasonic testing, X-radiography, eddycurrent testing, magnetic methods of crack detection, liquid penetrant inspection, acoustic emission and acousto-ultrasonic testing techniques.

MST G512 Ceramics Technology 3 2 5

Ceramic raw materials, their beneficiations and characterisations; crystal structure of important ceramic systems and structural defects; various types of ceramics; white wares, glasses, refractories, cements, abrasives, glass-ceramic, ceramic coatings, electronic ceramics; fabrication processes; grinding, pressing, slip casting, drying, sintering, glass blowing; development of ceramic microstructures; properties of ceramic materials; mechanical, thermal, electrical, optical, magnetic and chemical; ceramic composites, cermets.

MST G521 Materials Characterization Techniques 3 2 5

Materials characterisation - definition; importance and application with case studies, principles and general methods of compositional, structural and defect characterisation, techniques of X-ray, electron and neutron diffraction, EDAX, thermal methods - DTA, TGA, DSC. TMA and DMA; microscopy-optical, electron (TEM & SEM) and spectroscopy -UV, visible, IR and Raman spectroscopy, ESCA and Auger spectroscopy, SIMS resonance method- NMR, ESR, Mossbauer techniques, particle size analysis, electrical and magnetic characterization techniques.

MST G522 Advanced Composites 3 2 5

Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fibre reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibres, concept of microfibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture thoughness and fatigue; properties of fibre reinforcement and production technology of composites.

MST G531 Experimental Stress Analysis Techniques 3 2 5

Strain gauges, photoelasticity, brittle lacquer, three dimensional photoelasticity, Moire methods.

MST G532 Electronic Materials 3 2 5

Electrical conduction in glasses and ceramics, non-stoichiometry and valence controlled conduction, ceramic heating elements, fast ion conductors, superconducting materials and devices, dielectric ceramics, ceramics in micro electronics, voltage dependent resistors, positive and negative temperature coefficient resistors. Piezo electric, pyroelectric, ferroelectric and electrooptic ceramic materials and devices, ceramic sensors, magnetic and magneto-optic ceramic devices, ceramics for microwave applications, luminescent and photoconducting ceramics, light transmitting filters, IR transmitting glass, optical fibre technology.

Music

MUSIC N103T Indian Classical Music (Vocal) I 3*

MUSIC N104T Indian Classical Music (Vocal) II 3*

MUSIC N203T Indian Classical Music (Vocal) III 3*

MUSIC N204T Indian Classical Music (Vocal) IV 3*

MUSIC N111T Hindi Classical Music (Instrumental) I 3*

MUSIC N112T Hindi Classical Music (Instrumental) II 3*

MUSIC N113T Indian Classical Music (Instrumental) I 3*

MUSIC N114T Indian Classical Music (Instrumental) II 3*

MUSIC N213T Indian Classical Music (Instrumental) III 3*

MUSIC N214T Indian Classical Music (Instrumental) IV 3*

The eight courses given above – four in vocal and four in instrumental - are designed to give theoretical and practical knowledge of Indian Classical Music in Hindustani or Carnatic style.

In the Hindustani series, the student will be introduced to the Hindustani system, *swaragyan,* structure of *Raag*s and *Taal*s, the ten *Thaat*s, and practice in performing selected *raag*s through compositions with elaborations.

For the Carnatic style series, the syllabus includes basic *Swara gyana*, structure of *Raagas* and *Taalas*, renderings of graded compositions in the form of *Geetam, Swarajati,Varnam* and *Keertanam*, introduction to the *Melakarta* and *JanyaRaaga* system with reference to the seventy two Melakartas, performance practice including compositions and elaborations.

These courses are not available for fulfilling the requirements of any programme in the institute and can be taken only as audit courses.

MUSIC N105T Western Classical Music I 3*

MUSIC N106T Western Classical Music II 3*

MUSIC N205T Western Classical Music III 3*

MUSIC N206T Western Classical Music IV 3*

The above four courses are designed to introduce and train the student in notation, rhythmic concepts and practice of western classical music.

The beginning level will develop the skills of reading and writing notations, supported by singing exercises. The objective of the theory part is to impart the required skills for reading music while either playing an instrument or plain vocal. Thestudent will be trained further in keyboard or violin practice.

At the advanced level, the student will be trained in more complex notations, rhythms, concept of Harmony melody etc., and composing rhythms and melodies. Training syllabus and examination tests will be based on that of the Associated Board of the Royal Schools of Music, London, and/or the Trinity-Guildhall board of music examinations.

(These courses are not available for fulfilling the requirements of any programme in the institute and can be taken only on audit).

MUSIC N303T Advanced Indian Music Practice (Vocal) 0

MUSIC N313T Advanced Indian Music Practice (Instrumental) 0

These courses are designed to allow facilities for practice with minimum supervision for students who have satisfactorily completed MUSIC N204T or MUSIC N214T respectively. These courses carry zero units. A student who has met the prerequisite can take these courses as audit courses as many times as he needs.

Pharmacy

PHA F211 Pharmaceutical Analysis 2 1 3

Basic techniques of pharmaceutical analysis, data handling and analysis, sources of error in analysis. The analytical methods would comprise of various titrimetric methods, such as acid-base, complexometric, non-aqueous, oxidation-reduction, precipitation, conductometric; physical and instrumental analysis such as gravimetric, polarography, nephelometry, amperometry, turbidometry, potentiometry; chromatographic separations such as TLC, coloumn, ion-exchange,

extraction methods such as gel-filtration, fractionation processes, analysis of metallic and non-metallic elements; water content, as well as evaluation of drug constituents in various pharmaceutical preparation.

PHA F212 Dispensing Pharmacy 2 1 3

Prescriptions, principles involved in the dispensing of prescriptions; physical, chemical and therapeutic incompatibilities involved and their remedy in such prescriptions; techniques involved in dispensing of mixtures. ENT preparations, parenteral products, radiopharmaceuticals, etc.

PHA F213 Microbiology 2 1 3

Introduction and classification of microbes; structure and physiology of microbial cell; infection and immunity; host parasite relationship; microbiology of milk, air, water and food; physical and chemical methods of controlling microbes; experiments for isolation, cultivation, physiological and biochemical characterization of microbes.

PHA F214 Anatomy Physiology & Hygiene 2 1 3

Anatomical study of the important organs of human body; physiology of various functional systems of human body; general principles of personal and community hygiene and prevention of communicable diseases.

PHA F215 Introduction to Molecular Biology & Immunology 3 0 3

Basic aspects of cell and molecular biology, DNA replication, transcription, translation and control mechanisms of protein synthesis. Post transcriptional modifications and post-translational modifications, DNA-protein interactions and regulation of gene expression. Cell signalling. Regulation of cell cycle. Basic aspects of immune system, cell-mediated and humoral immunity.

PHA F216 Pharmaceutical Formulations I 2 1 3

Prescriptions; understanding commonly used terminologies in a prescription; principles involved in the dispensing of prescriptions; labelling; posology; pharmaceutical calculations; physical, chemical and therapeutic incompatibilities; types of dosage forms; additives employed in dispensed preparations; 'techniques involved in preparation, packaging, quality control and stability of various preparations including liquid preparations (solutions, emulsion, suspensions, mixtures, elixirs, etc.), semi-solid preparations (creams, ointments, pastes, etc.), suppositories, powders, sterile liquids like ophthalmic drops and parenteral solutions etc.

PHA F217 Pharmaceutical Microbiology 2 1 3

Introduction and classification of microbes; structure and physiology of microbial cell; bacterial growth and nutritional requirement; isolation and preservation methods for pure cultures; sterilization techniques and its evaluation; microbial genomics and genetic exchange; infection and immunity; microbial diseases; antimicrobial drugs; production of antibiotics and vaccines etc.

PHA F241 Pharmaceutical Chemistry 2 1 3

This course deals with study of important classes of organic compounds such as alcohols, ethers, esters, aldehydes etc and their reactions. The mechanisms for various reactions will also be dealt with to comprehensively cover the basics of chemical reactions. Some important five and six member heterocycles with their reactions will also be part of the course. This course also emphasizes the use of inorganic compounds in pharmacy.

PHA F242 Biological Chemistry 2 1 3

This course focuses upon the physiological and medical significance of important biomolecules along with their use as drug targets. The course also elaborates the role of vitamins as prosthetic groups of enzymes and enzyme kinetics and regulation. The course deals with the understanding of chemical structures, biochemical reactions metabolic pathways related to carbohydrates, lipids, nucleic acids and protein synthesis and diseases arising from defects in these pathways.

PHA F243 Industrial Pharmacy 2 1 3

Pharmaceutical processes and equipments commonly used in pharmaceutical industries; drug extraction and clarification; mixing and granulation; pharmaceutical preparations such as aromatic waters, spirits, syrups, elixirs, lotions, liniments, official solutions, etc.; galenical products like infusions, decoctions, tinctures, extracts, etc, glandular preparations and blood plasma substitutes.

PHA F244 Physical Pharmacy 2 1 3

Preformulation characterization including solid state pharmaceutics, crystallinity, solubility, micromeritics, drug stability and compatibility, reaction kinetics, rheology, interfacial phenomenon, principles of diffusion and dissolution. Different types of colloidal systems and their properties and complexation.

PHA F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

PHA F311 Pharmacology I 2 1 3

This course is intended to impart the knowledge regarding the sources, routes of drug administration, pharmacokinetics (ADME) and pharmacodynamics (mechanism of action) of various drugs. This course is also intended to impart the knowledge regarding the concepts of action of drugs on various systems of the human body including ANS, SNS and CNS. The course also deals with therapeutic uses, side effects and contraindications of the drugs, which are commonly prescribed for the treatment of various disease conditions.

PHA F312 Medicinal Chemistry I 2 1 3

Study of important classes of drugs predominantly acting on CNS, ANS, SNS. Structure, properties, therapeutic and pharmaceutical importance and the uses of drug molecules both of natural and synthetic origin. Study of physiochemical properties, mechanism of action, S.A.R. and metabolism, factors affecting metabolism of drugs. Special emphasis on important topics such as Cholinergic drugs, Adrenergic drugs, Local anaesthetics and general anaesthetics, Sedatives, hypnotics and anti-anxiety drugs, Antiepileptics, Antihistamines, NSAIDS, Thyroid and Antithyroid Drugs, Drugs for Erectile Dysfunction.

PHA F313 Instrumental Methods of Analysis 2 1 4

Principle, configuration, applications of instruments like mass spectrophotometer, NMR, UV, IR, X-ray apparatus, atomic absorption/emission spectrophotometer, chromatographic techniques such as gas, HPLC, HPTLC, ion exchange, gel, affinity, high voltage electrophoresis, DTA, DSC, TGA, etc.

The course is specially designed for students in the first degree majoring in experimental sciences and would require groups of students to work with the above instruments in order to appreciate the potentiality of such modern instrumental methods of analysis.

PHA F314 Pharmaceutical Formulations and Bio-pharmaceutics 2 1 3

Physical, chemical and biopharmaceutical considerations in formulations, absorption, distribution and elimination of drugs; pharmaceutical additives; formulation and stability aspects of solid dosage forms, semi-solid dosage forms and liquids dosage forms; sustained release medication; aerosol products and packaging.

PHA F315 Pharmaceutical Formulations II 2 1 3

Physical, chemical and biopharmaceutical considerations in formulations, absorption, distribution and elimination of drugs; pharmaceutical additives; formulation, manufacturing, packaging, quality control and stability of solid dosage forms, semi-solid dosage forms, liquids dosage forms, and sterile preparations including parenteral suspensions, emulsions, depot formulations; microencapsulation and controlled release formulations; targeted drug delivery systems; multi-unit particulate systems; transdermal, gastroretentive, and nasopulmonary drug delivery systems; aerosol products and packaging.

Pre-requisite:

PHA F216: Pharmaceutical Formulations I

PHA F316 Pharmaceutical Regulatory Science 3 0 3

Fundamental knowledge on the regulatory requirements for approval of new drugs, and drug products in regulated markets of India & other countries like US, EU, Japan, Australia, UK, etc. Regulatory documentation requirements and registration procedures for marketing the drug products in these countries.

PHA F317 Safety Pharmacology and Toxicology 3 0 3

Introduction to toxicological principles, their role in new drug design and development, toxicokinetics, various influencers that give rise to mutagenesis, teratogenesis, carcinogenesis including developmental toxicity, organ toxicity with special reference to hepatic, renal, cardiovascular and neurological systems would be covered. ICH, OECD guidelines on toxicity studies, their importance in pre-clinical drug development.

Pre-requisite:

PHA F311 : Pharmacology I

PHA F341 Pharmacology II 2 1 3

This course is intended to impart the knowledge regarding the concepts of actions of drugs on various systems of the human body including cardiovascular system, urinogenital system, respiratory system, gastrointestinal and endocrine system etc. The course also imparts the knowledge regarding the mechanisms of action of various antimicrobial agents in the treatment and prevention of various diseases caused by the bacteria, fungi viruses and parasites. The course also deals with the drug-drug interactions, therapeutic uses, side effects and contraindications of the drugs, which are commonly prescribed for the treatment of various disease conditions.

PHA F342 Medicinal Chemistry II 2 1 3

This course deals with the study of important classes of drugs. Various aspects like structure, properties, therapeutic and pharmaceutical importance, mechanism of action, S.A.R. and metabolism of drugs and the uses of drug molecules both of natural and synthetic origin will be covered. Special emphasis will be given to topics such as Anti-hypertensive drugs, Anti-diabetic drugs, Steroids and steroidal drugs, Antimalarial drugs, Anticancer agents, Antiviral agents, Antiprotozoals, Antihelmintics, etc. Concepts of QSAR approach to drug design, molecular modelling, and combinatorial chemistry will also be discussed in addition. Principles of Toxicology.

PHA F343 Forensic Pharmacy 2 - 2

A study of the professional pharmacist's relation to the public and to other professions; a critical survey of statutory regulations governing the practice of pharmacy and drug industry in all its aspects; history and ethics of the profession of pharmacy.

PHA F344 Natural Drugs 2 1 3

The course imparts a knowledge of the crude drugs of natural origin used in pharmaceutical and medical practice. Study will include the different systems of classifications of crude drugs; cell contents; general principles of cultivation, collection, drying, storage and commerce of natural products of current medical and pharmaceutical importance; their morphologial and microscopical study: use and knowledge of common substitutes and adulterants.

PHA F366 Lab Project 3

PHA F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

PHA F376 Design Project 3

PHA F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

PHA F413 Pharmaceutical Management and Quality Control 3 0 3

Concepts of Pharmaceutical management, Managing of pharmaceutical industry, planning, layouts, designs, current good manufacturing practices, pharmaceutical process validation, documentation, pilot plant scale up technique optimization, pharmaceutical marketing, quality aspects and quality control, managing hospital pharmacy and its importance.

PHA F414 Biopharmaceutics 3 0 3

Biopharmaceutics and Biopoharmaceutical aspects of drug delivery covering absorptions, distribution, metabolism and elimination (ADME) characters of drugs. Compartment model, pharmacokinetics of drugs and their applications, bioavailability, bioequivalence and their studies, drug-drug interactions and other re-

lated matters.

PHA F415 Pathophysiology 3 0 3

Cellular pathology, inflammatory, genetic and immunological disorders, infectious diseases- their expression and cause, targets for therapy, diseases of the organ systems, environmental and nutritional pathology.

PHA F416 Chemistry of Synthetic Drugs 3 0 3

Heterocyclic drugs; methods of heterocyclic drug synthesis; mechanisms of important heterocyclic compounds; mechanism based optimization of lead compounds on target sites; biological properties of heterocyclic drugs; synthesis of other special organic compounds of biological importance like polynuclear hydrocarbons etc. Introduction to Retrosynthetic approaches.

PHA F417 Pharmacoeconomics 3 0 3

Economic aspects of health care and its applications in the health sector are broadly emphasized. Cost-benefit, cost-effectiveness, cost-minimization, and cost-utility analyses to compare the different pharmaceutical products, drug therapy and treatments are focused. Economic concepts such as supply, demand, efficiency, equity, health policy, market failures, health insurance, pharmaceutical market, measurement of direct and indirect costs to a health care program, economic issues, pharmaceutical regulations, pricing policy and related topics will be covered.

PHA F418 Biopharmaceutics and Pharmacokinetics 3 0 3

Biopharmaceutics and Biopharmaceutical aspects of drug delivery covering absorptions, distribution, metabolism and elimination (ADME) characters of drugs. Compartment model, pharmacokinetics of drugs and their applications, bioavailability, bioequivalence and their studies, drug-drug interactions and other related matters.

PHA F419 Herbal Drug Technology 3 0 3

Operations in herbal drug industry, the quality of raw material, guidelines for quality of herbal drugs, classical ayurvedic and conventional formulations, nutraceuticals, herbal cosmetics, herbal excipients etc. Good Manufacturing Practices (GMP), patenting and regulatory issues of herbal drugs.

Pre-requisite:

PHA F344 : Natural Drugs

PHA F422 Cosmetic Science 2 1 3

Principles of formulation of typical cosmetic preparations such as cosmetic creams, powders, lipsticks, rouges, hair preparations, dentrifices, aerosol cosmetics, perfumes for cosmetic, their blending and mixing techniques. Some recent and new trends.

PHA F432 Hospital Pharmacy 3 0 3

Definition and function, location, organisation, staff, space, equipment. Pharmaceutical services, Medical stores, objectives, procedures for procurement and suplies, Distribution & control, inspection of stocks, Licensing procedures for stocking of alcohol, narcotics, Maintenance ofrecords of stocks, issue and use. Pharmaceutical services for out - patient and in - patient department.

PHA F441 Biochemical Engineering 3 0 3

Principles of Chemical Engineering applied to Bioprocesses; Kinetic Models for growth, substrate utilization and product formation; Biological reaction kinetics and applied enzyme catalysis; immobilized biocatalysts; Bioreactor Design and Operation; Fermentation, Upstream & Downstream processing; Novel Bioreactor Configurations; Transport phenomena in Bioprocesses; Instrumentation and control; Bioprocess Optimization and Scale up; Industrial Protein Purification Techniques; Commercial Enzymes & Biopharmaceuticals; Bioprocess Patenting, Economics & Feasibility Studies.

PHA F442 Applied Pharmaceutical Chemistry 3 0 3

The course comprises of structure, reactions and synthesis of selected carbocyclic and heterocyclic ring systems. Their application for drug design, structure activity relationship, pharmacological action, methods of assay.

PHA F461 Phytochemistry 2 1 3

This course is intended to impart knowledge to the students in the isolation, characterization and chemistry of the natural products derived from various sources, which are of pharmaceutical importance. Intriguing chemistry involved in their invivo production and their importance as structural materials, biologically active molecules like toxins, hormones, life process substrates and drugs will be covered in this course, the evaluation of these substances using qualitative and quantitative methods will also be covered; specail emphasis will be given to newer techniques in the biogenesis of these molecules.

PHA F491 Special Projects 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

PHA G510 Application of Statistics and Computer in Pharmacy 5

to data classification, analysis and probability; statistical inference – estimation and hypothesis testing; linear regression and correlation; design of experiments; analysis of variance; non parametric procedures & tests; statistical quality control; experimental design in clinical trials and validation; basic techniques in optimization. Introduction to computer and its components; operating systems; principles and use of standard software packages having application in drug design, development, analysis, etc.; principles of software creation; processing concepts, flow charting and algorithms, programming constructs, programming languages, program development sequence; information systems: need, significance concepts, their analysis, design and implementation; software life cycle with special reference to software planning and maintenance.

PHA G511 Fermentation & Biotechnology 2 3 5

Industrial scale production by fermentation processes of antibiotics, vitamins, alcohol and other selected products, development, selection, isolation and preservation of mutants, media sterilisation, accretion and air sterlisation, continuous fermentation, recent advances in fermentation biotechnology, enzymes, their large scale extraction and purification, principles of immobilisation of enzymes and its applications.

PHA G512 Chemistry of Natural Drugs 3 1 4

Study of recent methods of phytochemical investigations with reference to alkaloids like rauwolfia,vinca, cantharanthus etc.; some selected steroids, terpenes & flavoring agents, their chemistry, structure activity relationship, pharmacological actions and synthetic routes.

PHA G521 Molecular Biology & Immunology 3 1 4

General principles governing the structures and functions of various molecules of the immune system, acquired immune responses, immunological tolerance, genetic control of immunity, hypersensitivity reactions, protein structure, functions, RNA and DNA cloning, principles of Genetic Engineering and its future in drug production.

PHA G522 Chemistry of Macromolecules 2 2 4

Physical, Chemical and Biological properties of biopolymers like proteins, nucleic acids, poly saccharides. Synthetic polymers, biomedical and pharmaceutical polymers with emphasis on recent development.

PHA G523 Total Quality Management and Regulatory Affairs (5*)

Quality control, quality assurance, total quality management,

various parameters for achieving quality products, application of statistics in quality assurance, statistical process control, current good manufacturing practice (cGMP), introduction to process validation, drug regulatory affairs, clinical research protocols, new drug applications, intellectual property rights.

PHA G531 Disinfection and Sterilization 2 2 4

Theories and kinetics of the disinfection reaction, study of the principles involved in vivo and in vitro evaluation of disinfectants and antiseptics, structure activity relationships of the representative groups of disinfectants, sterilisation, heat, ionizing and ultraviolet radiations, ultrasonic waves, filtration, gaseous sterilisation and cellular dessication methods, controls used and special problems involved.

PHA G532 Quality Assurance & Regulatory Affairs 3 2 5

Quality control, quality assurance, quality management, various parameters for achieving quality pharmaceutical products, application of statistics in quality assurance, reliability, current good manufacturing practice (cGMP) for pharmaceutical manufacturing, pharmaceutical process validation, drug regulatory affairs, clinical research protocols, new drug applications, drug product labeling.

PHA G533 Pharmaceutical Process Chemistry 4

Selection of routes, process optimization, Catalysis, plant layout and design, processes and flow sheets, Impurities - separation, synthesis and characterization, Good manufacturing practices in API (active pharmaceutical ingredients) industry, Industrial Safety, Occupational Health & Safety, Chiral separation.

PHA G534 Separation and Structure Elucidation Techniques 4

Advance separation methods for complex Natural, Semisynthetic and Synthetic New Chemical Entities (NCEs) using LC-MS, LC-MS-MS, LC-NMR, GC-MS, GC-MS-MS, CE-MS, Supercritical Fluid Chromatography. Structure elucidation of NCEs using 2D and 3D (1H and 13C) Nuclear Magnetic Resonance (NMR) spectroscopy and X-ray diffraction technique. Prediction of structures using Software tools.

PHA G535 Biomaterials 5

Introduction to biomaterials for pharmaceutical applications; polymeric biomaterials; Natural and synthetic polymers for drug delivery, regenerative medicine and nanomedicines; Polymer properties including crystallinity, glass transition, polymer degradation influencing pharmaceutical formulations; biocompatibility; biodegradation; in-vitro and in-vivo assessment of polymer toxicity.

PHA G536 Cosmetics and Cosmeceuticals 3 2 5

Fundamental concepts required in the field of cosmetics and cosmeceuticals, Biological aspects of cleansing and care required for skin, eye, lips, scalp, hair, nail etc. along with suitable agents/ingredients required for the same, Various aspects of the nature of cosmetic products and consumers' demand with respect to quality and elegancy, Regulatory and safety guidelines catering cosmetic products, misbranded and spurious products, Special purpose cosmeceutical products, herbal cosmetics etc.

PHA G537 Parenteral Product Development 5

Parenteral product & their types, products characteristics; Vehicle requirement for Parenteral Product manufacturing; Formulation & process consideration for development of parenteral products; Various aspects of unit operation in parenteral product manufacturing; Critical Quality attributes of Parenteral Product; Sterilization techniques for parenteral products; Key requirements for aseptic processing; Lyophilization techniques of stable product development; Regulatory consideration for safety assessment of Parenteral Products; Packaging requirement for Parenteral Drug Products; Regulatory perspective for complex injectable products development and filing.

PHA G538 Immunopharmacology 4

The course will include an overview of the cell types and key mediators involved in the innate and adaptive immune responses, the use of antibody preparations and small molecule immunotherapeutics to target chronic inflammation, cancer, metabolic diseases, neurodegenerative diseases and autoimmunity in selected diseases. This course will explore the role of gut microbiota and regulation of immune response. The development of therapeutic anti-bodies and proteins will be discussed along with aspects of immunotoxicology.

PHA G539 Principles of Drug Discovery 4

Concepts of cellular mechanisms and processes involving cell surface receptors, membrane-bound enzymes, protein kinases, proteases, integrins, transporters and channels that facilitate drug discovery, with special emphasis on non-communicable diseases such as neurological, neuropsychiatric diseases and disorders, metabolic disorders, cancer. siRNA, anti-sense oligonucleotides, transgenic animals in drug discovery, long non-coding RNA, emerging trends in receptor - drug trafficking

PHA G540 Modern Pharmaceutical Analytical Techniques 3 1 4

Principles of sample preparation, method development for analysis and characterization of Active Pharmaceutical Ingredients (API) and formulations, using techniques such as High Performance Liquid chromatography (HPLC), biochromatography, size exclusion, affinity, chiral, fast protein chromatography (FPLC). Characterization of nanopharmaceutcials using Atomic Force Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Dynamic Light Scattering techniques. 1H and 13C Nuclear Magnetic Resonance (NMR) spectroscopy in structural characterization, Mass Spectrometry and its applications, Elemental analysis, Optical, chiro-optical techniques in structure elucidation.

PHA G541 Computer Aided Drug Design 3 2 5

3D structure and function of bio-molecules; targets of drugs and design principles; molecular modeling methodologies; cheminformatics, quantitative structure-activity relationships; chemical compound databases and search tools; interactive graphics in drug design; molecular surfaces and algorithm of automated docking of drugs into receptor sites; receptor mapping; introduction to molecular modeling and docking software.

PHA G542 Advanced Physical Pharmaceutics 3 2 5

Preliminary evaluations and molecular optimization, Drug substance considerations including protein, peptide and biological products, Bulk characterization, Solubility analysis, Rheology and dispersed systems, Micrometrics and shape factor analysis, Compression and compaction, Principles of dissolution, Dissolution test design and release kinetics evaluation, Compatibility testing, Stability analysis and test design according to international standard, Rationale basis of formulation recommendation.

PHA G543 Clinical Research 5*

Fundamentals of clinical trials including design, conduct, analysis and interpretation, randomization and blinding methods, sample size determination, recruitment methods, choice of controls, ethical, regulatory and research clearance including GCP, trial requirements-multi-centric/collaborative and related operational issues, data collection, processing, protocol management and quality control issues, interim analysis and critical review of intervention and therapies, design and results, statistical techniques in analysis and interpretation of results, documentation and reporting, pharmacovigilance.

PHA G544 Advanced Pharmaceutical Chemistry 3 2 5

Stereochemical aspects of drugs and biological molecules; effect of stereochemistry on drug action and isomerism in various drugs; rearrangements and name reactions useful in synthesis of bioactive molecules; example applications of rearrangements and name reactions in synthesis of existing drugs.

PHA G545 Intellectual property rights and Pharmaceuticals 3 0 3

Key aspects of intellectual property law and their impact on Pharmaceutical industry; concept of property with respect to intellectual creativity; emerging debates, policy issues and law reforms related to IPR with respect to pharmaceuticals; Issues of Intellectual Property such as Patents, Copyright, Trademarks, and Design; rules and regulations of marketing and competition; Patent processing, infringement of patents, ethics and economic issues related to IPR;

PHA G546 Pharmaceutical Biostatistics 3 0 3

Different types of data; methods for data collection;organization and summarization of data; probabilitydistributions; descriptive measures (measures of centraltendency and measures of dispersion); sampling andestimation of parameters (point estimates and intervalestimates); tests of hypothesis using parametric (t-test andANOVA) and various non-parametric tests; correlation andlinear regression; determination of sample size for a study;estimating bio-equivalence of pharmaceutical products

PHA G547 Quality-by-Design in Pharmaceutical ProductDevelopment 3 2 5

Principles and tools of Quality-by-Design (QbD) forpharmaceutical product development and manufacturing;essential elements of QbD approach including basic riskanalysis techniques; constructing the quality target productprofile (QTPP); identification of critical quality attributes(CQAs); critical process parameters (CPPs); design ofexperiments (DoE); identifying design space and controlstrategy; selection of critical factors using various screeningdesigns; optimization of factors using various experimentaldesigns; introduction to process analytical technologies(PAT)

PHA G548 Chemistry of Natural Drugs 3 2 5

Study of recent methods of chemical investigations on bioactive secondary metabolites of plants, microbes and marine origin with reference to alkaloids, steroids, terpenes, phenyl propanoids (flavonoids, coumarins, stilbenes, lignans, etc.) their chemistry, structure elucidation, structure activity relationships and their synthesis.

PHA G611 Advanced Pharmacology 3 2 5

Biochemical pharmacology and cellular basis for pharmacological functions, pharmacodynamics, organ systems pharmacology – gastro-intestinal, cardiovascular, renal and respiratory systems, metabolic disorders, recent developments in the treatment of infectious, communicable diseases -epidemics and pandemics and their impact on organ systems and health, neuropharmacology and psychotherapeutic agents, autocoids and autoimmune disorders, free radical pharmacology and their role in degenerative disorders, introduction to ethnopharmacology, pharmacogenetics, Prosthetics as adjuncts, alternates to therapy.

PHA G612 Pharmacokinetics & Clinical Pharmacy 3 2 5

Introduction to pharmacokinetic modeling of drugs; Compartmental modelling including one compartmental and two compartmental models; Non-compartmental analysis (NCA); Bioequivalence and comparative bioavailability studies; Pharmacokinetic Pharmacodynamic modelling techniques, determination of order of absorption and absorption rate constant by Wagner-Nelson method; non-linear pharmacokinetics; Pharmacokinetic drug interactions; multi-dose pharmacokinetics of drugs following one compartmental model; Design of multi-dose regimen; Dosage regimen adjustment in renal impairment; Application of the pharmacokinetic principles for better therapeutic outcomes.

PHA G613 Pharmaceutical Biotechnology 3 2 5

Molecular biology, immunology, recombinant DNA technology and principles of biochemical engineering. Application of biotechnology in diagnosis, therapeutics and production of products of fermentation. Bioinformatic tools required to store, analyze and use biological information for therapeutic utility, immense potentiality and application f decoding the human genome.

PHA G614 Clinical Pharmacy and Therapeutics 3 2 5

Basic concepts of Clinical pharmacy and its applications, analysis of patient data interpretation of clinical laboratory tests, drug information queries, their sources and interpretation of the information. Clinical pharmacokinetics, therapeutic drug monitoring, drug-drug interactions.

PHA G615 Pharmacy Practice ¦ 2 5

Overview of health care systems, providing drug information, physical examination, diagnostic procedures, drug administration, selection of alternate therapies, clinical alert, nutrition and electrolyte therapy, documentation of pharmacy services, patient counseling, paediatric pharmacy practice, evaluation of drug related problems, environmental, and health care management.

PHA G616 Pharmaceutical Administration and Management 3 2 5

Technology innovation and creativity, new drugs and products planning, strategic considerations, project implementation, product development, production management and scale up, preparation of product literature and marketing strategy, IPR processes, human resource development, industrial relations, documentation, R & D management, ethical aspects.

PHA G617 Advanced Drug Delivery Systems 3 2 5

A study of physicochemical and biopharmaceutical factors involved in the design of novel drug delivery systems like mucosal, particulate systems for systemic delivery of bioactive molecules. Special considerations for delivery of protein, peptide and other biological products. In vitro and in vivo evaluation of novel drug delivery systems.

PHA G618 Reterosynthetic Analysis 3 2 5

Methods and techniques to transform target molecule to precursors, functional group, stereo-chemical, structural, transform based and topological strategies involving organic reactions, functional group inter-conversions, reconnection and disconnection approaches, acyclic, ring structure synthesis, rearrangement reactions pertaining to the synthesis of selected medicinally important compounds.

PHA G619 Screening Methods and Techniques In Pharmacology 3 2 5

Ethics in animal research, CPCSEA guidelines, Biochemical assays, qualitative and quantitative estimation of receptor specific drugs, animal handling, breeding, nutrition and diet manipulation for testing, methods and techniques involved, therein. Design and development of new animal models and evaluation techniques for co-morbid illnesses and their standardization, toxicological, teratogenic, carcinogenic studies, data analysis, normalization in tabular and graphical formats.

PHA G621 Advanced Medicinal Chemistry 32 5

Methods of Modern Drug Discovery such as Me too drugs, Peptidomimetics, Diversity oriented synthesis, Lead optimization, Rational Drug Design, etc, Pro-drugs, Combinatorial Chemistry, Principles of Green Chemistry in drug synthesis

PHA G622 Chemistry of Natural Drugs & Macromolecules ¦ 2 5

Size and shape of macromolecules, biomedical polymers, their structure, synthesis and function, chemistry of newer oral contraceptive agents, terpenes used as flavouring agents, newer phytochemical investigations in glycosides, alkaloids, etc.

PHA G623 Pharmaceutical Applications of Polymers and Biopolymers 5

Analysis and design of materials used in contact with biological systems, surface molecular interactions, approaches to design materials that control cell functions and their application in tissue engineering, drug delivery, vaccines, and targetting. Basic concepts behind synthetic and bio-polymers that interfere with cellular biological functions, their manufacturing, characterization and applications of smart biomaterials in healthcare, nanotherapeutics. Wear particles, Cementless fixation, porous ingrowth materials, PSHA, chemically deposited coatings, Fracture fixation, fracture fixation plates, degradable fixation plate, bone screws and plugs, Calcium phosphate and polyalkenoate cements, Bone substitutes, autografts and allografts, Apatite glass ceramics, Bioglass/ sol-gel, Porous ceramics, Porous metals and porous glass, Materials based on natural products, collagen based materials, alginates, hyaluronic acid and chitin, Blood contacting devices, vascular grafts, stents, catheters and heart valves, artificial organs.

PHA G624 Principles of Toxicology 5

Principles, Organization of Economic Cooperation and Development (OECD), International Council for Harmonization (ICH) guidelines, toxicity testing methods in organ systems – acute, sub-acute, chronic, dermal, inhalational, reproductive, genotoxicity, invivo, invitro, insilico toxicity studies, toxicokinetics evaluation in preclinical studies, saturation kinetics, mutagenicity, safety pharmacology.

PHA G625 Cellular and Molecular Pharmacology 5

Molecular basis of the action of drugs; characteristics of interactions between drug molecules and substrates of drug action in the cell including cell signalling pathways; molecular, biochemical and cell biological techniques; proteomics, epigenomics and pharmaco-genomics in therapeutics, long non-coding RNA, pathophysiology of protease receptors.

PHA G626 Pharmacovigilance 4

Scope and purpose of pharmacovigilance, safety and Adverse Drug Reactions (ADRs)- causation, pre-clinical, human volunteer, post marketing surveillance studies, signal detection, assessment and risk/crisis management and planning, legislation, regulatory system, WHO, ICH, OECD, Council for International Organizations of Medical Sciences (CIOMS) guidelines, stakeholders perspectives, ethical principles transparency, pharmacovigilance of select organ systems such as cardiovascular, renal and conditions like pregnancy, pediatrics, geriatrics, current limitations and future perspectives, individualized therapy considerations.

PHA G627 Medical Devices and Testing 4

ISO and OECD guidelines for medical devices and related assay methods, in vitro and in vivo models for sensitization, toxicity and safety, Blood, system function analysis and their significance, drug eluting stents, pacemakers, prefilled, programmable drug delivery systems, dental and bone cements, replacement prosthetics for organs based on function, regulation, diagnostic instruments in healthcare, newer tools and techniques in diagnosis, treatment - such as Optical Coherence Tomography, fracture putty, tissue regeneration, robotic assist devices, etc.

PHA G632 Dosage Form Design 3 2 5

Role of physical, chemical and biopharmaceutical factors (preformulation studies) of drug in the design, manufacture and stability of dosage forms; dosage form factors affecting the absorption of drugs; Biopharmaceutical Classification System (BCS); development of in-vitro in-vivo correlation; Controlled release drug delivery systems; Design of delivery systems for various routes/purposes like oral (gastro-retention, colon targeted), parenteral, buccal/sublingual, nasal, ocular, pulmonary and transdermal.

PHA G642 Laboratory Project 6

Exercises illustrating principles discussed in theory courses.

PHA G645 Molecular Pharmacology 3 0 3

Molecular basis of the action of drugs; the characteristics of interactions between drug molecules and substrates of drug action in the cell; molecular, biochemical and cell biological techniques; response of cells to pharmacologic agents.

Physics

PHY F110 Physics Laboratory 0 2 1

An introductory experimental course covering experiments in Mechanics, Oscillations and Waves. In addition to performing classic experiments in physics, the course aims at strengthening experimental skills and ability to take proper measurements. The course should motivate students to enter the exciting world of experimental physics.

PHY F111 Mechanics, Oscillations and Waves 3 0 3

Conservation Principles, Rotational Dynamics, Oscillations, Wave Motion, Reflection and Refraction, Interference, Diffraction, Polarisation.

PHY F112 General Physics 3 0 3

Philosophy of Science; Newton's laws of motion; Work Energy, Impulse and Momentum; Equilibrium; Moment of a force; Rotation; Periodic motion; First law of thermodynamics; Second law of thermodynamics; Electromagnetic waves; Interference and diffraction; Polarization; Relativistic mechanics; Photons, Electrons and Atoms; Quantum Mechanics; Atoms, Molecules and Solids; Nuclear Physics.

PHY F211 Classical Mechanics 3 1 4

Review of Newtonian mechanics, constraints and generalized coordinates, Lagrange's equation of motion, calculus of variation and principle of least action, central force motion, kinematics of rigid body motion, rigid body equations of motion, heavy symmetrical top, Hamilton's equations of motion, canonical transformations.

PHY F212 Electromagnetic Theory I 3 0 3

Review of mathematics - scalar and vector fields, calculus of scalar and vector fields in Cartesian and curvilinear coordinates, Dirac delta function; Electrostatics - electric field, divergence & curl of electric field, electric potential, work and energ y in electrostatics, conductors, electric dipole; Electrostatics in Matter - polarization and field of a polarized object, electric displacement, linear dielectrics; Magnetostatics - Lorentz force law, Biot-Savart law, divergence & curl of magnetic field, magnetic vector potential, magnetic dipole; Magnetostatics in matter - magnetization and field of a magnetized object, the H-field, linear & non-linear magnetic media; Electrodynamics - electromotive force, electromagnetic induction, Maxwell's equations in free space, plane wave solutions of Maxwell's equations in free space.

PHY F213 Optics 3 0 3

Geometrical optics - light as rays, Fermat's principle, matrix methods in ray tracing; scalar wave theory of light, spatial and temporal coherence, theory of diffraction - Fresnel & Fraunhoffer diffraction, diffraction at rectangular and circular aperture, diffraction around opaque objects; crystal optics - electromagnetic wave propagation in anisotropic media, birefringence, e-m waves in nonlinear media, eleme nts of nonlinear optics; scattering of light – Thomson and Rayleigh scattering; elements of modern optics - lasers and applications, holography, fiber optics, Fourier optics.

PHY F214 Electricity, Magnetism, and Optics Lab 0 2 2

This lab will consist of experiments on electromagnetism, optics and lasers.

PHY F215 Introduction to Astronomy and Astrophysics 3 0 3

Introduction and scope, telescopes, distance and size measurements of astronomical objects, celestial mechanics, the Sun, planets, planet formation, interstellar medium, star formation, stellar structure, stellar evolution, star clusters - open clusters, globular clusters, the Milky-Way galaxy, nature of galaxies - normal and active galaxies, Newtonian cosmology, cosmic microwave background radiation, the early universe.

PHY F221 Modern Physics 3 0 3

Special theory of relativity; quantum mechanics and applications; atomic and molecular physics; statistical physics; nuclear physics.

PHY F241 Electromagnetic Theory II 3 1 4

Maxwell's equations in matter, boundary conditions on electric and magnetic fields; energy of e-m fields and Poynting's theorem, linear momentum and angular momentum of e-m fields, Maxwell's stress tensor; electromagnetic waves in dielectric media – reflection, refraction and transmission at interfaces; wave propagation in metals – absorption and dispersion; guided waves; potential formulation of e-m fields, retarded potentials & Jefimenko's equations, Lienard-Weichert potentials and fields of a moving point charge; dipole radiation & radiation due to point charges; special theory of relativity, relativistic mechanics, relativistic electrodynamics.

PHY F242 Quantum Mechanics I 3 0 3

Origin of the quantum theory - black body radiation, photoelectric effect, Compton scattering, electron diffraction, Bohr model of hydrogen atom, Frank-Hertz experiment, Bohr-Sommerfeld quantization condition; notion of wave function, statistical interpretation of the wave function, issues of normalization, the Heisenberg uncertainty relation; Schrodinger equation, stationary states and time independent Schrodinger equation, energy eigenvalues and eigenfunctions, one-dimensional problems – potential wells, potential barriers, the harmonic oscillator; Hilbert space formalism – state vectors, Dirac's bra-ket notation, observables as Hermitian operators, eigenvalues and eigenstates of Hermitian operators, the measurement postulate.

PHY F243 Mathematical Methods of Physics 3 0 3

Tensor analysis in Cartesian and curvilinear coordinates; linear vector spaces, linear transformations and theory of matrices; functions of a complex variable, contour integration and applications; elements of calculus of variation; series solution of ordinary differential equations, special functions, Sturm-Liouville theory; Fourier integral; partial differential equations of physics, solution of partial differential equations by separation of variables method, the Green function method.

PHY F244 Modern Physics Lab 0 2 2

This lab will consist of experiments on modern physics and electromagnetism.

PHY F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

PHY F311 Quantum Mechanics II 3 0 3

Hilbert space formalism (continued from QM-I) - operators and their matrix representations, change of basis, position and momentum representations, commuting and non-commuting observables, the generalized uncertainty relation; the time evolution operator and Schrodinger equation, Schrodinger and Heisenberg picture, simple harmonic oscillator using operator method; angular momentum operators and their commutation relations, eigenvalues and eigenvectors of angular momentum, spherically symmetric potentials, the hydrogen atom; time independent perturbation theory, WKB approximation, variational method; time dependent perturbation theory, interaction of atom with classical radiation field; identical particles.

PHY F312 Statistical Mechanics 3 0 3

Review of Thermodynamics - First and the second law of thermodynamics, reversible and irreversible processes, entropy, absolute temperature, thermodynamic potentials ; Statistical description of macroscopic systems - micro and macro states, phase space distribution, Liouville theorem, microcanonical ensemble, statistical definition of temperature, pressure and entropy; Canonical ensembles, probability distribution in canonical ensemble, partition function and calculation of thermodynamic quantities, equipartition and virial theorems, Maxwell velocity distribution, paramgnetism, harmonic oscillators, polyatomic molecules; Grand canonical ensembles - probability distribution in grand canonical ensemble, grand partition function, calculation of thermodynamic quantities; Quantum statistics - indistinguishable particles, Bose-Einstein and Fermi-Dirac distribution, classical limit, photon statistics, Planck distribution; Ideal Fermi gas - equation of state of ideal Fermi gas, free electron gas in metals, Pauli paramagnetism, Landau diamagnetism, statistical equilibrium of white dwarf stars; Ideal Bose Gas - equation of state, Bose-Einstein condensation.

PHY F313 Computational Physics 3 0 3

Review of programming language - C/C++, Matlab and Mathematica; Functions and roots - Newton-Raphson method, rate of convergence, system of algebraic equations; Numerical integration - Romberg integration, Gaussian quadrature; Ordinary differential equations - Euler Method, Runge-Kutta method, predictor-corrector method, system of equations; Partial differential equations - boundary value problems, finite difference method, finite element method; discrete and fast Fourier transform; Eigen-value problems; Monte-Carlo method - random numbers, sampling rules, metropolis algorithm.

PHY F315 Theory of Relativity 3 0 3

Special theory of relativity : Experimental background and postulates of the special theory, Lorentz transformation equations and their implications, space-time diagrams, Four vectors, tensors in flat space-time, relativistic kinematics and dynamics, relativistic electromagnetism. General theory of relativity : Principle of equivalence, gravitational red shift, geometry of curved space-time, Einstein field equation, spherically symmetric solution of field equation.

PHY F316 Musical Acoustics 3 0 3

Mathematical description of sound waves; physical

sound production by vibrations in different dimensions; perception of music by the human ear and brain, the scientific meaning of psycho-acoustic concepts of pitch, loudness and timbre; Fourier analysis as a tool for characterizing timbre; musical scales, harmonics and tones; musical instruments with plucked, bowed and struck strings, wood-wind instruments, reed instruments and the human voice, percussions instruments such as tympani, and drums; engineering for sound reproduction in transducers, mikes, amplifiers and loudspeakers; sound spectrum analysis; basics of signal processing for electronic music production, filtration and enhancement; rudiments of room and auditorium acoustics ; hands-on work and projects.

PHY F317 Introduction to Radio Astronomy 3 0 3

Overview of Astronomy, Stellar and Galactic Astrophysics, Bremsstrahlung, Synchrotron radiation, free-free radiation, and Compton scattering, Radiative- transitions/line-emission, The radio sky and sources of radio signals, Theory of statistical random signals, Radio telescopes and Radio observations. Techniques of Line and continuum observations, Pulsar observations. Radio telescopes, antennas and receivers. Single dish and interferometric observations, Beam patterns, aperture synthesis and deconvolution, Phased arrays, Flux and Phase Calibration techniques. Study some radio telescopes GMRT, VLA, OWFA.

PHY F341 Solid State Physics 3 0 3

Crystal structure - direct and reciprocal lattice, Brillouin zone, X-ray diffraction and crystal structure; free electron theory of metals; periodic potential and band theory of solids, the tight-binding approximation; lattice vibration and thermal properties; semiconductors - energy band gap in semiconductors, carrier density of intrinsic and extrinsic semiconductors, the p-n junction; magnetism - paramagnetism and diamagnetism, spontaneous magnetism, magnetic ordering; super conductivity-basic properties, the London equation, elements of BCS theory.

PHY F342 Atomic and Molecular Physics 3 0 3

Interaction of electromagnetic field with atoms - transition rates, dipole approximation, Einstein coefficients, selection rules and spectrum of one electron atom, line intensities and shapes, line widths and lifetimes; one electron atoms - fine and hyperfine structure, interaction with external electric and magnetic fields; two electron atoms - para and ortho states, level scheme, ground and exited states of two electron atoms; many electron atoms - central field approximation, Thomas –Fermi model, Hartree- Fock method, L-S coupling and j-j coupling; Molecular structure - Born-Oppenheimer approximation, rotation and vibration of diatomic and polyatomic molecules, electronic structure and spin, rotational-vibrational and electronic spectra of diatomic molecules, nuclear spin.

PHY F343 Nuclear and Particle Physics 3 0 3

Bethe-Weizsacker mass formula, nuclear size, mirror nuclei, electric multipole moments, Spherically and axially symmetric charge distribution, electric quadrupole moment, nuclear magnetic moment, nuclear decay, alpha and beta decay processes, nuclear fission, Bohr-Wheeler theory, two-body problem, deuteron wave function with central and non-central potential, electric quadrupole moment & magnetic moment, exchange forces, low energy nucleon-nucleon scattering, scattering length, effective range theory, spin dependence of n-p scattering, magic numbers, independent particle model, collective model. Mesons and baryons, antiparticles, neutrinos, strange particles, eightfold way, quark model, intermediate vector bosons, four fundamental forces, basic vertices and charactesitics of quantum electrodynamics, quantum flavordyamics and quantum chromo dynamics, decays and conservations laws, basic ideas of standard model of particle physics, qualitative discussion of current issues in particle physics.

PHY F344 Advanced Physics Lab 0 3 3

This lab will consist of experiments on solid state physics, spectroscopy and nuclear physics.

PHY F345 Quantum Mechanics for Engineers 3 0 3

Wave particle duality, Schrödinger wave equation, probability and current densities, position and momentum operators and state space, expectation values of operators, normalization, particle in a box, particle in finite height barrier and finite well, reflection and transmission, Harmonic oscillator, particle in linearly varying potential, Infinite potential well, delta function potential. Time dependent Schrödinger equation, time evolution of stationary states: Infinite well and harmonic oscillator, wave packets and time evolution with example, group velocity.

Crystals, one electron approximation, Bloch theorem, density of states in k space, effective mass theory, effective mass approximation in semiconductor heterostructures, density of states in energy, density of states in quantum well, K.P model for two-band semi conductor. Band structure calculations for cubic crystals, Nanostructures: quantum wire, quantum well, quantum dots

PHY F346 Laser Science and Technology 3 0 3

Introduction to lasers, theory of radiation, laser basics, optical resonators, longitudinal / transverse modes, pumping of laser media, Line broadening mechanism, Transient behaviour - Q-switching, mode locking, devices, techniques; Types of lasers - solid state lasers, gas lasers, liquid lasers, semiconductor laser, x-ray laser, free electron laser, maser; Non-linear optics: Phase matching, second harmonic generation, third harmonic generation, difference frequency generation, optical parametric generation; Applications of lasers : Industry, medicine, biology, optical /quantum communication, thermonuclear fusion, isotope separation, holography, laser cooling.

Pre-requisite: PHY F212: Electromagnetic Theory I or EEE F212 or INSTR F212 or ECE F212 : Electromagnetic Theory

PHY F366 Lab Project 3

PHY F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

PHY F376 Design Project 3

PHY F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

PHY F378 Plasma Physics and its Applications 0 3

Introduction to plasma physics. Motion of single charged particles in Electric and Magnetic fields. Fluid description of plasma and study of waves in plasmas, Theory of instabilities in plasma, A Kinetic theory description of plasma and some basic plasma phenomenon, Applications of plasma physics to plasma based accelerators, plasma based energy radiation sources, magnetic confinement fusion, laser-plasma interaction, astrophysical plasma, and studying plasma physics using computer simulation.

PHY F379 Thin Film Technology 3 0 3

Overview of thin film technology, Structure and bonding of materials, Defects in thin film, Thermodynamics and phase diagram, Kinetics and diffusion mechanism, Surface nucleation and film growth, Epitaxy and growth modes, Basics of vacuum science and technology, Thin film growth technology, Epitaxial growth techniques, Structure and morphology of thin films, Surface reconstruction and surface chemistry, Electrical and magnetic properties, Special topics on thin film application, Laboratory based experiments or assignments related to thin films.

PHY F412 Introduction to Quantum Field Theory 3 1 4

Klein-Gordan equation, SU(2) and rotation group, SL(2,C) and Lorentz Group, antiparticles, construction of Dirac Spinors, algebra of gamma matrices, Maxwell and Proca equations, Maxwell's equations and differential geometry; Lagrangian Formulation of particle mechanics, real scalar field and Noether's theorem, real and complex scalar fields, Yang-Mills field, geometry of gauge fields, cannonical quantization of Klein-Gordan, Dirac and Electromagnetic field, spontaneously broken gauge symmetries, Goldstone theorem, superconductivity.

PHY F413 Particle Physics 3 1 4

Klein-Gordan equation, time-dependent non-relativistic perturbation theory, spinless electron-muon scattering and electron-positron scattering, crossing symmetry, Dirac equation, standard examples of scattering, parity violation and V-A interaction, beta decay, muon decay, weak neutral currents, Cabibo angle, weak mixing angles, CP violation, Weak isospin and hypercharge, basic electroweak interaction, Lagrangian and single particle wave-equation, U(1) local gauge invariance and QED, non-abelian gauge invariance and QCD, spontaneous symmetry breaking, Higgs mechanism, spontaneous breaking of local SU(2) gauge symmetry.

PHY F414 Physics of Advanced Materials 3 1 4

Review of fundamentals of crystallography, structural properties of crystals, polymers and glasses, processes involved in materials preparation, viz., diffusion, phase diagrams, advanced techniques to prepare low dimensional systems and thin films, kinetics of phase transformations, Mechanical, structural, thermal and electrical characterization of advanced materials, e.g., high Tc superconductors, superionic conductors, conducting polymers, dielectrics, ferroelectric materials, polycrystalline semiconducting materials, magnetic semiconductors, magneto resistance and GMR materials, shape memory alloys.

PHY F415 General Theory of Relativity and Cosmology 3 1 4

Review of relativistic mechanics, gravity as geometry, descriptions of curved space-time, tensor analysis, geodesic equations, affine connections, parallel transport, Riemann and Ricci tensors, Einstein's equations, Schwarzschild solution, classic tests of general theory of relativity, mapping the universe, Friedmann-Robertson-Walker (FRW) cosmological model, Friedmann equation and the evolution of the universe, thermal history of the early universe, shortcomings of standard model of cosmology, theory of inflation, cosmic microwave background radiations (CMBR), baryogenesis, dark matter & dark energy.

PHY F416 Soft Condensed Matter Physics 3 1 4

Forces, energies, timescale and dimensionality in soft condensed matter, phase transition, mean field theory and its breakdown, simulation of Ising spin using Monte Carlo and molecular dynamics, colloidal dispersion, polymer physics, molecular order in soft condensed matter – i) liquid crystals ii) polymer, supramolecular self assembly.

PHY F417 Experimental Methods of Physics 3 1 4

Vacuum techniques, sample preparation techniques, X-ray diffraction, scanning probe microscopy, scanning electron microscopy, low temperature techniques, magnetic measurements, Mossbauer and positron annihilation spectroscopy, neutron diffraction, Rutherford backscattering, techniques in nuclear experimentation, high energy accelerators.

PHY F418 Lasers and Applications 3 1 4

Properties of laser light, theories of some simple optical processes, basic principles of lasers, solid-state lasers, gas lasers, semiconductor lasers, free electron lasers, liquid, dye and chemical lasers, dynamics of laser processes, advances in laser physics, Q-switching, modelocking (active and passive), saturable absorbers, Kerr lens mode locking, non-linear optics, laser spectroscopy, time resolved spectroscopy, multi-photon spectroscopy.

PHY F419 Advanced Solid State Physics 3 1 4

Schrodinger field theory (second quantized formalism), Bose and Fermi fields, equivalence with many body quantum mechanics, particles and holes, single particle Green functions and propagators, diagrammatic techniques, application to Fermi systems (electrons in a metal, electron – phonon interaction) and Bose systems (superconductivity, superfluidity).

PHY F420 Quantum Optics 3 1 4

Quantization of the electromagnetic field, single mode and multimode fields, vacuum fluctuations and zero-point energy, coherent states, atom - field interaction - semiclassical and quantum,

the Rabi model, Jaynes-Cummings model, beam splitters and interferometry, squeezed states, lasers.

PHY F421 Advanced Quantum Mechanics 3 1 4

Symmetries, conservation laws and degeneracies; Discrete symmetries - parity, lattice translations and time reversal; Identical particles, permutation symmetry, symmetrization postulate, two-electron system, the helium atom; Scattering theory - Lippman-Schwinger equation, Born approximation, optical theorem, eikonal approximation, method of partial waves; Quantum theory of radiation - quantization of electromagnetic field, interaction of electromagnetic radiation with atoms; relativistic quantum mechanics.

PHY F422 Group Theory and Applications 3 1 4

Basic concepts – group axioms and examples of groups, subgroups, cosets, invariant subgroups; group representation – unitary representation, irreducible representation, character table, Schur's lemmas; the point symmetry group and applications to molecular and crystal structure; Continuous groups – Lie groups, infinitesimal transformation, structure constants; Lie algebras, irreducible representations of Lie groups and Lie algebras; linear groups, rotation groups, groups of the standard model of particle physics.

PHY F423 Special Topics in Statistical Mechanics 3 1 4

The Ising Model – Definition, equivalence to other models, spontaneous magnetization, Bragg- William approximation, Bethe-Peierls Approximation, one dimensional Ising model, exact solution in one and two dimensions; Landau's mean field theory for phase transition – the order parameter, correlation function and fluctuation-dissipation theorem, critical exponents, calculation of critical exponents, scale invariance, field driven transitions, temperature driven condition, Landau-Ginzberg theory, two-point correlation function, Ginzberg criterion, Gaussian approximation; Scaling hypothesis – universality and universality classes, renormalization group; Elements of nonequilibrium statistical mechanics – Brownian motion, diffusion and Langevin equation, relation between dissipation and fluctuating force, Fokker-Planck equation.

PHY F424 Advanced Electrodynamics 3 1 4

Review of Maxwell's equations – Maxwell's equations, scalar and vector potentials, gauge transformations of the potentials, the electromagnetic wave equation, retarded and advanced Green's functions for the wave equation and their interpretation, transformation properties of electromagnetic fields; Radiating systems – multipole expansion of radiation fields, energy and angular momentum of multipole radiation, multipole radiation in atoms and nuclei, multipole radiation from a linear, centre-fed antenna; Scattering and diffraction – perturbation theory of scattering, scattering by gases and liquids, scattering of EM waves by a sphere, scalar and vector diffraction theory, diffraction by a circular aperture; Dynamics of relativistic particles and EM fields – Lagrangian of a relativistic charged particle in an EM field, motion in uniform, static electromagnetic fields, Lagrangian of the EM fields, solution of wave equation in covariant form, invariant Green's functions; Collisions, energy loss and scattering of a charged particle, Cherenkov radiation, the Bremsstrahlung; Radiation by moving charges – Lienard-Wiechert potentials and fields, Larmor's formula and its relativistic generalization; Radiation damping – radiative reaction force from conservation of energy, Abraham-Lorentz model.

PHYF425 Advanced Mathematical Methods ofPhysics 3 1 4

Course description is to be developed.

PHY F426 Physics of Semiconductor Devices 3 1 4

Course description is to be developed.

PHY F427 Atmospheric Physics 3 0 3

Course description is to be developed.

PHY F428 Quantum Information Theory 3 0 3

Classical Information, probability and information measures, methods of open quantum systems using density operator formalism, quantum operations, Kraus operators. Measurement and information, Entropy and information, data compression, channel capacity, Resource theory of quantum correlations and coherence, and some current issues.

PHY F431 Geometrical Methods in Physics 3 0 3

Manifolds, tensors, differential forms and examples from Physics, Riemannian geometry, relevance of topology to Physics, integration on a manifold, Gauss theorem and Stokes' theorem using integrals of differential forms, fibre bundles and connections, applications of geometrical methods in Classical and Quantum Mechanics, Electrodynamics, Gravitation, and Quantum field theory.

PHY F432 Classical Theory of Fields: A Symmetry Perspective 4*

Rotations in real complex and Minkowski spaces laying group theoretical basis of 3-tensors and 4 tensors and spinors, transition from a discrete to continuous system, stress energy tensor, relativistic field theory, Noether's theorem, tensor and spinor fields as representation of Lorentz group, action for spin-0 and spin-1/2, and super-symmetric multiplet, introduction of spin-1, spin-2 and spin-3/2 through appropriate local symmetries of spin-0 and spin-1/2 actions.

PHY F433 Topics in Nonlinear Optics 3 0 3

Lorentz model for various order nonlinearities, properties of tensor elements; Second order processes (second harmonic generation, Pockels effect, optical parametric oscillator); phase matching in crystals; Third order processes (third harmonic generation, phase conjugation, Kerr effect, self-phase modulation, Raman effect, Stimulated Raman scattering (Stokes / anti-Stokes), Stimulated Brillouin scattering); Light interaction with plasma (waves in plasmas, Landau damping, absorption of light by inverse Bremsstrahlung, resonance absorption, two plasmon absorption, parametric decay, stimulated Raman scattering, stimulated Brillouin scattering); Concepts of ponderomotive force / energy, second harmonic generation in plasma, self-focussing, above threshold ionization, odd harmonic generation, optical field ionization, Coulomb explosion; Applications : Holography (low intensity), optical solitons (medium intensity), inertial confinement fusion (high intensity) and acceleration of charged particles with light (ultra-high intensity).

Pre-requisites: PHY F212 & PHY F213

PHY F434 Foundations of Quantum Mechanics 3 0 3

A review of pre-quantum (classical) theories from the lens of determinism, locality, ontology, measurement, and abstract spaces; A discussion on Bell's generic formulation of locality and ontological issues through gauge redundancy in the description of electrodynamics; Review basic quantum theory and develop a toolbox for simple quantum examples to be used later to address the issues of locality, ontology and measurement; The measurement problem; the locality problem; the ontology problem; Copenhagen interpretation; Bohm's Pilot wave theory; Bell's theorem; many world interpretations.

Pre-requisite: PHY F242: Quantum Mechanics I

PHY F491 Special Project 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brainstorming sessions.

PHY G511 Theoretical Physics 5

Calculus of Variations and its applications to Lagrangian and Hamiltonian Dynamics, Thermodynamics and Geometric Optics and Electrodynamics. Geometric and Group theoretic foundations of Hamiltonian Dynamics, Hamilton-Jacobi Theory, Integrability and Action-Angle Variables, Adiabatic Invariants, Transformation (Lie) Groups and Classical Mechanics. Modern Theory

of Phase Transitions and Critical Phenomenon: Thermodynamics and Statistical Mechanics of Phase Transitions, General Properties (eg Scaling, Universality, Critical exponents) and Order of Phase Transitions; Introduction to Landau-Ginzburg (Mean Field Theory) theory for Second Order Phase Transitions, the Ising Model and some Examples, Phase Transitions as a *symmetry-breaking* phenomenon.

PHY G512 Advanced Quantum Field Theory 3 0 3

Diagrammatics : Feynman diagrams & rules, Loop diagrams, S-matrix, Path integrals, Gauge theories, QED and QCD Lagrangians, Renormalization group, Non-perturbative states.

PHY G513 Classical Electrodynamics 4

Review of Electrostatics, Magnetostatics, and solution of Boundary Value Problems. Method of Images. Maxwell equations for time dependent fields, Propagation of electromagnetic waves in unbounded media. Waveguides & Cavity Resonators. Absorption, Scattering and Diffraction, Special Relativity, Covariant formulation of Classical Electrodynamics. Dynamics of charged particles in electromagnetic fields. Radiation by moving charges and Cerenkov Radiation.

PHY G514 Quantum Theory and Applications 4

Mathematics of linear vector spaces, Postulates of Quantum Mechanics, Review of exactly solvable bound state problems, WKB methods, Angular momentum, Spin, Addition of angular momenta, Systems with many degrees of freedom, Perturbation theory, Scattering theory, Dirac equation.

PHY G515 Condensed Matter Physics 4

Free electron models, Reciprocal lattice, Electrons in weak periodic potential, Tight-binding method, Semiclassical model of electron dynamics, Theory of conduction in metals, Theory of harmonic crystals, Anharmonic effects, Semiconductors, Diamagnetism and paramagnetism, Superconductivity.

PHY G516 Statistical Physics & Applications 4

Liouville's theorem, Boltzmann transport equation, H-Theorem; Postulate of statistical Mechanics; Temperature; Entropy; Microcanonical, Canonical, Grand-canonical ensembles - Derivation, calculation of macroscopic quantities, fluctuations, equivalence of ensembles, Applications, Ideal gases, Gibbs Paradox; Quantum mechanical ensemble theory; Bose-Einstein statistics – derivation, Bose Einstein condensation, applications; Fermi-Dirac Statistics – derivation, applications - Equation of state of ideal Fermi gas, Landau Diamagnetism, etc; Radiation; Maxwell-Boltzmann statistics; Interacting systems – cluster expansion, Ising model in 1-d & 2-d; Liquid Helium, phase transitions and renormalization group.

PHY G517 Topics in Mathematical Physics 4

Functions of complex variables, special functions, fourier analysis, sturm-Liuoville theory, partial differential equation with examples, Greens functions, Group theory, differential forms, approximation methods in solutions of PDE's, vector valued PDE's.

PHY G518 Computational Methods in Physics 3 2 5

Basics of computer programming; errors and stability of methods; Numerical techniques for: differentiation, integration, root finding, interpolation, solving linear equations, matrix inversion & diagonalization, solving ODEs & PDEs, spectral methods and Monte Carlo methods; Applications: ID Schrodinger equation, Diffusion, Vibration of strings, Ising model, 3-body problem, Chaotic systems, Electronic structure of atoms. Power spectrum of a driven pendulum, Laplace equation, Wave equation, Scattering problems.

(**This course is meant for PhD Students as a part of their course work**)

PHY G521 Nuclear and Particle Physics 5

Course description for the above course is to be developed.

PHY G531 Selected Topics in Solid State Physics 5

Schrodinger Field Theory (2nd Quantized formalism), Bose and Fermi fields, equivalence with many body quantum mechanics, particles and holes, Single particle Green functions and propagators, Diagrammatic techniques, Application to Fermi systems electrons in a metal, electron-phonon interaction) and Bose systems (superconductivity, superfluidity).

PHY G541 Physics of Semiconductor Devices 5

Electrons and Phonons in Crystals; Carrier dynamics in semiconductors; Junctions in semiconductors (including metals and insulators); Heterostructures; Quantum wells and Low-dimensional systems; Tunnelling transport; Optoelectronics properties; Electric and magnetic fields; The 2d Electron gas; Semiconductor spintronic devices

M.E. Sanitation Science, Technology and Management

SAN G511 Sanitation Technology 3 2 5

This course aims to give the participants a review ofthe fundamentals as well as the latest technologicaldevelopments applied in the field of sanitation. UrbanDrainage and Sewerage, Carbon, nitrogen andphosphorus removal & recovery; sludge treatment, Siteevaluation; toilets; onsite sanitation systems; emptyingand transport; established and transferring technologiesfor dewatering, stabilization, pathogen inactivation andnutrient management, urban low cost drainage,Innovation processes, Intro & Exercise technologyselection tool / decision support system; discussoutcomes.

SAN G512 Sanitation and Public Health 3 2 5

This course will have four modules – Introduction toSanitation, Sanitation system and services, PublicHealth and Analysis of sanitation flow. Background onurban sanitation, Material flow analysis, Monitoringframeworks, Shit Flow Diagrams, Human HealthHazards and Waste, Review and Assessment ofTransmission Routes, Review and Assessment ofTransmission Routes, Disease Cycles – Lifecycles &Vectors, Control Measures, Risk Evaluation Tools,Urban development trends, demography, Urbansanitation planning & programming

SAN G513 Sanitation Governance, Behaviour Change andAdvocacy 5*

This particular course will have two modules –Sanitation Governance and Behaviour change &Advocacy. Water & sanitation governance: definitions,debates, controversies, Power relations among actorsin the local and global levels: Gender, class & racerelations and power asymmetries, Practices ofcoordination & decision, making around contestedwater distribution, Case studies on regulatoryframeworks around the world – how is sanitationmanaged: where, how and why, Everyday sanitationfrom different perspectives. Behaviour with referenceto Societal and cultural aspects, Types: Knowledge,motivations and reactions, Reinforcements: Norms andbehaviour Settings

SAN G514 Sanitation Financing and Project Management 5*

This course will have two modules – SanitationFinancing and Project Management. Introduction tofinancial viability, CAPEX, OPEX, business modelsand PPP of sanitation project, Calculating CAPEX andOPEX of a sanitation project and developing abusiness model, Local authority/municipal budgetingand public/government financing, Key aspects ofproject management including stakeholders'relationship, people management, risk management,budget management, reporting, Objective OrientedProject Planning.

SAN G515 Emergency Sanitation and Leadership 5*

This course will have two modules – EmergencySanitation and Leadership. The evolution ofhumanitarian aid: historical events and thehumanitarian system as it stands today. Overview ofthe international legal framework (Refugee law,International Humanitarian Law-IHL, InternationalDisaster Relief Law-IDRL), code of conduct andguiding principles of humanitarian action. Standardsapplied by relief agencies and global cluster, Sphere,WASH cluster. Disaster cycle, risk reduction/response/ recovery/ development, emergency responsephases. Overview of relief organizations, theirmandates, their commitments and priorities inemergencies.

Sanskrit

SANS F111 Sanskrit 3 0 3

Simple pieces of Sanskrit prose and poetry to be used for teaching the basic construction of Sanskrit words and sentences. The

course will aim at making the student read elementary Sanskrit like a Subhashita Sloka or a Sloka from Ramayana or Mahabharata and be able to understand it with the help of a dictionary.

Russian

RUS N101T Beginning Russian 3 0 3

Basic grammar; vocabulary; reading practice; translation of simple passages.

Not available for meeting the requirements of any programme except as prerequisite for another Russian course. Can be taken only on audit

RUS N102T Technical Russian 3 0 3

Prerequisite: RUS N101T

Phrases and sentence patterns in technical literature; special technical vocabulary; reading and translation of current technical literature from Russian to English with the help of a dictionary. This course is designed to meet the foreign language requirement of the Ph.D. programme. Can be taken only on audit

Skill Area

SKILL G611 Computer Operation and Software Development I 5

SKILL G612 Computer Operation and Software Development II 5

These two courses to be offered in two successive semesters will aim to develop the computer skills for running program packages and writing and developing software programmes for as wide areas as possible. Areas would include both the developmental processes involved in innovative education and of academic and applied research.

The operation of and evaluation in the courses would be done through seminars, group discussions, log books and programme outputs. One component of the evaluation will invariably consist of a lengthy involvement on an intricate task.

SKILL G621 Computer Maintenance I 5

SKILL G622 Computer Maintenance II 5

These two courses, to be offered in two successive semesters, will aim to develop the skill for maintenance of computer systems. Through these courses the student would be required to acquire a competence of planned and preventive maintenance, trouble shooting safety procedures etc. If required the student may be asked to undergo part of his training in established computer maintenance organisations. The operation and the evaluation of this course would be achieved through practicals, log books, seminars, quizzes etc. One component of the evaluation will invariably consist of a lengthy involvement on an intricate task.

SKILL G631 Professional Communication I 5

SKILL G632 Professional Communication II 5

These two courses, to be offered in two successive semesters, will aim at imparting communicative competence and demand training in the art of teaching and development of subject matter pertaining to the overall goal of the programme. The courses will operate on unstructured basis and would be monitored by a team of teachers identified for the purpose. Professional Communication II will be a project Course and must coterminate with a project report.

SKILL G641 Modern Experimental Methods I 5

SKILL G642 Modern Experimental Methods II 5

These two courses to be offered in two successive semesters will impart experimental skills in modern areas of interest to the Institute. Emphasis will be laid on operation and use of sophisticated instruments. The organisation and evaluation of these courses would be achieved through practicals, demonstrations, discussion on significance of results, seminars, quizzes etc. One component of evaluation will invariably be full finding of lengthy assignments. These courses will be conducted by a team of teachers who will incorporate professional competence into experimental method taken up for study.

SKILL G651 Techniques in DevelopmentManagement I 5

SKILL G652 Techniques in Development Management II 5

These two courses, to be offered in two successive semesters, will aim to lead a student into the theory and practice of activities connected with innovation, institutional change and development of teaching and research. Actual cases would be included from BITS. New cases are to be developed. The power of analysis design of models would be the main thread of treatment in these courses. These courses will be operated by a team of teachers. The organisation and evaluation would be achieved through practicals, log books, seminars, quizzes etc. One component shall invariably be a full finding of a lengthy assignment on a particular instrument (Technique) or their use in a larger context of teaching and research.

SKILL G661 Research Methodology I

SKILL G662 Research Methodology II 5

These two courses, to be offered in two consecutive semesters, are designed to impart training in methodology of research such as analysis of research problems, mathematical and statistical analysis of data, computer simulation methods, experimental techniques etc. The actual contents of these courses will depend upon the needs and research goals of a particular student. A project report has to be submitted by each student at the end of each course.

The organisation and evaluation of these courses would be achieved through seminars, group discussions, project reports etc. The courses will be conducted by a team of teachers.

Note: All the above mentioned Skill courses will be 'Unstructured' in the sense that they would be completely of 'non- lecture, type but would require committed involvement in the concerned professional engagement. Each course is a combination of two course numbers I & II running in two successive semesters where grades would be awarded for the two components separately. While normally a student will be required to take I & II, in rare occasions he may be asked to take only Course No. I depending on his prior preparation and the ultimate goal to be achieved through the programme. No student can register I and II of the same course concurrently in a semester. Where there is sufficient academic justification to meet the goals of these courses, the Dean Instruction may permit delayed registration in course No. II or in the pair of courses.

Software Systems

SS G511 Design and Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

SS G512 Object Oriented Programming 4

Basics of object oriented programming: objects, classes, instances; inheritance; polymorphism; operator overloading; static and dynamic binding; small talk, C++, cases from other object oriented languages like Ada, Loop, Flavors, Objective-C, etc.; object oriented software engineering.

SS G513 Network Security 3 1 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, securitystandards, security system interoperation and case studies of the current major security systems.

SS G514 Object Oriented Analysis and Design 2 2 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SS G515 Data Warehousing 3 2 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SS G516 Computer Organization & Software Systems 5

Programmer model of CPU; Basic concept of buses and interrupts; Memory subsystem organization; I/O organization; Concept of assembler, linker & loader; Types of operating systems; Concept of process; OS functions: Process scheduling, Memory management, I/O management and related issues.

SS G517 Data Structures & Algorithm Analysis 5

Abstract data types; Linear data structures; Hash functions, Binary and other trees, traversal algorithms; Heaps and balanced trees; Sorting and searching techniques; Divide and conquer, recursion, backtracking, branch and bound; Computational complexity and bounds.

SS G518 Database Design & Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SS G519 Social Media Analytics 3 1 4

Basics of social media, its modelling & representation, node classification, community detection, user behaviour, herd behaviour, influence, recommendations in SM, controversy detection, sarcasm detection, fake post detection, behavioural analysis, SM driven problems such as mental health, spreading rumours, etc.

Equvalent: CS G519

SS G520 Advanced Data Mining 3 1 4

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

SS G521 Fourth Generation Languages and Applications 4

Nature of 4GLs; application generators; RDBMS and 4GLs; SQL based 4GLs; 4GLs and development of information systems and decision support systems; other types of 4GLs; case studies.

SS G522 Software Development Standards 4

Standards and their role in software development; Institutions involved in formulating and promoting standards; operating environment standards; POSIX; software design standards; diagramming standards; coding standards; language design, code generation and usage standards; software portability and standards; standards in software development tools; standards in compilers and interpreters; open systems; OSI; user interface standards.

SS G523 Software for Embedded Systems 3 2 5

Real-time and embedded systems; software issues in embedded system; software development process; requirement analysis: use cases, identification and analysis of use cases, use case diagrams; design: architectural design, design patterns and detailed design; implementation: languages, compilers, runtime environments and operating systems for embedded software; testing: methodologies, test cases. The course will also consist of laboratory practices and development of software for embedded systems.

SS G527 Cloud Computing 5

Review of Distributed computing - Concurrency, message passing, connectivity and failure models, replication. Computing Infrastructure - Processing Power, Storage aggregation, I/O & Communication, Clusters and Data Centers. Resource modeling and virtualization - CPU virtualization, memory and storage virtualization, virtualized networks. Services - Service models and service contracts; Programming on the cloud. Cloud Applications - Software on the Cloud and Infrastructure Services. Cloud infrastructure - Private vs. Public Clouds, Resource scaling and Resource provisioning. Quality of Service - Performance models, scalability, Performance measurement and enhancement techniques. Security issues - Data/ Storage Security, Resource Access Control, Process Isolation and Control, Service Policies and Privacy Issues.

SS G531 Pervasive Computing 4*

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

SS G532 Information Theory 4

Course description is same as given under BITS G532.

SS G541 User Interfaces 4

SS G542 Knowledge Management 3

Increasing knowledge work in organizations; technologies to support growth of knowledge work in organizations; scope, cost, efficiency and reliability of technologies to support knowledge work; role of knowledge in an enterprise; knowledge management process; knowledge management strategies; human aspects of knowledge management; knowledge management technologies; applications of technologies to be covered through cases; reading assignments and use of appropriate software.

SS G551 Advanced Compilation Techniques 5

Generic Code Optimization Techniques - loop optimization, inlining, and other transformations. Impact of architectures on code generation and optimization: RISC architectures, VLIW architectures, special-purpose architectures. Architecture-specific code optimizations – register allocation, instruction scheduling. Code Optimizations under real-time / embedded constraints - cacheless / diskless memory models, bounded time responses. Garbage Collection Techniques. Virtual Machines and Just-in-Time Compilation techniques - HotSpot-like optimizations. Implementation of exception handling, concurrency, and generic jumps (like call/cc).

SS G552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools, functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SS G554 Distributed Data Systems 3 2 5

Distributed File Systems - File System Models; Replication and Synchronization - Caching; Failure & Recovery; File System Security. Distributed Databases - Distributed Data Sources and Updates; Database Connectivity; Concurrency Control and Distribution mechanism; Distributed indexing schemes. Database security. Data on the Web - Web as a distributed data repository. Data Collection and Use Crawlers, Search Engines, and Indexing Schemes. Information Retrieval Techniques.

Data Exchange - Hierarchical Data Models, XML, and query languages. Semi-structured / Unstructured data -querying and synchronization.

Pervasive Data - Data distribution and access for non-computing devices, small computing devices, embedded computing devices

and sensory devices.

SS G562 Software Engineering & Management 5

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SS G624 Computer Based Simulation and Modlling 5

Discrete event simulation on computers; Systems simulation & simulation languages; GASP & GPSS; Continuous simulation - languages and modelling techniques; Forrester's models; case studies.

SS G641 Management Information and Decision Support Systems 5

Data & information; characteristics of information; components of management information systems; information flows; design and maintenance of management information systems; decision support systems.

SS G651 Project Formulation and Preparation 5

This course is designed to inculcate principles of technical documentation as required within S&T organizations. Through this course, students are expected to acquire familiarity with several of the following: Proposals, feasibility reports, formal project reports, short reports, memos, negotiations, contracts, etc. In the process principles of project formulation and evaluation, such as technical considerations; performance specifications; preliminary block diagrams, types and analysis of contracts; cost estimation concepts, work breakdown structure; project data preparation, scheduling facilities etc., would be introduced. The course would invariably include the preparation of a detailed report embodying as many of the above concepts as appropriate.

SS G653 Software Architectures 3 2 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

PART VII
COURSE DESCRIPTIONS
(Work Integrated Learning Programmes)

Course descriptions for Work-Integrated Learning & Collaborative Programmes

AAOC ZC111Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

AAOC ZC221 Graphs and Networks 3

Basic concepts of graphs and digraphs behind electrical communication and other networks behind social, economic and empirical structures; connectivity, reachability and vulnerability; trees, tournaments and matroids; planarity; routing and matching problem; representations; various algorithms; applications.

AAOC ZC222Optimization 3

Optimization of functions of one and many variables with and without constraints; Kuhn-Tucker conditions; gradient methods; linear programming; simplex based and integer programming methods; duality theory; transportation and assignment problems; dynamic programming; branch and bound methods; models of linear production systems, sequencing and scheduling, PERT, CPM.

AE* ZC442 Advanced Driver Assistance Systems 4

Automotive safety systems, assist and autonomous systems, automotive sensors and actuators for ADAS (stereo and mono cameras ultrasonic sensors, LIDAR, RADAR), fundamentals of machine vision, data fusion for ADAS, mechatronics for ADAS, human – machine interface for ADAS, telematics and infotainment, ADAS system, legal and ethical aspects of ADAS, real time systems and development, advanced driver assistance systems, advanced computer systems, automated driving applications and systems.

AE* ZC443 Connected Cars 4

Fundamentals of IOT - Architecture, Sensors, Cloud and the trade-off between polling and storage requirements, Structure and implementation of CAN networks, CAN message, priority & arbitration and the control hardware involved in the network, data analytics by creating a simple data model using OBD tools, ethical and legal aspects of connected car applications including data theft, privacy and security vulnerabilities, building of predictive analytic model based on in-vehicle data.

AE* ZG510 Automotive Control Systems 5

Introduction to vehicle electronics, semiconductor diodes, FETs, rectifiers, small signal amplifiers, circuit models, automotive applications and case studies, automotive micro controllers, auto sensors and actuators, vehicle electronics, feedback control, control strategy, analog and digital controllers, expert systems and neural networks, advanced topics in EMC, vehicle communication networks, automotive control system design, transmission and powertrain, brake, traction, suspension, active safety and supplementary restraint systems, intelligent vehicle systems and ADAS.

AE* ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

AE* ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

AE* ZG513 Maintenance Engineering 5

Introduction, maintenance systems, methods and tools of maintenance analysis, eligibility and safety, maintainability, supportability, design for maintenance, maintenance integration, computerized maintenance management systems, TPM, world-class maintenance systems, and maintenance effectiveness and performance evaluation.

AE* ZG514 Advanced Automotive Systems 4

Frame, suspension, springs and wheels, clutch and gear box, propeller shaft, universal joint, final drive, differential and rear axle, front axle and steering mechanism, brakes, automotive air conditioning, electrical vehicles, automotive electrical systems, automotive electronics systems.

AE* ZG515 Non-Destructive Testing 5

Ultrasonic testing, X-radiography, eddy current testing, magnetic methods of crack detection, liquid penetrant inspection, acoustic emission and acousto-ultrasonic testing techniques.

AE* ZG516 Advances in Internal Combustion Engines 4

Air standard cycles, fuel air cycles, actual cycles and their analysis, fuels, alternative fuels, carburetion, mechanical and electronic injection systems, ignition, combustion and combustion chambers, engine friction and lubrication, heat rejection and cooling, engine emissions and their control, measurements and testing, performance parameters and characteristics, engine electronics, supercharging, two-stroke engines. Power-train auxiliary systems integration, newer engine technologies such as hybrid engines.

AE* ZG517 Automotive Systems Engineering 4

Automotive systems development and testing, compatibility issues, performance prediction, design requirements and engineering metrics, systems engineering process, life cycle standards and management, concurrent engineering, systems analysis applications, and advanced model based development.

AE* ZG518 Electric and Hybrid Vehicles 4

Electric motors, drives, control, batteries, architectures, energy storage, recovery, and management, characteristics of autonomous vehicles, modelling, simulation, analysis and comparison of relations among multiple parameters for electric, hybrid and autonomous vehicles, insights into regulations and norms with respect to electric, hybrid and autonomous vehicles, hybrid vehicle propulsion systems, sustainable automotive power technology.

AE* ZG519 Automotive Security 4

Security concepts, security attacks and risks, architectures, policy management, mechanisms, understanding the risks and advantages of vehicle to internet (V2I), vehicle to vehicle (V2V), vehicle to IoT (V2IoT) connectivity, issues concerning the security of intelligent transport systems that communicate with the vehicle, telematics, cryptography, security standards, security system interoperation and case studies of the automotive security systems and connectivity technologies, automotive cyber security and autonomous vehicles, connected vehicle driver responsibility, issues around liabilities related to automotive cyber security incidents.

AE* ZG520 World Class Manufacturing 5

The world-class manufacturing challenge, developing a world-class manufacturing strategy, just-in-time, total quality, total employee involvement, world-class information systems, managing the change, methods and procedures; improved brainstorming methods, using the check-total quality - the first steps, getting people involved, monitoring world-class performance.

AE ZG521 Power Electronics and Drives 4

Introduction to power electronic switches, semiconductor switches- SCR, MOSFET, IGBT, DIODE, SiC based devices, introduction to gate drive, power electronic converters - rectifiers (controlled and uncontrolled), DC-DC converters – buck, boost, buck-boost, cuk, isolated converters – design and topologies, Inverters – VSI and CSI (single phase and three phase), PWM techniques, Introduction to drives – Motors for xEVs, comparison of motors and ICE, control strategies

AE* ZG522 Advanced Vehicle Acoustics 4

Fundamentals of noise sources, transfer paths, principles of noise and vibrations control, assessment and control of engine noise and vibration, road / tyre noise, vehicle body noise and vibration, evaluating the vibration and acoustic characteristics of future vehicle systems.

AE* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

AE* ZG524 Vehicle Dynamics 4

Fundamentals of vehicle dynamics, steering, single and two degree-of-freedom systems, vibration isolation, absorbers, anti- vibration mounts, exhaust mount, tire properties, influence on vehicle dynamics, tire forces/moments & kinematics, modified SAE tire axes & terminology, introduction to tire modeling ,suspension and steering effects , basic tire modeling consideration, brush tire model, steady state lateral/longitudinal slip force generation, interaction between lateral slip and longitudinal slip, transient tire forces, steady state cornering stability analysis, handling diagram, quasi steady state cornering, straight line braking stability analysis, transient cornering dynamic cornering, principles of anti-lock braking system (ABS), steady state cornering of single unit heavy trucks, effect of tandem axles and dual tires, equivalent wheelbase handling diagram of complex vehicles, vehicle parameters and states estimation, road and basic driver models principles, basic powertrain, modeling, brake system modeling, electronic stability control (ESC), vibration mounts, construction and heavy engineering equipment.

AE* ZG531 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

AE* ZG532 Computer Aided Engineering 5

Mathematics and computer implementation methodologies of parametric geometric modeling for computer aided design including modeling of curves, surfaces, solids and NURBS, geometric transformations, concepts of elasticity and material behavior, theories of failure, finite element analysis (FEA) of one-, two- and three-dimensional problems with special emphasis on the application areas of noise and noise, vibration and harshness (NVH), durability, crash, occupant safety, computational fluid dynamics (CFD) and heat transfer, FEA of mechanical vibrations and fracture. In all implementation work and assignments, suitable commercial CAE software packages such as ABAQUS is required to be used.

AE ZG533 Autotronics 5

Fundamentals of automotive EMC, control concepts, control design with the help of sensors and signal conditioning. Understanding of autotronics and vehicle intelligence, sensor technologies, intelligent systems and mechatronic modelling. Introduction, electricity and electronic fundamentals, sensors, sensor types, signal conditioning, system modelling, dynamic response of systems, feedback/closed loop controllers, electronic fuel control systems, actuators: fuel injectors, exhaust gas recirculation, motors and ignition systems, hydraulics.

AE* ZG535 Advanced Engineering Mathematics 5

Boundary value problems; wave equations; nonlinear partial differential equations; calculus of variations; Eigen value problems; iteration problems including forward and inverse iteration schemes – Graham Schmidt deflation – simultaneous iteration method – subspace iteration – Lanczo's algorithm – estimation of core and time requirements.

AE* ZG542 Just-in-time Manufacturing 4

Introduction; Toyota production system; JIT implementation surveys; Design, development and implementation of JIT manufacturing systems; Supply management for JIT; Framework for implementation of JIT; Theoretical research in JIT systems; Various case studies.

AE ZG557 Artificial and Computational Intelligence 5

Agents and environments, Task Environments, Working of agents; Uninformed Search Algorithms: Informed Search. Local Search Algorithms & Optimization Problems: Genetic Algorithm; Searching with Non-Deterministic Actions, Partial Information and Online search agents, Game Playing, Constraint Satisfaction Problem, Knowledge Representation using Logics: TT-Entail for inference from truth table, Proof by resolution, Forward Chaining and Backward Chaining, Inference in FOL, Unification & Lifting, Forward chaining, Backward Chaining, Resolution; Probabilistic Representation and Reasoning : Inference using full joint distribution, Representation of Conditional Independence using BN, Reinforcement Learning; Difference between crisp and fuzzy logic, shapes of membership function, Fuzzification and defuzzification, fuzzy logic reasoning; Decision making with fuzzy information, Fuzzy Classification; Connectionist Models: Introduction to Neural Networks, Hopfield Networks, Perceptron Learning, Backpropagation & Competitive Learning, Applications of Neural Net: Speech, Vision, Traveling Salesman; Genetic Algorithms - Chromosomes, fitness functions, and selection mechanisms, Genetic algorithms: crossover and mutation, Genetic programming.

AE* ZG611 Computational Fluid Dynamics and Heat Transfer 4

Integral and differential conservation laws for mass, momentum, and energy, solution of Navier-Stokes equations, theory of potential flow, boundary layer theory, hydrodynamic stability turbulent flow, compressible flow quasi-one-dimensional nozzle flows numerical solution of a two-dimensional supersonic flow, incompressible Couette flow. supersonic flow over a flat plate, experimental techniques and uncertainty analysis, integral and differential forms of energy conservation law for heat transfer, heat transfer in internal laminar and turbulent flow, heat transfer in external laminar and turbulent flow, natural convection heat transfer, mixed convection heat transfer, convective heat transfer in porous media flow, condensation, evaporation, and boiling. radiation heat transfers in non-participating and participating media. radiation transport equation, heat transfer of engine cooling, exhaust manifold and HVAC for automobiles, computational analysis of fluid flow, heat transfer and multi-phase flow problems with special emphasis on problems relevant to automotive applications.

AE* ZG612 Advances in Materials, Composites & Plastics 4

Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fiber reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibers, concept of microfibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture toughness and fatigue; properties of fibre reinforcement and production technology of composites. Plastics and their processing technology including injection moulding, blow moulding etc. Mathematical modeling and simple computational techniques for the mechanics of composites and plastics. Applications of plastics and composite in automotive and aerospace structures. Advanced metals and alloys including titanium, aluminum and magnesium, Ceramic and metal alloys (CERMETS) including Aluminum based alloys and other ceramic components.

AE* ZG613 Tribology 5

Introduction, lubricants and lubrication, surface texture, bearing materials, fundamentals of viscous flow, reynolds equation and applications, thrust bearings, journal bearings, squeeze-film bearings, hydrostatic bearings, gas bearings, dry and starved bearings, selecting bearing type and size, principles and operating limits, friction, wear and lubrication.

AE* ZG614 Fracture Mechanics 5

Introduction, energy release rate, stress intensity factor and complex cases, anelastic deformation at the crack tip, elastic plastic analysis through J-integral, crack tip opening displacement, test methods, fatigue failure, numerical analysis, mixed mode crack initiation and growth.

AE* ZG615 Advanced Engine Technology 5

Engine Design & Development: Design and development of various engine components viz. cylinder block, head, combustion chamber, pistons, crank shaft, connecting rod, cam shaft, valves, intake and exhaust systems, fuel supply systems, Engine balance and vibration; Engine Combustion: Process, analysis and diagnostics; Engine Emissions & Controls: Analysis of gas emissions and control; Alternate Fuels: Alternative Fuels for Land, Rail, Marine and Aviation Transportation, Utilization of Alternative Fuels in Internal Combustion Engines; Engine Testing & Certification: Test facilities and methods, Instrumentation, Engine tests and quality standards; Vehicle Component Testing: Test facilities and methods for interior and exterior parts of an automotive vehicle.

AE ZG616 Applied Digital Signal Processing 5

Introduction; continuous time and discrete time signals and their Fourier analysis; discrete and continuous Fourier transform; convolution, filtering, modulation, sampling and reconstruction of signals; digital filter design; digital filters; multirate digital signal processing; random signal, correlation and power spectra; automotive applications

AE* ZG621 Durability, Crash and Safety Engineering 4

Classical failure theory ,creep, fatigue, buckling, low and high cycle fatigue test, crack initiation and fracture mechanics, Effect of surface and metallurgical parameters on fatigue, EN-SN curves, plasticity corrections, Road load acquisition methods/instruments, Proving ground events & duty cycle preparation accordance with vehicle GVW, Joint Design, bolt slippage & torque relaxation methods in FEM. Durability of plastics - material failure criteria, Rattle & squeeze issues in automotive trims, IP panels. Optimization techniques/algorithms - Influence of space, size, weight etc., on form design, aesthetic and ergonomic considerations, Fundamentals of Crash Analysis, Transient Dynamic solutions, Lagarangian and Eulerian codes of solution, explicit and implicit methods of solving crash problems, crash worthiness, Contact theory and algorithms, Quasi-static and dynamic events for crash analysis, time-step computation and mass scaling of models, different element types, formulations and application, Material representations for Crash analysis, Human modeling and biomechanics, Human injuries and remedies, Impact sensor, types and developments, Active and Passive safety, Regulations for Automotive safety, Crash Worthiness Ratings, Model building and integration, Quasi-static load cases – Roof Strength, side door intrusion, Seating load cases, Internal head impacts, Whiplash, Airbag – types, modeling and applications.

AE* ZG622 Advanced Manufacturing Processes 4

High strength material forming, tooling for high strength materials, Cold and hot stamping, hydro forming, vacuum forming, high speed stamping, Aluminum forming & tooling technology including progressive and transfer dies for sheet metal forming, Advanced Automotive BIW assembly/welding technology, laser welding technology, robotic hemming. Tooling for lightweight composites, Carbon fibre moulds & advanced plastic moulding technology, High speed machining, precision machining technology, Resistance welding. Aluminum part manufacturing technique including die casting, tailor-made blanking etc. Mathematical modelling and analytical and numerical computations for sheet metal forming processes using AutoForm. Newer sheet metal forming techniques.

AE ZG623 Safety Critical Advanced Automotive Systems 4

Functional safety, safety in electrical engineering, architecture / design practices for safety critical systems, ISO 26262: Road vehicles – functional safety, IEC 1508 standards; Methodology of certification and qualification for IEC 1508, modelling real time systems (UML-RT, and the tools), reliable, common system bus – VME, ASCB, safeBus, multiBus II etc. Real time and safety standard and certifications, FPGA and ASIC based design, low-power techniques in RT embedded systems on-chip networking; Hardware software partitioning and scheduling, co-simulation, synthesis and verifications, architecture mapping, HW-SW interfaces.

AE* ZG629T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

AE ZG631 Automotive Diagnostics and Interfaces 5

Sensors used in today's vehicles, such as temperature, pressure, position, distance, velocity, torque and flow; Designing and building analogue interfaces, regulation and control problem with reference to power electronic converters; converter models for feedback: basic converter dynamics, fast switching, piece-wise linear models, discrete-time models, On board diagnostics II (OBD II); Voltage mode and current mode controls for DC-DC converters, comparator based control for rectifier systems, proportional and proportional-integral control applications; Control design based on linearization: transfer functions, compensation and filtering, compensated feedback control systems; Hysteresis control basics, and application to DC-DC converters and inverters; Automotive diagnostics, electronic interfaces, sensors and interfacing, introduction to microsystems packaging, microcomputer control systems, reliability, diagnostics, and testing of vehicles.

AE* ZG633 Advances in Vehicle Body Structures 4

Light Weight design of Vehicle Structure i.e. Front-End, Under Body etc; Materials Selection in Automotive Design; Material Matching and gauge Optimization; Lightweight Automotive Alloys; Mechanical Behaviour of Structural Polymers; Designing and Manufacturing with Lightweight Automotive Materials; Design and Manufacturing for Environment – Light Weight material perspective; Vehicle Crashworthiness - Light Weight material perspective; Advanced Light Weight Steels for Automobiles; Fuel Cell Materials and Manufacturing; Automotive Assembly Processes - Light Weight material perspective; Analysis of Lightweight Automotive Structures; Light Weight Power-train Materials and Design; Environmental Degradation of Materials - Light Weight material perspective; Application of Hybrid material and Joining methods.

AEL* ZC441 Automotive Vehicles 3

Internal combustion engines; vehicle performance; analysis and design of vehicle components. Experimental or theoretical investigation of problems selected from the field of automotive vehicles.

AEL* ZC442 Advanced Driver Assistance Systems 4

Automotive safety systems, assist and autonomous systems, automotive sensors and actuators for ADAS (stereo and mono cameras ultrasonic sensors, LIDAR, RADAR), fundamentals of machine vision, data fusion for ADAS, mechatronics for ADAS, human – machine interface for ADAS, telematics and infotainment, ADAS system, legal and ethical aspects of ADAS, real time systems and development, advanced driver assistance systems, advanced computer systems, automated driving applications and systems.

AEL* ZC443 Connected Cars 4

Fundamentals of IOT - Architecture, Sensors, Cloud and the trade-off between polling and storage requirements, Structure and implementation of CAN networks, CAN message, priority & arbitration and the control hardware involved in the network, data analytics by creating a simple data model using OBD tools, ethical and legal aspects of connected car applications including data theft, privacy and security vulnerabilities, building of predictive analytic model based on in-vehicle data.

AEL* ZG510 Automotive Control Systems 5

Introduction to vehicle electronics, semiconductor diodes, FETs, rectifiers, small signal amplifiers, circuit models, automotive applications and case studies, automotive micro controllers, auto sensors and actuators, vehicle electronics, feedback control, control strategy, analog and digital controllers, expert systems and neural networks,advanced topics in EMC, vehicle communication networks, automotive control system design, transmission and powertrain, brake, traction, suspension, active safety and supplementary restraint systems, intelligent vehicle systems and ADAS.

AEL* ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

AEL* ZG513 Automotive Communication Systems 5

Introduction to communication engineering; automotive communication systems: basic, current and future generation automotive communication protocols and telematics, advanced communication, intersystem communication and multiplex systems, wireless and photonics systems engineering, communications and networking, signal propagation in a mobile environment, modulation, coding, equalization, multiple access techniques, spread spectrum systems, second and third generation systems, UMTS, IMT-2000; Intra Vehicular Buses - CAN, TTCAN, FTTCAN, RT and FT Ethernet, TTP/A, TTP/C, Flexray, LIN, MOST; Clock Synchronization and Diagnostic Services in Intra Vehicular Buses.

AEL* ZG514 Robust and Intelligent Systems Design 5

Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems, configurations, design aspects, intelligent transport systems, neural networks and fuzzy logic, reconfigurable hardware system design, energy aware computing systems.

AEL* ZG517 Automotive Systems Engineering 4

Automotive systems development and testing, compatibility issues, performance prediction, design requirements and engineering metrics, systems engineering process, life cycle standards and management, concurrent engineering, systems analysis applications, and advanced model based development.

AEL* ZG518 Electric and Hybrid vehicles 4

Electric motors, drives, control, batteries, architectures, energy storage, recovery, and management, characteristics of autonomous vehicles, modelling, simulation, analysis and comparison of relations among multiple parameters for electric, hybrid and autonomous vehicles, insights into regulations and norms with respect to electric, hybrid and autonomous vehicles, hybrid vehicle propulsion systems, sustainable automotive power technology.

AEL* ZG519 Automotive Security 4

Security concepts, security attacks and risks, architectures, policy management, mechanisms, understanding the risks and advantages of vehicle to internet (V2I), vehicle to vehicle (V2V), vehicle to IoT (V2IoT) connectivity, issues concerning the security of intelligent transport systems that communicate with the vehicle, telematics, cryptography, security standards, security system interoperation and case studies of the automotive security systems and connectivity technologies, automotive cyber security and autonomous vehicles, connected vehicle driver responsibility, issues around liabilities related to automotive cyber security incidents.

AEL* ZG531 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

AEL* ZG533 Autotronics 5

Fundamentals of automotive EMC, control concepts, control design with the help of sensors and signal conditioning. Understanding of autotronics and vehicle intelligence, sensor technologies, intelligent systems and mechatronic modelling. Introduction, electricity and electronic fundamentals, sensors, sensor types, signal conditioning, system modelling, dynamic response of systems, feedback/closed loop controllers, electronic fuel control systems, actuators: fuel injectors, exhaust gas recirculation, motors and ignition systems, hydraulics.

AEL* ZG534 Automotive Networking 4

Overview of TCP/IP systems, Disturbed and Networked Embedded systems, Embedded Internet, Real Time Networks and Fault Tolerant Networks – Issues and Design, Intelligent Transport Systems and IoT for Automotive Systems; Fault and Error Containment, Intra and Interworking in Vehicular Systems: Intra Vehicular Buses - an overview, Time Triggered and Event Triggered Networks in Intra Vehicular Systems, Automotive Network Domains – Power Train, Chassis, Body Domains – Network Characteristics and Domain Requirements, V2I/V2R, V2V , VANETS - MANETS vs VANETS, Safety Applications vs Comfort Applications of VANETS, Network Architecture, Protocols, Network Stack, MAC protocols, IEEE Wave and DSRC, Routing Protocols, Network Security – Attacks and Solutions. Emerging and

advanced automotive networks – Aerial Networks; Interconnection between various networks in ITS – Interconnection between Intra and Inter Vehicular Systems, Network Models in Automotive Systems – Publisher Subscriber Model, Producer Consumer Models, Device Interoperability Issues in Interconnected Vehicles, Middleware in Automotive Systems, Network Management Function, Objects and Device Management - AutoSar and Networked OS; Protocol-independent design methodology for distributed real-time networks in vehicles – Volcano.

AEL* ZG554 Reconfigurable Computing 5

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and Switch Networks. Design and Synthesis of Combinational and Sequential Elements. Placement and Routing. Pipelining and other Design Methodologies. Fine-grained and Coarse-Grained FPGAs. Static and Dynamic Reconfiguration. Partitioning. Hardware/Software Portioning and Partial Evaluation; Systolic Architectures.

AEL* ZG557 Artificial and Computational Intelligence 5

Agents and environments, Task Environments, Working of agents; Uninformed Search Algorithms: Informed Search. Local Search Algorithms & Optimization Problems: Genetic Algorithm; Searching with Non-Deterministic Actions, Partial Information and Online search agents, Game Playing, Constraint Satisfaction Problem, Knowledge Representation using Logics: TT-Entail for inference from truth table, Proof by resolution, Forward Chaining and Backward Chaining, Inference in FOL, Unification & Lifting, Forward chaining, Backward Chaining, Resolution; Probabilistic Representation and Reasoning : Inference using full joint distribution, Representation of Conditional Independence using BN, Reinforcement Learning; Difference between crisp and fuzzy logic, shapes of membership function, Fuzzification and defuzzification, fuzzy logic reasoning; Decision making with fuzzy information, Fuzzy Classification; Connectionist Models: Introduction to Neural Networks, Hopfield Networks, Perceptron Learning, Backpropagation & Competitive Learning, Applications of Neural Net: Speech, Vision, Traveling Salesman; Genetic Algorithms - Chromosomes, fitness functions, and selection mechanisms, Genetic algorithms: crossover and mutation, Genetic programming.

AEL* ZG621 Safety Critical Advanced Automotive Systems 4

Functional safety, safety in electrical engineering, architecture / design practices for safety critical systems, ISO 26262: Road vehicles – functional safety, IEC 1508 standards; Methodology of certification and qualification for IEC 1508, modelling real time systems (UML-RT, and the tools), reliable, common system bus – VME, ASCB, safeBus, multiBus II etc. Real time and safety standard and certifications, FPGA and ASIC based design, low-power techniques in RT embedded systems on-chip networking; Hardware software partitioning and scheduling, co-simulation, synthesis and verifications, architecture mapping, HW-SW interfaces.

AEL* ZG626 Hardware Software Co-Design 5

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

AEL* ZG631 Automotive Diagnostics and Interfaces 5

Sensors used in today's vehicles, such as temperature, pressure, position, distance, velocity, torque and flow; Designing and building analogue interfaces, regulation and control problem with reference to power electronic converters; converter models for feedback: basic converter dynamics, fast switching, piece-wise linear models, discrete-time models, On board diagnostics II (OBD II); Voltage mode and current mode controls for DC-DC converters, comparator based control for rectifier systems, proportional and proportional-integral control applications; Control design based on linearization: transfer functions, compensation and filtering, compensated feedback control systems; Hysteresis control basics, and application to DC-DC converters and inverters; Automotive diagnostics, electronic interfaces, sensors and interfacing, introduction to microsystems packaging, microcomputer control systems, reliability, diagnostics, and testing of vehicles.

AEL* ZG628T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

AIML* ZC416 Mathematical Foundations for Machine Learning 4

Vector and matrix algebra, systems of linear algebraic equations and their solutions; Eigenvalues, eigenvectors and diagonalization of matrices, multivariate calculus, vector calculus, Jacobian and Hessian, multivariate Taylor series, gradient descent, unconstrained optimization, constrained optimization, nonlinear optimization, stochastic gradient descent, dimensionality reduction and PCA, optimization for support vector machines.

AIML* ZC418 Introduction to Statistical Methods 4

Basic probability concepts, Conditional probability, Bayes Theorem, Probability distributions, Continuous and discrete distributions, Transformation of random variables, estimating mean, variance, covariance, Hypothesis Testing, Maximum likelihood, ANOVA – single factor, dual factor, time series analysis: AR, MA, ARIMA, SARIMA, sampling based on distribution, statistical significance, Gaussian Mixture Model, Expectation Maximization.

AIML* ZG511 Deep Neural Networks 4

Introduction to neural networks, approximation properties, back propagation, deep network training, regularization and optimization, convolution neural networks, recurrent neural networks, attention models, transformers, neural architecture search, federated learning, meta learning, applications in time series modelling and forecasting, online (incremental) learning

AIML* ZG512 Deep Reinforcement Learning 4

Introduction and applications. Markov decision processes(MDP), Tabular MDP planning, Tabular RL policy evaluation, Q-learning, model based RL, deep RL with function approximation, policy search, policy gradient, fast learning, applications in game playing, imitation learning, RL for neural architecture search, batch RL

AIML* ZG513 Advanced Deep Learning 4

Introduction to Representation Learning, PCA and variants, likelihood based models, flow models, autoregressive models, latent variables, Deep autoencoders, Boltzmann Machines, Generative Adversarial learning, Variants of GAN and

applications, DeepDream, neural style transfer, self-supervised learning, semi-supervised learning, language model learning, applications in time series modelling, representation learning for reinforcement learning, deep clustering

AIML* ZG514 Graph Neural Networks 4

Basics of graph theory, machine learning on graphs, node embeddings, link analysis, representation learning for graphs, label propagation for node classification, empirical risk minimization, graph convolutional filters, composition with pointwise nonlinearities, permutations, dilation and stability, transferability, graph RNN, algebraic neural networks, applications of graph NN in subgraph mining, recommendation systems, community structures in networks, deep generative models, knowledge graph embeddings and reasoning.

AIML* ZG515 Distributed Machine Learning 4

Introduction to parallel and distributed models of computation: Scalable frameworks to parallelize machine learning algorithms, Data and computation heterogeneity, Data parallelism vs Model parallelism, Challenges: consistency, fault tolerance, communication, resource management, programming models; Distributed ML algorithms: K-means, DBSCAN, Distributed association rule mining: FDM, Linear and logistic regression; Distributed DL Algorithms: Gradient descent techniques for empirical risk minimization, SGD in Neural Network Training and its convergence analysis, Distributed Synchronous SGD, Asynchronous SGD, Hogwild, Local-update SGD, Decentralized SGD, Overlap SGD, Quantized SGD, Adacomm Vs Distributed SGD, Elastic Averaging, AdaSyn, AdaQuant; Federated learning: Privacy and security in federated learning; Hyper parameter optimization; In depth case studies of a few algorithms.

AIML* ZG516 ML System Optimization 4

Review of parallel and distributed systems, System Performance Trade-offs, Distributed machine learning for large models and datasets, general purpose distributed computing frameworks - Hadoop, map reduce and Apache Spark, Deep Learning frameworks and runtimes, deep learning hardware, Deep learning compilers with optimizations, scalable training and Inference Serving , parameter serving, Federated Learning, model compression for optimizing communication and resource constrained devices, Case studies of machine learning on single GPU systems, on GPU Clusters.

AIML* ZG517 Fair, Accountable, Transparent Machine Learning 4

Biases and fairness, fair representation learning, Interpretability and Transparency, Example and Visualization Based Methods for Interpretability, Interpreting deep neural networks, Fairness Through Input Manipulation, Fair NLP/Vision, Robustness and adversarial attacks/defence, ML auditing, privacy

AIML* ZG518 Computational Learning Theory 4

Introduction. The PAC model, Overfitting and Occam's razor, The Online Mistake-Bound model, Combining Expert Advice / Multiplicative Weights, Regret Minimization, sleeping experts, The Perceptron Algorithm, Margins, and introduction to Kernels. SVMs, Uniform Convergence and VC-Dimension, Rademacher Bounds. Boosting. Statistical Query Model, Computational Hardness Results for Learning. MDPs and Reinforcement Learning. Differential Privacy and Learning. Semi-Supervised Learning.

AIML* ZG519 NLP Applications 4

Sentiment Analysis, Grammar and Spelling Checkers, Cross Lingual Language Models, Machine Translation including Indic Languages, Question answering and Chatbots, Information extraction (named entity recognition, relation extraction), Knowledge graph.

AIML* ZG520 Speech Processing 4

Introduction to statistical speech processing. HMM, WFST and neural net based acoustic modelling, language modelling, acoustic feature analysis, neural networks for speech recognition, search and decoding, speech synthesis

AIML* ZG521 Conversational AI 4

Intro to conversational AI, Use cases of chatbots, NLU and Dialog Management, Design the flow of conversation, Crafting training data, Training the NLU model, Understanding Dialog Management, Intent classification and entity extraction, using slots for context understanding, Understanding NLU components, supporting multiple languages, Voice bots, Testing the bot, Failing gracefully with fall back action

AIML* ZG522 Social Media Analytics 4

Social Media Platforms, NLP in SMA, Text Summarization, Opinion Science and dynamics, ML/DL in SMA- Community detection, Ethical Social Media, Case Studies- Role of social media in disaster management, SM driven mental health and behaviour Analysis

AIML* ZG523 MLOps 4

Adaptation of DevOps for building and deploying machine learning systems, Model Deployment: Infrastructure requirements; Deployment patterns, Model CI/CD (Build, Test, Integration and Delivery of model); Model Serving tools and technologies; Model life cycle management, ML pipelines with data management support, model assessment, evolution and management in production, MLOps infrastructure and tools; Trends in Model deployment: ML on the Cloud / Edge / Browsers; VMs, Containers, Docker, Kubernetes (K8S), FaSS; ML-as-a-Service.

AIML* ZG524 Design of Algorithms 5

Review of important data structures, Design techniques such as divide-and-conquer, greedy, recursion, backtracking, branch-and-bound, simulation, Dynamic Programming (Examples, Analysis, General Structure of Solutions, Limitations and Applicability); Illustrations dealing with problems in AI and machine learning; Computational complexity and bounds; NP-hard and NP-complete problems; Introduction to Approximation algorithms; Randomized algorithms.

AIML* ZG525 Computer Vision 4

Image formation, structure, and transformations; Low-level(filters, features, texture), Mid-level(segmentation, tracking, morphology) and High-Level Vision (registration, contour geometry, object detection and classification, segmentation); deep learning for object detection; recognition; face detection and face recognition; Facial key point recognition;Optical Character recognition; visual annotation; Activity recognition; Applications for autonomous cars – Landmark detection and tracking, track pedestrians; 3D projection; Image search and retrieval; edge devices for computer vision

AIML* ZG526 Probabilistic Graphical Models 4

HMM, Markov Random Field, Bayesian networks, Representation, Learning, Inference; Dynamic Bayesian Networks and Temporal Bayesian networks, applications.

AIML* ZG527 Audio Analytics 4

Audio data; sound analysis using DFT, STFT, file formats; Spectrogram; Spectral features; Feature extraction from Audio signal; Sinusoidal model; Harmonic model; Sound transformations; Sound and music description; Automatic speech recognition - Acoustic Phonetics, Dialog, Speech Synthesis, Text to Speech (TTS); Meaning Extraction; Music genre classification; Indexing music collections; Recommending music; Speech processing and synthesis — generating artificial voice for conversational agents; tagging and generation; Similarity search for audio files; HMM; AI for ultrasonic and infrasonic applications

AIML* ZG528 AI and MLfor Robotics 4

Fundamentals of robotics. Aerial robots, warehouse robots, under actuated robots. Sensor systems for robots. Effectors and actuators. Robot Operating System. Robot motion models. PID control, Beam model of range finders. Recursive state estimation - Bayes filters, Kalman, extended Kalman, information filters, and nonparametric filters such as particle filters. Mobile robot localization - extended Kalman filter, Grid and Monte Carlo. Simultaneous mapping and localization algorithms, path planning algorithms, Instance based learning, demonstration based path planning using reinforcement learning, deep learning and reinforcement learning based mapping, navigation and control of mobile robots.

AIML* ZG529 Data Management for Machine Learning 4

Data Models and Query Languages: Relational, Object-Relational, NoSQL data models; Declarative (SQL) and Imperative(MapReduce) Querying; Data Encoding: Evolution, Formats, Models of dataflow; Machine learning workflow; Data management challenges in ML workflow; Data Pipelines and patterns; Data Pipeline Stages: Data extraction, ingestion, cleaning, wrangling, versioning, transformation, exploration, feature management; Modern Data Infrastructure: Diverse data sources, Cloud data warehouses and lakes, Data Ingestion tools, Data transformation and modelling tools, Workflow orchestration platforms; ML model metadata and Registry, ML Observability, Data privacy and anonymity.

AIML* ZG530 Natural Language Processing 4

Natural Language Understanding and Generation, N-gram and Neural Language Models, Word to Vectors / Word Embedding (Skip gram/CBOW, Glove, BERT/ XLM, MURIL), Part of Speech Tagging, Hidden Markov Models, Parsing - Syntactic, Statistical, Dependency, Word Sense Disambiguation, Semantic Web Ontology.

AIML* ZG531 Video Analytics 4

Digital Video; Spatio temporal sampling; Low-Level Features to High-Level Semantics; Video enhancement technologies (denoising, stabilization, unsharp masking, super-resolution); background modelling and Foreground Detection; ML techniques for Video Motion Detection; tracking; compression; Indexing and Retrieval; Browsing and Summarization; Applications in License plate detection on moving vehicles, monitor traffic jams; Activity recognition; crowd management; gesture recognition.

AIML* ZG532 Automated Reasoning 4

Propositional Logic: Propositions and logical connectives, Propositional logical consequence, Logical equivalence, Inductive definitions and structural induction and recursion; Deductive Reasoning in Propositional Logic: Axiomatic systems for propositional logic, Semantic Tableaux, Natural Deduction, Clausal Resolution, Resolution-based derivations; First-order Logic: Syntax and Semantics of first-order logic, Logical validity, consequence, and equivalence, Syllogisms; Deductive Reasoning in First-order Logic: Axiomatic system for first-order logic, Semantic Tableaux, Natural Deduction, Prenex and clausal normal forms, Resolution, Soundness and completeness; Limitations: Hilbert's programme, Tarski's theorem on the undefinability of truth, Incompleteness of axiom systems, Godel's incompleteness theorem, Definability and decidability, Church's theorem, Church-Turing hypothesis.

AIML* ZG537 Information Retrieval 4

Organization, representation, and access to information; categorization, indexing, and content analysis; data structures for unstructured data; design and maintenance of such data structures, indexing and indexes, retrieval and classification schemes; use of codes, formats, and standards; analysis, construction and evaluation of search and navigation techniques; search engines and how they relate to the above. Multimedia data and their representation and search.

AIML* ZG548 Advanced Data Mining 4

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

AIML* ZG557 Artificial and Computational Intelligence 5

Agents and environments, Task Environments, Working of agents; Uninformed Search Algorithms: Informed Search. Local Search Algorithms & Optimization Problems: Genetic Algorithm; Searching with Non-Deterministic Actions, Partial Information and Online search agents, Game Playing, Constraint Satisfaction Problem, Knowledge Representation using Logics: TT-Entail for inference from truth table, Proof by resolution, Forward Chaining and Backward Chaining, Inference in FOL, Unification & Lifting, Forward chaining, Backward Chaining, Resolution; Probabilistic Representation and Reasoning : Inference using full joint distribution, Representation of Conditional Independence using BN, Reinforcement Learning; Difference between crisp and fuzzy logic, shapes of membership function, Fuzzification and defuzzification, fuzzy logic reasoning; Decision making with fuzzy information, Fuzzy Classification; Connectionist Models: Introduction to Neural Networks, Hopfield Networks, Perceptron Learning, Back propagation & Competitive Learning, Applications of Neural Net: Speech, Vision, Traveling Salesman; Genetic Algorithms - Chromosomes, fitness functions, and selection mechanisms, Genetic algorithms: crossover and mutation, Genetic programming.

AIML* ZG565 Machine Learning 4

Introduction to Machine Learning, Various kinds of learning, Supervised Learning, Unsupervised Learning, Model Selection; Bayesian Learning, MAP Hypothesis, MDL Principle, Bias Variance Decomposition, Bayes Optimal Classifier, Naive Bayes Classifier; Linear Models for Regression, Linear Models for Classification; Non-Linear models, Decision trees; Instance Based Learning, KNN Algorithm, CBR Learning; Support Vector Machines, VC Dimension; Neural Networks, Perceptron Learning, Back Propagation Algorithm; Introduction to Genetic Algorithms.

AIML* ZG567 AI and ML Techniques for Cyber Security 5

Introduction to Cyber-Security; Supervised Learning for Misuse/Signature Detection; Machine Learning for Anomaly Detection; Malware detection and classification; Network Intrusion detection and classification; Detection and categorization of domain names; Profiling Network Traffic; Adversarial Machine Learning for Malware detection

AIML* ZG577 Metaheuristics for Optimization 4

Metaheuristics refers to class of approximation algorithms which can solve hard optimization problems within an acceptable time limit. This course covers principles behind such algorithms and application to real world problems. The algorithms covered in the courses include simulated annealing, evolutionary algorithms, ant colony method, and particle swarms.

BA* ZC411 Marketing 4

Definition and scope, consumer behavior, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

BA* ZC412 Models and Applications in Operations Research 4

This course provides a survey of selected topics in operations research (OR). Emphasis is placed on the practical application of OR tools rather than on the mathematical properties. Application areas include: financial planning and portfolio selection, production, priority planning and marketing. Topics

include linear programming and its applications; programming to achieve a set of goals or targets with applications in finance and production; capital budgeting and project selection; transportation and network models; and portfolio models.

BA* ZC413 Introduction to Statistical Methods 3

Different types of data; Data Visualization; Data summarization methods; Tables, Graphs, Charts, Histograms, Frequency distributions, Relative frequency measures of central tendency and dispersion; Box Plot; Chebychev's Inequality on relationship between the mean and the standard deviation of a probability distribution. Basic probability concepts, Conditional probability, Bayes Theorem, Probability distributions, Continuous and discrete distributions, Transformation of random variables, Moments, Correlation and Covariance, Parameter Estimation, Hypothesis Testing.

BA* ZC414 Optimization Methods for Analytics 4

This course will focus on development of analytical models using optimization (and simulation) techniques to analyze and recommend appropriate solutions for complex business problems across various functional areas including finance, economics, operations, and marketing. Key topics covered in this course are as follows: solving various problems related to planning, production, transportation, microeconomics, etc. using LP models.Decision making in the context of multi stage LP models.Application of Goal Programming (GP) and Analytic Hierarchy Process (AHP) for decisions relating to large teams and complex problems with long term implications. We will use various tools including spreadsheets and other software for the experiential components of this course to illustrate the application of these techniques to various industries.

BA* ZC415 Analytics for Competitive Advantage 4

In today's competitive business environment, high performing companies are doing more than just collecting data, storing it and generating reports. They are developing competitive strategies using Business Analytics. In this course we will look at how to use data-driven insights to differentiate a firm's business/ product strategy from other companies that are making the same product or delivering the same service. This course is designed for analysts in any function: marketing, operations, quality, customer service, IT, finance/accounting or human resources. We will use case studies and other experiential components to study the application of data-driven insights in the context of various industries.

BA* ZC416 Investment Banking Analytics 4

Modern portfolio theory, Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory (APT), and efficient market theory; Passive investing: indexing; Introduction to behavioral finance; Active investing: security analysis – fundamental analysis (strategic, financial, marketing tools) and technical analysis; Portfolio management including allocation, rebalancing and risk management; Transaction cost analysis; Fixed-Income and Credit Sensitive Instruments.

BA* ZC417 Financial Risk Analytics 4

The course will first cover the basics of Financial Risk and then focus on applications such as: currency, interest rate derivatives, equity markets and products, and commodity markets and products. Major topics include methodologies for measuring and analyzing volatility (a key metric of risk) including EWMA, ARCH & GARCH processes, volatility clusters and the issue of time varying volatility; Extreme value theory; Measuring risk using Value-at-Risk, including computation of VaR by various methods, and stress testing; Monte Carlo simulation, address issues in generating price process (such as Brownian Motion, Ito Process), Cholesky decomposition in computing multi-asset VaR; Currency risk analysis in global investing, interest rate parity (covered and uncovered); Value at risk for fixed income portfolios; Credit Risk Analytics. The topics covered in this course will have inbuilt case studies in financial risk management so as to understand the practical implications of the methodologies covered in the course.

BA* ZC418 Advanced Financial Modeling 4

Valuation of equity securities, fixed income securities, and derivatives. Topics include Introduction to Financial Modelling and Spreadsheet Essentials, Measuring Risk (Testing market efficiency with regression analysis & pivot tables), Portfolio optimization (Mean-variance portfolio selection, Bond portfolio selection, Term structure estimation, Capital budgeting), Advanced risk analysis (Monte-Carlo simulation, Risk analysis of discounted cash flow models, Spreadsheet features using @Risk for Monte-Carlo simulation and combining macros with @Risk), Business and equity valuation modeling , LBO Analysis Model , Stock Merger Model, etc.

BA* ZC420 Data Visualization 3

Information overload and issues in decision making. Design of visual encoding schemes to improve comprehension of data and their use in decision making; presentation and visualization of data for effective communication. elementary graphics programming, charts, graphs, animations, user interactivity, hierarchical layouts, and techniques for visualization of high dimensional data & discovered patterns.

BA* ZC421 Marketing Models 4

The primary purpose of this course is to enhance your ability to develop and critically evaluate marketing models. The course will examine a variety of models, including models of consumer behavior, industrial buying and firm behavior, (aggregate) market models (e.g., competition, market entry), strategic marketing models, forecasting methods, new product models, marketing response models (e.g., channels, pricing, advertising, promotion), forecasting models and decision support systems.

BA* ZC422 Marketing Analytics 4

This course discusses in detail how analytics can play a vital role in the various elements of the marketing research process viz. Problem Definition, Development of an approach to the problem, Research Design formulation, Fieldwork or Data collection, Data preparation & Analysis and finally Report preparation and Presentation. The emphasis of the course is proportionately focused on Concepts, Techniques & Methodology, and Marketing Research Applications.

BA* ZC423 Retail Analytics 4

RFM (recency, frequency, monetary) analysis, chum modeling, retention modeling, shopper analytics, market basket association analysis, customer segmentation and profiling, propensity scoring models to identify prospective customers, best customers, lifetime value modeling, marketing campaign response modeling, cross sell modeling, etc.

BA* ZC424 Supply Chain Analytics 4

Demand Management and Forecasting: static, adaptive and rolling plans. Supply chain Network design: Mathematical Programming Models for Selecting the right number, location, territory, and size of warehouses, plants, and production lines; and optimizing the flow of all products through the supply chain. Space Determination and Layout Methods. Inventory Management: Inventory aggregation Models, Dynamic Lot sizing Methods, Multi-Echelon Inventory models. Transportation Network Models and scheduling algorithms: Efficient and responsive supply chains. Maximal Flow Problems, Multistage Transshipment. Supply chain dynamics and integration: Cost analysis of supplier selection, order fulfillment process, levers for improved supply chain performance, pricing and revenue management and coordination in supply chain. Application of Analytic Hierarchy Process (AHP) to supply chain analytics.

BA* ZC425 HR Analytics 4

In this course students will learn how to leverage analytic techniques in the context of the challenges faced by the HR and Talent Acquisition and Management functions. The primary goal is to leverage analytical techniques to deliver meaningful insights for effectively managing employees for achieving the goals of the organization. Applications include

attracting right talent, forecasting future staffing needs, managing attrition and improving employee satisfaction levels. We will be extensively leveraging experiential components such as case studies to understand how various organizations have applied these concepts in practice.

BA* ZC426 Real-time Analytics 4

Motivation and challenges of real-time, distributed, fault-tolerant data processing, distributed messaging architecture (Apache Kafka), Real time data processing platform: Storm, Storm basic programming skills, linking Spouts, and connecting to the live Twitter API to process real-time tweets, multi-language capability of storm (with Python scripts), Case study: Networking fault prediction. This course also helps a student to analyze and understand Big-data using visuals. Topics include, Design principles, Perception, color, statistical graphs, maps, trees and networks, high dimensional data, data visualization tools.

BA* ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

BA* ZG512 Predictive Analytics 4

Basic concepts in predictive analytics / predictive modeling. Two core paradigms for predictive modeling: classification and regression. Identification of important variables and their relation to each another. Basic modeling techniques such as k-nearest neighbors, classification and regression trees (CART), and Bayesian classifiers. Ensemble techniques. Model selection techniques.

BA* ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

BA* ZG522 Business Data Mining 4

Principles andcurrent practices of data mining; data analytics tools and applications; acquiring and cleaning data, role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for classification, association rules, and clustering; Time series analysis.

BA* ZG523 Introduction to Data Science 3

Context and use of Data Science. High-dimensional data, graphs, vectors in high dimensional space and large matrices; Algorithms for massive data problems, sampling techniques. Techniques for extracting information/patterns from data.

BA* ZG524 Advanced Statistical Methods 4

Point and interval estimation and hypothesis testing, chi-square tests, non- parametric statistics, analysis of variance, regression; linear and multiple linear, correlation, factor models, decision theory, Bayesian statistics and autocorrelation, multivariate regression, randomization and sampling processes, Markov processes with discrete/continuous state space, statistical simulation and pattern recognition, Time Series Analysis.

BA* ZG525 Big Data Analytics 4

Big Data and its applications in various domains such as banking and finance, social media, e-commerce, and healthcare. Five V's of big data, namely Volume, Variety, Velocity, Veracity, and Value. Analysis of structured and unstructured data in various forms, including web logs, videos, e-mails, photographs, tweets etc. Uncovering hidden patterns and unknown correlations for better business decisions. Key technologies used in storing, manipulating, and analyzing big data. Tools for statistical analysis and key methods used in machine learning as applied to Big Data. Distributed computing techniques used in Big Data Analytics. Open source frameworks for data analysis including tools, languages, and platforms such as Hadoop, Pig, Hive, R, Spark, Mahout Etc.

BA* ZG537 Text Analytics 4

Emerging methods of organizing, summarizing, and analyzing collections of unstructured and lightly-structured text. Basics of text processing and natural language processing. Applications of text analysis such as sentiment analysis and opinion mining. Text processing techniques stop word removal, text parsing, and other relevant tree processing steps; text preprocessing, feature selection, text classification, text clustering, and summarization. Natural language processing techniques/steps – Syntactic Analysis, Semantic analysis, and Pragmatic analysis. Case studies with focus on business processes.

BA* ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

BCS ZC219 Discrete Mathematics 3

Sets & operation on sets; relations, functions, Recursive functions, sequences and summations, Mathematical Induction, Proof Methods (direct, indirect, proof by contradiction), principle of inclusion & exclusion, pigeonhole principle; Permutations and Combinations; Recurrence Relations; basic algebraic structures and their applications. Introduction to graphs, properties and applications

BCS ZC230 Linear Algebra and Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

BCS ZC233 Probability & Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

BCS ZC112 Introduction to Logic 2

Propositional logic – syntax, semantics, natural deduction, satisfiability & validity, predicate or first order logic – syntax, semantics, proof theory satisfiability & validity, completeness & compactness, proof techniques, Undecidability & incompleteness; Godel's incompleteness theorem; overview of applications in program verification, knowledge representation.

BCS ZC151 Writing Practice 3

Introduction to academic writing – Purpose, Type, Features, Originality, integrity and plagiarism; Paragraph writing – Structure, Development of ideas, Linking paragraphs together, Introduction, opening sentence and conclusion; Elements of writing – Argument and discussion, Cause and effect, Comparison, Generalizations, Problems and solution, Process writing, Visual information, Accuracy in writing, Academic vocabulary, Caution, Conjunction/Linkers/Signposting, Punctuation, Passives, Tense forms, Summarizing and paraphrasing; Writing models - E-mails (formal), Short essays (2-paragraph essay, thesis statement), and Reports (Introduction, Methods, Results, Conclusion, Abstract).

BCS ZC220 Environmental Studies 3

Environment, human population, and industrialization; natural resources and the impact of man-made activities on them; structure and function of ecosystem, population ecology, biodiversity and its conservation, environmental pollution, social issues and the environment, and environmental impact assessment.

BCS ZC223 General Biology 3

Living systems and their properties; major biological compounds; basic physiological processes; introduction to genetics; environment and evolution.

BCS ZC240 General Physics 3

Philosophy of Science; Newton's laws of motion; Work Energy, Impulse and Momentum; Equilibrium; Moment of a force; Rotation; Periodic motion; First law of thermodynamics; Second law of thermodynamics; Electromagnetic waves; Interference and diffraction; Polarization; Relativistic mechanics; Photons, Electrons and Atoms; Quantum Mechanics; Atoms, Molecules and Solids; Nuclear Physics.

BCS ZC111 Basic Electronics 2

Course covers basic passive circuit elements, dependent and independent sources, network theorems, circuit analysis techniques and response of first and second order circuits. Semiconductors - operation of diodes, bipolar junction transistors and field effect transistors. Biasing techniques and transistors. Introduction to operational amplifiers and applications.

BCS ZC113 Online Social Media 2

Social media - evolution, definition, classification, Present social media landscape; Different kinds of online community and social structure; benefits of social media for individuals, business and society; impacts of people and artificial intelligence on social media; Impacts of Social media - personal, professional, social aspects with cases; Concerns (Privacy, authenticity, Informed Consent, Anonymity, Risks), Safety.

BCS ZC114 Video Games - Technology and Social Impacts 2

Video Games- introduction, play and game- deconstructing video games: narrative structures of videogames, critiquing rules in videogames, immersion and materiality- puzzles, drama and socio-technical system of video games- Themes of videogames: violence, addiction, language, sexuality, gender, identity, communities, values and ethics, game genres: e-sports, indie games, serious games-gamification, game design.

BCS ZC313 Introduction to Programming 4

Basic representation of data and how to process data using the representation inside a computer. Techniques for specifying data, operations on data, and problem solving using C programming language. Systematic techniques and approaches for constructing programs.

BCS ZC228 Introduction to Computing Systems 3

This course teaches a beginner what a computer is and how it can be programmed. The course starts with basic building blocks required to understand the structure of a computer: numbers, bits, structures to implement operations on numbers, and structures to control the execution of commands by a computer. The course progresses to introduce logic gates, combinational and sequential circuits. It introduces a simple processor design with a small instruction set architecture and basic assembly programming with that processor.

BCS ZC216 Computer Systems and Performance 3

Processor Architecture (Instruction Set Level)- Different types of instructions AL, Memory Access, Branch/Jump; Straight Line Programs vs. Branches: Different Loop Structures, Performance of Loops, Nested Conditionals, Inner Loops – Examples; Cost of Procedure Calls vs. goto statements; Memory Hierarchy: Motivation – Cost vs. Size vs. Access Time. Main Memory and Cache. Write-through vs. Write-back Cache. Access Time Calculation and Hit Ratio; Locality of Reference; Paging (of Main Memory) and Page Faults, Performance Impact; Procedure Calls and Space; Hard Disks and Disk Access (Disk Access Time vs. RAM access Time.); Disk IO and File IO, Buffered vs. Unbuffered IO. Performance: Read vs. Write vs. Read-and-Write; Disk Locality. Sequential Access vs. Random Access in Files - Examples; Flash / SSD Storage: SSD access and access times; Write limitations; Flash File Systems; Performance Impact.

BCS ZC215 Command Line Interfaces and Scripting 3

Files and Directory, internals of a file system, inode structure, block I/O; File commands, pipes and filters, programming with commands; Shell and interpretation of commands, programming with shell scripts, feature usage, interaction with I/Os; Systems calls, usage with C Programming, file system and I/O calls.

BCS ZC311 Data Structures and Algorithms 4

Introduction to Asymptotic Notations, Solving Recurrences (substitution method, iteration method, master theorem), Abstract Data Types, Linear Data Structures (Stacks, Queues, and Linked Lists), Non-Linear Data Structures-Heap, Hash Tables, Binary Search Trees, Balanced Binary Search Trees, Sorting Algorithms (insertion sort, selection sort, merge sort), Graph Data Structures (Adjacency List and Adjacency Matrix), Graph Traversal algorithms, Topological sort, Strongly connected components.

BCS ZC212 Algorithm Design 3

Effective construction and analysis of algorithms. Understanding, application, and implementation of algorithm design techniques like divide-and-conquer, greedy, dynamic programming, and back-tracking. Worst case and average case analysis of algorithms. Basic notions of complexity classes – P, NP, and NP-complete and Reduction.

BCS ZC316 Object Oriented Programming 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; overloading and overriding; static and dynamic binding; multithreaded programming; event handling and exception handling; process of object oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages. Object Oriented Design Patterns: Behavioral, Structural and Creational.

BCS ZC317 Relational Databases 4

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Modeling; Data Definition and Manipulation; Relational Data Model; Relational Algebra & Relational Calculus; Structured Query Languages; Database Design techniques; Functional Dependencies & Normalization; Query processing and optimization; Indexing techniques; Transaction management - concurrency control and recovery; Distributed Databases; Concepts of security and integrity in databases.

BCS ZC234 Programming for Mobile Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and accessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking; Trends in mobile application development.

BCS ZC238 Web Programming 3

Technologies related to web development and associated technologies that make the web work. Scripting languages like HTML, CSS and JavaScript; Design of dynamic websites; on both client-side and server-side scripting technologies; full-stack web development. Design and development of web applications, web applications that could query database and fetch information over the network; development and testing of web applications.

BCS ZC232 Operating Systems 3

Introduction to operating systems; Various approaches to design of operating systems ; Overview of hardware support for 0perating systems; Process/thread management: synchronization and mutual exclusion, inter process communication, CPU scheduling approaches ;Memory management: paging, segmentation ,virtual memory, page replacement algorithms ; File systems: design and implementation of file systems; Input /Output systems; device controllers and device drivers; Security and protection ; Case studies on design and implementation of operating system modules.

BCS ZC236 Software Design Principles 4

Software Development lifecycle; Role of high level and low level design in lifecycle. Object-Oriented Abstraction and Object Oriented Design. Design for Reuse and Design for Change – Refactoring. Design Patterns - History of Patterns in Building Architecture and Relevance to Software Design, Evolution of Software Design Patterns and Impact of Using Design Patterns in Lifecycle. Crosscutting Concerns and Aspects – Aspect Oriented Design. High-level design vs. Low-level design. Basic Architectural Elements and Styles – Layered Architectures and Event-Driven Architectures, MVC architecture in User Interfaces.

BCS ZC214 Building Database applications 3

This course discusses end-to-end application programming involving databases using SQL, PL/SQL, front-end framework, and exposing back-end through APIs. Debugging, Testing, Monitoring, Documenting and Maintaining database applications are discussed. Particular focus will be on Database connectivity; stored procedures; data ingestion/loading; ingestion latency and query performance. This course culminates with a project that involves programming, implementing, and demonstrating a database solution for a business or organization

BCS ZC211 Software Development Practices 3

Review of Use Cases. Design using use cases and data flow; Development Tools and Technologies - IDEs (Eclipse); Compilers and Compiler Options, Libraries and APIs; Code Reviews and walkthroughs; Debugging and Unit Testing, Runtime conditions and Assertions; Runtime Environments (JVM, Android) Code Repositories (GitHub); Versioning; CI/CD.

BCS ZC231 Network Programming and Client Server Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

BCS ZC222 Formal Languages and Applications 3

Regular Expressions, Typical languages expressible using Regular expressions - Regular Languages, Closure Properties; Tokens or Lexemes of Languages (Formal or Natural) – Token descriptions, Scanning Sentences or Programs, Scanner - Design and Implementation. Applications: Specifying patterns, Test cases; Context Free Grammars and Rules, Context Free Languages; Defining the syntax of formal and natural languages; Closure Properties; Limitations of CFGS – features not expressible via CFGs; Context-sensitive Grammars and Languages; Parsing sentences or programs. LL Parsing vs LR Parsing; Look heads - LL(1) parsing, LL(1) parsing engine, and construction of LL(1) parsing table; LL(k) parsing examples and counterexamples, Issues – Ambiguity in CFGs and CFLs. Resolving Ambiguity – Left Factoring and Left Recursion. LR(1) parsing; Application – Natural Language Parsing and POS Tagging;

BCS ZC224 Graphs and Networks 3

Basic concepts of graphs and digraphs, Modelling problems from application domains as graph problem, connectedness, reachability, Euler Tours, Hamiltonian Cycles, planarity, Applications; real world networks: measures (centrality, transitivity, reciprocity), properties and models (random networks, small world model, preferential attachment model), communities in social networks

BCS ZC213 Automata and Computability 3

Finite Automata – DFA, Equivalence of DFAs to regular expressions; PDA – DFA with a stack, equivalence of PDAs to CFLs; Turing Machines – Comparative power of DFAs, PDAs, and TMs. Universal TM; Brief Overview of Chomsky's hierarchy and Church-Turing hypothesis; Non-computable functions; Informal equivalence between TMs and General Purpose computers.

Pre-requisite: BCS ZC222 Formal Languages and Applications

BCS ZC221 Experimental Algorithmics 3(2+1)

Review of time complexity, order of complexity, and Big-O notation; Comparing Theoretical analysis of time and space complexity of elementary algorithms (Sorting, Binary Search trees, Hash tables) with experimental running-time and space measurements. Experiments on key distribution: Measuring heights of BSTs for different datasets and order of arrivals, Uniformity of buckets/bins in hashtables with different hash functions; Size Experiments: Growth of hash table size with datasets and query sequences, Bloom filter size vs. false positive rates, Sketches and cardinality estimation via HyperLogLog. IO Complexity and disk access measurements: Sorting, BSTs vs. B-Trees, Sparse Graphs vs. Dense Graphs. Caching in Data Structures. Case Studies: Use of B-Tree variants in datasets, Bloom filters in Distributed file systems, and HyperLogLog in Redis.

Pre-requisites: BCS ZC311 Data Structures and Algorithms
BCS ZC212 Algorithm Design

BCS ZC227 Introduction to Bioinformatics 3

Course description to be developed.

BCS ZC217 Data Visualization 3

Information overload and issues in decision making. Design of visual encoding schemes to improve comprehension of data and their use in decision making; presentation and visualization of data for effective communication. Elementary graphics programming, charts, graphs, animations, user interactivity, hierarchical layouts, and techniques for visualization of high dimensional data & discovered patterns.

BCS ZC312 Introduction to Data Analytics 4

Introduction to data analytics, applications, Python fundamentals (variables, strings, simple math, conditional logic, for loops, lists, tuples, dictionaries, etc.); Preparing the data - download the data in python, visualizing using matplotlib, seaborn to gain insights, data cleaning, transformation; Regression - applications, fitting models, gradient descent, evaluation, regularized models); Classification - applications, fitting models (decision tree, logistic regression), addressing overfitting, performance, Model selection techniques ; Clustering - applications, k-means and hierarchical clustering, quality of clustering; Discussion on advanced topics ; Ethical implications of handling data and building models.
Pre-requisites: BCS ZC230 Linear Algebra and Optimization
BCS ZC233 Probability and Statistics
BCS ZC313 Introduction to Programming

BCS ZC315 Multi-Core Programming and GPGPU Programming 3

Multi-threaded Programming. Review of multicore processors and caching. Shared Memory Programming in the multi-core context. – Use of Locks for Synchronization. Shared Memory data structures - Synchronization issues and models, Lazy synchronization, Design of shared memory data structures. Review of GPGPU architecture and GPGPU programming model. Programming with many-core processors and NUMA. CUDA Programming.
Pre-requisite: BCS ZC216 Computer Systems and Performance

BCS ZC237 TCP/IP and the Internet 3

Review of the OSI model and the Internet model; A top-down approach. Application Layer – HTTP, HTTPS/TLS, DNS, and Multi-media transport; The Internet – Transport, TCP vs. UDP, Routing, and Gateways. IP – Addressing and Routing.
Pre-requisite: BCS ZC231 Network Programming and Client Server Programming

BCS ZC226 Information Security 3

Program security, Web security, Database security, Protection in operating systems, Cloud security fundamentals; Privacy and Anonymity in computing; Legal and ethical issues in security, Secure programming and Trusted systems design; policy, administration and procedures; auditing; physical security; content protection.

BCS ZC225 Human Computer Interaction 3

Principles of human-computer interaction; Evaluation of user interfaces; Usability engineering; Task analysis, user-centered design, and prototyping; Conceptual models and metaphors; Software design rationale; Design of windows, menus, and commands. Voice and natural language I/O; Response time and feedback; Color, icons, and sound; Internationalization and localization; User interface architectures and APIs.

BCS ZC218 Designing Multimodal Interfaces 3

UI Design Principles; GUI Design; Interfaces with multiple modes of interaction – text, graphics, and speech; Identification and authentication: CAPTCHAs; Smart Cards; Design of multi-factor authentication schemes; Identification in Personal Devices – fingerprints, voice-print identification; Design of interfaces for Smart Personal Assistants; Case Study: Siri/Cortana, Alexa/Google Device. Design of chatbots with emphasis on design of Natural language interaction / conversations.
Pre-requisite: BCS ZC316 Object Oriented Programming

BCS ZC314 Modern Databases 4

Different types of content - Structured vs. Unstructured vs. Semi-structured data, notion of Atomicity (or Consistency) ACID vs. BASE; Strong vs. Weak Consistency model; Serializability; Eventual Consistency; CAP Theorem and Implications; Solution models and Design Examples (some of MongoDB, REDIS, Cassandra, Neo4j); Document stores, Key-Value Stores, Column stores, Graph stores and languages for their query processing, In-memory databases, and cloud databases (E.g, Amazon RDS); Exposure to application development.
Pre-requisite: BCS ZC214 Building Database Applications

BCS ZC229 Introduction to Economics 3

Big ideas in economics; Functioning of economy; Scarcity and choice; Consumer behaviour; Firm behaviour; Competitive markets; Labour markets; Unemployment; Capital market; Banking and non-banking financial institution; Central banking; Economic growth; Inflation; Monetary policy; Fiscal Policy.

BCS ZC241T Study Project 5

In this course, students are expected to carry out an organized study and identify a problem which requires a software solution. Students also study the impacts of solving the problem and the existing solutions. At the end of the course, students submit a report with the project proposal, details on background, scope and solution methodology (including requirement specifications).

BCS ZC242T Project 5

The students registered in this course will identify a problem which requires software based solutions. The students will identify the details of requirements, design the solution of the problem and implement it using any of the tools/techniques covered as a part of the program. The students will demonstrate their work and submit the detailed project report at the end of the semester.

BCS ZC428T Project 10

In this course, the students work to produce a software solution to a problem whose requirements were studied and documented in the Study Project course. The students will demonstrate their work and submit the detailed project report at the end of the semester.

BHCS ZC321 Software Testing and Automation 3

Introduction to software testing: methodologies and best practices; Software testing life cycle; Test planning and test strategy; Test case design; Testing techniques: black box, white box, regression, smoke etc.; Test automation: frameworks & tools, Types: unit testing, integration testing, regression, performance, security, GUI, cross-browser etc.

BHCS ZC319 Natural Language Processing 4

Natural Language Understanding and Generation, N-gram and Neural Language Models, Word to Vectors / Word Embedding (Skip gram/CBOW, Glove, BERT/ XLM, MURIL), Part of Speech Tagging, Hidden Markov Models, Parsing - Syntactic, Statistical, Dependency, Word Sense Disambiguation, Semantic Web Ontology.

Prerequisite: BCS ZC312 Introduction to Data Analytics

BHCS ZC423 Introduction to Social Media Analytics 4

Basics of social media, its modeling & representation, node classification, community detection, user behaviour, herd behaviour, influence, recommendations in SM, controversy detection, sarcasm detection, fake post detection, behavioural analysis, SM driven problems such as mental health, spreading rumours, etc.

Pre-requisite: BCS ZC312 Introduction to Data Analytics

BHCS ZC416 Cryptography 3

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

BHCS ZG511 Agile Software Processes 4

Introduction to Agile; Basics of Agile Software Development approaches; Principles of Agile; Agile Methodologies; Release Planning; Roles and Artifcats in Agile; Agile Requirements; Iteration Planning and Ceremonies; Executing a Sprint; Agile

Metrics; Agile Testing and Maintenance; Agile Pitfalls; Ensuring Agile Success

BHCS ZC418 Distributed Systems 4

General introductory concepts in the design and implementation of distributed systems (e.g., Cloud Computing, Grid Computing, Cluster Computing) such as scheduling in multiprocessors, memory hierarchies, synchronization, concurrency control, fault tolerance including check pointing, rollback recovery, distributed memory message passing, distributed shared memory programming models, memory consistency model, asynchronous computation, naming, distributed file systems, process, data and communication distribution, service registration, discovery and lookup, lifecycle management of distributed objects, event handling, logical time, global state and snapshot.

BHCS ZC429 Open Source Software 3

Introduction to Open Source Software; Open Source Business Model; Lifecycle and Methodologies in Open Source Software; Contributing to Open Source Projects; Architecture of Open Source Applications; Tools and Technologies in OSSE; Case studies - popular Open Source Projects;

BHCS ZC433 Topics in Algorithms and Complexity 4

Topics in Turing Machines, Computability, Randomization, Approximation, and Game-Theoretic Techniques. Topics on the design of Graph, Parallel and Distributed Algorithms. Topics in the design of algorithms for application domains such as Internet / Web and other domains.

BHCS ZC324 Compiler Design 4

Introduction to Programming Languages and Compilers, Programming Language Features, Front End of a Compiler, Back End of a Compiler, Special aspects of compilers and runtime.

BHCS ZG512 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

Prerequisite: BCS ZC237 TCP/IP and the Internet

BHCS ZC421 Introduction to Machine Learning 4

Introduction to Machine Learning, Various kinds of learning, Supervised Learning, Unsupervised Learning, Model Selection; Bayesian Learning, MAP Hypothesis, MDL Principle, Bias Variance Decomposition, Naive Bayes Classifier; Linear Models for Regression, Classification; Non-Linear models, Decision trees; Instance-Based Learning, KNN Algorithm; Support Vector Machines;

Pre-requisite: BCS ZC312 Introduction to Data Analytics

BHCS ZC412 Artificial Intelligence 3

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving. The course also aims at understanding its implementation using LISP and PROLOG languages.

BHCS ZC417 Deep Learning and Applications 4

Basic neural networks, derivative-based optimisation, gradient descent and its variants, various learning algorithms: SGD, RMSProp, Adam, Shallow Networks, Stacking, multilayer perceptron, activation functions, parameter initialisation strategy, cost function, backpropagation using gradient descent, visual data, convolution operation, pooling, variants of convolution function, CNN architectures: Dense convolutional neural networks (DenseNets), Overview of modern CNN Architectures etc., Sequence models, GRU, LSTM, encoders-decoders, vanishing gradient, Transformers, Generative Learning, Real World Applications.

Pre-requisite : BCS ZC421 Introduction to Machine learning

BHCS ZC434 Topics in Data Mining 4

Data: Data Types, Statistical description of data, data similarity and dissimilarity, data cleaning, data integration, data reduction, data transformation; Data-reduction using PCA: Standardizing data, using principal components to eliminate attributes, applications, and limitations; Mining Frequent Patterns: Apriori Algorithm and applications; Topics in Clustering: Hierarchical and Density-based clustering (DBSCAN), Evaluation of Clustering; Outlier Detection: Approaches based on proximity, statistics, clustering; Topics in mining stream data, text data, and social media and applications

Prerequisites: BCS ZC312 Introduction to Data Analytics

BHCS ZC414 Cloud Computing Fundamentals 3

Introduction to Cloud Computing, Virtualization Techniques and Types, Infrastructure as a Service, Container Technology, PaaS and SaaS, Capacity management and Scheduling in cloud computing, Issues and Challenges : Availability, Multi-Tenancy, Security and SLA, Overview of Cloud data storage

BHCS ZC422 Introduction to Networking for Cloud 3

Review of Network fundamental concepts - OSI model, TCP/IP model, routing, switching, addressing; Introduction to software-defined networking, introduction to the network (function) virtualization, data center networking - underlay networks, overlay networks; VM networking - OVS, SR-IOV, OVS-DPDK; container networking, single-host and multi-host container networking; cloud network security basics; network observability

Pre-requisite: BCS ZC237 - TCP/IP and Internet

BHCS ZC420 Introduction to DevOps For Cloud 4

Introduction to DevOps; need and evolution; culture - process, people and technology; agile methodology for DevOps; containerization with Docker, container orchestration with kubernetes; continual service - continuous integration and continuous delivery / deployment; version control, configuration management; DevOps and Cloud - use of virtual machines and containers for multi-cloud deployment, automated cloud migration in DevOps, stack management - life cycle of stack and events, resource and event monitoring, auto healing; cloud DevSecOps in practice; Infrastructure automation with GitOps - infrastructure-as-code (IaC) and building CI/CD pipelines;

Prerequisites: BCS ZC414 - Cloud Computing Fundamentals

BHCS ZC430 Scalable Services in Cloud 4

Software principles related to scalability, Architecture for Scaling, Elasticity, Microservices - design, service discovery, load balancing, API management. Deployment – container configurations and orchestrations, automated deployments of microservices, integration with CI/CD pipelines. Performance: Scaling and load balancing with containers and microservices, Ensuring QoS and SLAs

Prerequisites: BCS ZC414 - Cloud Computing Fundamentals

BHCS ZC413 Backend and API Development 4

Full stack development: Typical components of full-stack - server/platform, web framework, database, front-end, web servers, load balancers, application servers, API gateways; Overview of stacks - LAMP, MEAN, MERN, MEVN etc.; Server-side web frameworks; Stack architecture; Server-side programming; Data modelling and ORM; Authentication and Authorizations; Session management; REST API; API development and testing; Third-party integrations; MEAN/MERN as exemplar frameworks.

BHCS ZC419 Frontend Development 3

Modern application landscape; Web applications: Typical structure of end-to-end application; Application components-Frontend / Backend / API / Database / Services; Web Browsers; Responsive web; Client-side frameworks overview;

Client-side web development tools: Complete toolchain for project development, package management, coding, building, Test and Deploy of the frontend portion of apps; Cross browser testing; Introduction to automated testing; MEAN/MERN as exemplar frameworks.

BHCS ZC415 Cross-platform Applications 3

Mobile application platforms; Cross Platform Apps - requirements, advantages and challenges; Types - Cross Platform Native and Web Apps; Overview of Cross-platform application development frameworks; Cross Platform – Native Applications: Working, Framework Choices (ReactNative, Xamarin, Flutter etc.), Comparison of frameworks; Cross Platform - Web Apps: Motivation, working, Framework Choices (Ionic, Cordova/PhoneGap, Capacitor), Comparison of frameworks;

Prerequisites: BHCS ZC419- Frontend Development

BHCS ZC432 Software Deployment 4

Continuous integration and continuous delivery; Scaling: automating infrastructure and infrastructure as-code; Use of virtual machines and containers for deployment; Micro-services; Application lifecycle management: deployment pipeline and application deployment, continuous deployment pipeline; Stack management - life cycle of stack and events, resource and event monitoring, auto healing; Security: security of deployment pipeline, policy-as-code.

Prerequisites: BHCS ZC413 - Backend and API Development; BHCS ZC419- Frontend Development

BHCS ZC427T Mini Project 5

Students will identify a problem whose software solution falls within the scope of the degree program/ chosen specialization stream. Identifying an appropriate problem, designing, implementing the solution, and documenting are broader tasks expected.

BHCS ZC327 Introduction to Calculus 3

Real numbers, functions and graphs, Limits and Continuity; Differentiation: Rules, applications, Integration: Fundamental theorem of calculus, techniques of integration, and applications; Sequences and Series: Convergence tests, power series, and Taylor series; Multivariable Calculus: Partial derivatives, multiple integrals, and vector calculus; Discrete Calculus: Difference equations, summation notation, and discrete differentiation and integration; Applications of Calculus in Computer Science: Optimization problems, complexity analysis, machine learning, and graphics.

BHCS ZC325 Differential Equations and Applications 3

Linear and non-linear first order ordinary differential equations (ODEs), Linearly dependence and independence properties of general solutions of second order differential equations, Different methods to solve second order ODEs, Solutions of ODEs using Laplace Transform technique, Fourier Series, Sturm-Liouville-Problems, Solutions of system of linear ODEs.

BHCS ZC320 Numerical Analysis 3

Computer arithmetic, Kinds of errors, Bisection method, Method of False–position, Secant method, Newton-Raphson method, Fixed-point iteration method, Gaussian elimination method, scaling and partial pivoting, Doolittle and Crout's decompositions, Jacobi iterative method, Gauss-Seidel iterative method and SOR Methods, Lagrange interpolation, Divided differences, Piecewise linear, Piecewise quadratic interpolations, Cubic spline construction, Numerical differentiation, Newton-Cotes integration formulae, Composite rules, Two and Three point Gaussian-Legendre quadrature rules, Euler methods, Higher order Taylor methods, 2^{nd} and 4^{th} order Runge-Kutta methods, Finite difference methods to BVPs.

BHCS ZC241 Microprocessors, Programming & Interfacing 4

Sequential Circuits and Memory; Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams ; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; Design of processor based system. This course will have a laboratory component.

BHCS ZC328 Introduction to IoT 4

Introduction to IoT; Sensors and Actuators for IoT; Programming IoT endpoints; IoT infrastructure and platforms; Industry applications of IoT; IoT application development; Communications and networking in IoT; Data management in IoT; Security issues in IoT; Emerging technologies.

Prerequisites: BHCS ZC237 TCP/IP and the Internet; BHCS ZC426 Microprocessors &Interfacing;

BHCS ZC243 Signals & Systems 3

This course is intended to provide a comprehensive coverage of Signals and Systems, a fundamental subject of Electrical Engineering. The topics covered are: Continuous-time and discrete time signals and systems, convolution, properties of linear time-invariant (LTI) systems, Fourier series, Fourier transform, Z transform, Laplace transform; System analysis, frequency response, analog filters, Sampling and reconstruction.

BHCS ZC244 Accounting for Managers 3

Significance of accounting; Indian Accounting GAAP; basic accounting concepts & principles for measuring and communicating financial data - accounting concepts and rationale behind concepts; understanding and recording transactions - preparation of journals & ledgers, and trial balance; preparation of financial statements - statement of income and expenditure, statement of sources and application of funds and statement of change in cash flow; cost concepts and dynamics, BEP and CVP Analysis; financial statements analysis and interpretation.

BHCS ZC322 Corporate Finance 3

Introduction to corporate finance; business objectives – value maximization versus share price maximization; concepts of corporate finance decision (investment, financing and rewarding decisions) ; concepts in valuation – time value of money; concepts and applications of risk and return- capital asset pricing model; measuring and analyzing business performance & risk – financial performance and leverage analysis; capex decisions – risk & return; capital structure decision; dividend decisions – dividend versus capital gain; working capital estimation and management - management of accounts receivable; inventory management and management of cash; working capital financing - short and intermediate term financing,

BHCS ZC323 Investment Management 3

Investment objectives and constraints, Framework of risk and return, Introduction to Securities Markets, Primary and Secondary Markets, Global and Indian Stock Markets and Indices, Regulation and Trading in Stock Exchanges, Efficient Market Hypothesis, Portfolio risk and return, Markowitz Portfolio Theory, CAPM,APT, Fundamental Analysis-Economic ,Industry and Company Analysis, Stock Valuation-Discount Dividend Model and Relative Valuation Techniques, Introduction to Technical Analysis, Bond Fundamentals-valuation, yield to maturity and relationship with interest rates, Overview of Derivatives Markets-Options and Futures, Introduction to Mutual Funds, Sharpe Ratio, Active and Passive Strategies.

BITS ZC411 Object Oriented Programming 3

Object orientation concepts and principles: abstraction, encapsulation, modularity, inheritance, and polymorphism;

classes and objects; static and dynamic binding; class utilities; metaclasses; object oriented software engineering; programming and problem solving using one or more of the popular object-oriented programming languages like C++ or Java.

BITS ZC423T Project Work 20

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

BITS ZC424T Project Work 10

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project. At the beginning of the semester, the student should select an area of work that is considered vital to the sponsoring organization, and prepare a detailed project outline, in consultation with his/her Mentor. The student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, and taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and a final seminar and viva-voce.

BITS ZC461Software Engineering 3

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

BITS ZC463 Cryptography 3

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

BITS ZC471Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

BITS ZC481Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

BITS ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi-processing and distributed systems.

BITS ZG628TDissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

BITS ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

BITS ZG659Technical Communication 4

Roleand importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

BSDC* ZC111 Probability & Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

BSDC* ZC112 Electrical Sciences 3

Course covers basic passive circuit elements, dependent and independent sources, network theorems, circuit analysis techniques and response of first and second order circuits. Introduction to three - phase circuits, magnetic circuits, transformers, basics of rotating machines. Semiconductors - operation of diodes, zener diodes, bipolar junction transistors and field effect transistors. Biasing techniques and applications of diodes and transistors. Introduction to operational amplifiers and applications. Introduction to Digital Electronics.

BSDC* ZC142 Computer Programming 4

Basic Model of a Computer; Problem Solving-Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files.

BSDC* ZC151 Writing Practice 3

The course aims to develop students' writing ability. It is assumed that students who will be part of this course have not received explicit and extensive training in academic writing. Therefore, the course begins with paragraph writing and goes on to cover areas such as elements of writing, language issues and vocabulary related to writing and ends with different models of writing. Effort has been made to provide students with a comprehensive background in writing so that they can write their assignments, examinations, letters, reports and essays more effectively.

BSDC* ZC211 Principles of Economics 3

Nature and scope of economic science, its relationship with other social sciences; quantification of economic variables, theories of consumer behaviour and of the firm: linear economic models; market structures; social accounting and basic elements of economic planning.

BSDC* ZC214 Science, Technology and Modernity 3

Interrelationship between science, technology and modern society; forms in which beliefs and values of a modern society shape sciences and technologies; forms in which scientific discoveries and technological developments influence and shape modern societies. Scientific Revolution and the emergence of modernity as a social condition; Enlightenment promise of progress within the economic system of capitalism. Some critiques of the received view; recent phase of capitalism and the role of technology in globalization.

BSDC* ZC215 Digital Design 4

Boolean Algebra & logic minimization; combinational logic circuits: arithmetic circuit design, Design using MSI components; Sequential Logic Circuits: flip flops & latches, registers and counters, Finite state machine; HDL Implementation of Digital circuits; Digital Integrated Circuits; Programmable logic devices; Memory organization; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

BSDC* ZC222 Discrete Structures for Computer Science 3

Sets & operation on sets; relations & equivalence relations; number theory; weak & strong form of mathematical induction; principle of inclusion & exclusion, pigeonhole principle; recurrence relations & generating functions; digraphs & graphs, graph isomorphism & sub-graphs, spanning trees, Euler & Hamiltonian graphs, planar graphs, chromatic numbers & graph coloring; groups; Lagrange theorem finite groups; Rings & Fields.

BSDC* ZC224 Print and Audio-Visual Advertising 3

The Dimensions of Advertising; Advertising and Marketing; Creative strategy and Creative process; Creative Execution: Art and copy; Media strategy; Advertising research; Relationship Building: Public relation and Corporate advertising; Ethical issues.

BSDC* ZC225 Environmental Studies 3

Environment, human population, and industrialization; natural resources and the impact of man-made activities on them; structure and function of ecosystem, population ecology, biodiversity and its conservation, overview of natural resources, environmental pollution, social issues and the environment, and environmental impact assessment.

BSDC* ZC226 Creative Thinking 3

Creative thinking & its importance, Process of creative thinking, Road blocks to creative thinking, Developing creative thinking, Brainstorming, Bloom's Taxanomy, Assessment of creative thinking, Conceptual framework for Critical thinking, Aspects of critical thinking, Stages of critical thinking; Reasoning: Fountain head of critical thinking, Need & benefit of critical thinking, Critical thinking in decision making, Developing critical thinking in classroom, Assessment of critical thinking skills.

BSDC* ZC231 Dynamics of Social Change 3

Nature of society, social institutions; concept and nature of socio-cultural change, obstacles, rate and direction of change; factors of social change-ideological, economic, technological and political demographies; agencies of social change-education, leadership, propaganda, legislative reforms; five-year plans and social change, peasant and land reform, bhoodan and gramdan; changing pattern of family, marriage, caste and religion.

BSDC* ZC234 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

BSDC* ZC236 Symbolic Logic 3

A brief historical survey of the development of logic; nature and kinds of arguments; sentential connectives; symbolization of statements and arguments; truth tables, establishing validity of arguments by truth tables and different types of proofs, quantified statements; quantified arguments and their validity.

BSDC* ZC242 Cultural Studies 3

Introduction to Cultural studies, Importance of cultural studies, types of cultural studies, relation to Critical theory, relation to Literary Criticism. Introduction to theories such as Communication studies, Film studies, Feminist theory, Art history/Criticism, Societal impact, business relevance, introduction to myriad practices, institutions, beliefs and varied social structures within a given culture.

BSDC* ZC311 – Information Security 3

Course Description to be developed

BSDC* ZC312 Evolution of Design 3

Intellectual nature of design - two thousand years of design - three forms in which the design appears -mechanism, structure and systems – energy and design-materials and design- the aesthetic basis of design- evolution and design-economy, form and beauty- production and design in nature-The relation between manufacturing and design- verbal and visual thoughts-some aids to design- evolution of design in decorative arts.[Design as an activity will be an integral part of teaching and learning as well as evaluation for this course.]

BSDC* ZC313 Object Oriented Programming and Design 4

Object oriented concepts and design, abstraction, architecture and design patterns, GUI programming and frameworks, design of object oriented solutions using UML, design for concurrency, implementation of solutions using object oriented languages like C++ or Java; Language level mapping and realization of object oriented constructs, realization and performance issues versus abstraction and usability.

BSDC* ZC314 Software Development for Portable Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and accessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains

such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

BSDC* ZC315 Web Programming 3

Technologies related to web development and associated technologies that make the web work. Scripting languages like HTML, CSS and JavaScript; Design of dynamic websites; on both client-side and server-side scripting technologies; full-stack web development. Design and development of web applications, web applications that could query database and fetch information over the network; development and testing of web applications.

BSDC* ZC316 Computing and Design 3

Design Principles - Separation of Concerns, Abstraction, and Modularity. Application of these principles in the design of Computers. Hardware and Components - Modularity. Instruction Set Architecture - Abstraction and Modularity. Computing Systems - Hardware, Operating Systems, and Communication. Highlights of Operating System Design: Abstraction and Interfaces in Operating Systems - Processes, System Calls; Modularity in Operating Systems - Kernels vs. external modules such as device drivers. Abstraction in Programming: Data Abstraction and Control Abstraction. Modularity and Reuse in Programming. Design Principle - Virtualization. Virtualization at the Architecture and OS level. Virtualization in Software.

[Design as an activity will be an integral part of teaching and learning as well as evaluation for this course.]

BSDC* ZC317 Algorithm Design 3

Effective construction and analysis of algorithms. Understanding, application, and implementation of algorithm design techniques like divide-and-conquer, greedy, dynamic programming, and back-tracking. Worst case and average case analysis of algorithms. Basic notions of complexity classes – P, NP, and NP-complete and Reduction.

BSDC* ZC322 Critical Analysis of Literature and Cinema 3

Creativity and Aesthetics; An overview of Major Movements in Literature and Cinema; Interpretation of Selected Works; Cinema & Art; Understanding Drama: Theme, Character, Plot, form; Understanding Poetry: Diction, Imagery, Symbolism, Structure and Form, Personification, Apostrophe, Sound and Rhythm; Understanding fiction: Setting, Point of View, Plot and Character; Understanding Short Fiction: Meaning and message, Style and Coherence; Understanding Cinema: Plot; Character; Screenplay; Linguistic, Social, Musical codes; Cinematic Codes; Camera Work.

BSDC* ZC327 Systems Programming 3

Batch processing Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces; other selected topics.

BSDC* ZC328 Humanities and Design 3

Ideas and Designs, Thinking about New Designs, Perspectives to Design: Historical, Social, Technical and Creative Dimensions; Engineering Design and Problem Solving; Basic Concepts in Engineering Design; Design Skills, Abstraction, Identification of Patterns in Processes and Products, Application of Systematic Techniques to Problem Solving, Application and Adaptation of tools and technologies to new problems; Core Principles of Design; Elements of Design, Form and Functionality, Central Activity of Engineering Designs; Language and Interface Design, Design Thinking: Influence of Context Vs. Conflict with Context.

BSDC* ZC329 Design for Social Media 3

The course Design for Social Media will help understand the emerging role of Social Media as an important vehicle for promoting a culture of participation, interaction, persuasion and influence where social networks, news, photos, blogs and videos are used to harness collective intelligence and encourage active communication among users. The course will focus on – Emergence of Social Media, Types of Social Media, Functions and Dysfunctions of Social Media, Design aspects for Usability, Design aspects for Sociability, Presentation and Navigation schema of content, Information Handling, Design for Interactivity, Media Richness, Language aspects of Social Media, Content and Design Analysis of Media, Working with mime types in Social Media, Using software tools like Photoshop / Illustrator.

BSDC* ZC330 Appreciation of Art 3

Visual perception and basic techniques used in art, compositional balance, space, movement form, light colour, texture, tensions, expressions lines; mainstreams of art; influence of Indian art abroad; various schools of art-Greecian, Medieval, Christian Renaissance, Baroque and Romanticism, impressionism and post impressionism, fauvism, futurism, expressionism, Dadaism and surrealism, metaphysical art, non-representational and abstract art; analysis of work of art and their evaluation.

BSDC* ZC342 Computer Mediated Communication 3

Computer Mediated Communication- Definitions and overview; Evolution of Computer Mediated Communication; Components of Computer Mediated Communication; Computer Mediated Discourse Analysis- Theories and faceted Approach; Information-Interactivity Dynamism in Computer Mediated Communication; Gender perspectives in Computer Mediated Communication; Privacy Issues in Computer Mediated Communication; Socialization in Social Media- Profiles, Identity and traversal; Computer Mediated Communication and technology acceptance; Computer Mediated Communication Theories; Human-Computer Interfaces.

BSDC* ZC343 Software Engineering 4

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

BSDC* ZC344 Professional Ethics 3

Ethics, nature and purpose; ethical theories; ethics in business and management; ethics in engineering, global ethical issues.

BSDC* ZC350 Human Rights: History, Theory and Practice 3

The meaning and history of human rights; Human rights debates and controversies; Political, civil, social and economic rights; Culture and human rights; Themes - Democracy, dictatorship, and human rights; Science, technology, and human rights; Ethnicity; Gender; Children's rights and others; Evaluating the progress made and challenges in practice of human rights.

BSDC* ZC351 Organizational Behaviour 3

A new perspective of management; conceptual model of organization behavior; the individual processes- personality, work attitude, perception, attribution, motivation, learning and reinforcement, work stress and stress management; the dynamics of organizational behavior- group dynamics, power & politics, conflict & negotiation, leadership process & styles, communication; the organizational processes- decision making, job design; organizational theory and design, organizational culture, managing cultural diversity; organizational change & development.

BSDC* ZC352 Advanced Writing Course 3

This course includes components related to development of creative content and writing skills required for professional communication and documentation purposes. In addition, the course also tries to enable students to become independent

and effective writers by exposing them to citation and referencing conventions, document formatting, use of web platforms for writing, international laws related to plagiarism, etc.

BSDC* ZC353 Computer Organization and Architecture4

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; Virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies; This course covers the fundamentals of computer organization and architecture from a programmer's perspective.

BSDC* ZC354 Introduction to Architecture 3

Origin and history of architecture; designing object, space, building, cities; form, space and order as fundamental design considerations; elements of architecture; iterative design process; developing concepts; tools and techniques for generating ideas; materials and perception of space; building structure and methods of construction; building systems; architectural practice and communication; allied fields

BSDC* ZC356 Data Structures 4

Elementary data structures; Linked lists, stacks, queues; Searching and Sorting. A selection of sorting algorithms and their usage and context; Non-linear data structures: Trees, binary trees, and heaps – applications, construction and operations, traversals, implementation techniques. Dictionaries - Hash tables, Binary Search Trees, and Balanced Binary Search Trees; Introduction to analysis of algorithms and complexity.

BSDC* ZC364 Operating Systems 3

Introduction to operating systems; Various approaches to design of operating systems ; Overview of hardware support for 0perating systems; Process/thread management: synchronization and mutual exclusion, inter process communication, CPU scheduling approaches ;Memory management: paging, segmentation ,virtual memory, page replacement algorithms ; File systems: design and implementation of file systems; Input /Output systems; device controllers and device drivers; Security and protection ; Case studies on design and implementation of operating system modules.

BSDC* ZC365 Human Computer Interaction 3

Principles of human-computer interaction; Evaluation of user interfaces; Usability engineering; Task analysis, user-centered design, and prototyping; Conceptual models and metaphors; Software design rationale; Design of windows, menus, and commands. Voice and natural language I/O; Response time and feedback; Color, icons, and sound; Internationalization and localization; User interface architectures and APIs.

BSDC* ZC412 Software Design Principles 4

Software Development lifecycle; Role of high level and low level design in lifecycle. Object-Oriented Abstraction and Object Oriented Design. Design for Reuse and Design for Change – Refactoring. Design Patterns - History of Patterns in Building Architecture and Relevance to Software Design, Evolution of Software Design Patterns and Impact of Using Design Patterns in Lifecycle. Crosscutting Concerns and Aspects – Aspect Oriented Design. High-level design vs. Low-level design. Basic Architectural Elements and Styles – Layered Architectures and Event-Driven Architectures, MVC architecture in User Interfaces.

[Design as an activity will be an integral part of teaching and learning as well as evaluation for this course.]

BSDC* ZC413 Database Design 4

Introduction to database systems; DBMS Three-schema architecture; Conceptual data modelling-ER modelling and Extended ER modelling and use of UML in modelling databases; Relational query languages- Relational algebra and SQL; Database design- functional dependencies, normalization, normal forms and decomposition; Query processing and Optimization; Database tuning; Introduction to - Indexing, Transaction processing, Concurrency control and Recovery.

BSDC* ZC432 Applied Statistical Methods 3

Review of estimation and testing of hypotheses; Simple and multiple regression methodology through method of least squares, Multicollinearity and residual analysis, Categorical data handling through logistic regression; Multivariate data analysis by Hoteling T^2, Mahalanobis D^2, discriminant analysis, cluster analysis and factor analysis; Data handling and forecasting time series data by various components time series methodology; Statistical Quality Control of variables and attributes control charts; Non parametric data handling through Kruskal walls test, Mann Whitney and KS two sample test.

BSDC* ZC481 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

BSDC* ZC229T Design Project 5

Operate, maintain, design and develop software in innovative areas and activities of the industry; the student's actual day-to-day task involvement would constitute the central thread of the learning process. The evaluation will recognize this aspect by demanding day-to-day engagement and productivity of the student.

BSDC* ZC499T Capstone Project 15

Real life problems encompassing computing and design problems/requirements obtained from organizations/third party vendors; Jointly mentored by the industry experts and faculty; Presentation of theprogress and results in appropriate forms; Periodic review of progress of the project.

BTEE ZC212 Engineering Mathematics 3

Vector space, Linear System of equations, LU decomposition, Eigen Decomposition, QR decomposition, SVD decomposition, least square theory, Quadratic forms, Analytical function, Cauchy-Riemen theory, Laurent series, Cauchy-residue theorem, and Partial Differential equations.

BTEE ZC216 Probability Theory and Random Processes 4

Random variables, pdf, cdf, Basic theorems, standard distributions, sampling distributions, Testing hypothesis, Random process, WSS, Ergodicity, ARMA.

BTEE ZC214 Object Oriented Programming 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; overloading and overriding; static and dynamic binding; multithreaded programming; event handling and exception handling; process of object oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages. Object Oriented Design Patterns: Behavioral, Structural and Creational.

BTEE ZC213 Engineering Physics 3

Philosophy of Science; Newton's laws of motion; Work Energy, Impulse and Momentum, Equilibrium, Moment of a force, Rotation; Periodic motion; First law of thermodynamics, Second law of thermodynamics, Semiconductor physics,

Dielectrics, Quantum Mechanics.

BTEE ZC211 Elements of Electrical and Electronic Circuits 4

Types of current and voltage sources, KVL & KCL theorem, Mesh & Node analysis, Network Theorems, Transient behavior and initial conditions of RC, RL and RLC circuits, two-port network theorems, Review of diode circuits and transistor biasing circuits, transistor at low frequencies, feedback amplifiers & oscillators and introduction to FET.

BTEE ZC311 Analog Electronics 4

Introduction to operational amplifiers, characteristics of ideal and real operational amplifiers, applications of operational amplifiers, multifunction modules & circuits, true rms converters, Precision and signal conditioning circuits, Waveform Generation: sinusoidal and non-sinusoidal signal generation; Wave shape converters, 555 timer based circuits, Phase lock loop circuits & applications, IC regulators, Output stage and large signal amplifiers, Power amplifiers, Tuned amplifiers, Analog and Digital interface circuits: A/D, D/A Converters.

BTEE ZC314 Electromagnetic Theory 3

Scalar and vector fields, calculus of scalar and vector fields in Cartesian and curvilinear coordinates Electrostatics field, electric potential, work and energy, electric dipole; Electrostatics in Matter, Magnetostatics, divergence & curl of the magnetic field, magnetic vector potential, magnetic dipole; Magnetostatics in the matter, electromotive force, electromagnetic induction, Maxwell's equations in free space, plane wave solutions of Maxwell's equations in free space.

BTEE ZC313 Digital Control Systems 4

Time response of feedback control systems, stability analysis, stability analysis in the frequency domain, Introduction to digital control systems, modeling discrete-time systems, time response and stability analysis of discrete-time systems, and state space model

BTEE ZC315 Introduction to Digital Signal Processing 4

Introduction to DFT and its properties; Linear filtering methods based on DFT, FFT algorithms, design of analog filters, analog to analog filter frequency transformation, design of IIR digital filters: analog to digital transformation, IIT and BLT technique, design of FIR filter: Frequency sampling and windowing technique, design structures for the realization of digital IIR and FIR filters.

BTEE ZC316 Microwave and Antenna Theory 3

Transmission lines and resonators; Smith chart, and its applications in stub matching and impedance matching; microstrip lines; waveguides, microwave generators, S-parameters, passive microwave components, antennas and radiation, halfwave dipole antenna, antenna arrays, and different types of antenna.

BTEE ZC319 Information Theory & Coding 4

Information sources and source coding theorem, Kraft inequality, Shannon-Fano codes, Huffman codes, Arithmetic Codes, Lempel-Ziv-Welch algorithm, universal source codes; channel capacity: channel capacity; noisy channel coding theorem for discrete memoryless channels; channel capacity with feedback; continuous and Gaussian channels; error control coding: linear block codes and their properties, hard-decision decoding, convolution codes and the Viterbi decoding algorithm.

BTEE ZC322 Telecommunication Switching Systems & Networks 3

Evolution and history of electro-mechanical switching, Introduction to digital telephony- signaling, multiplexing-time, spatial domain; voice digitization, fundamentals of traffic engineering, digital switching-blocking probability, voice, and data compression; Network queues; Circuit & Packet switching; ISDN & ATM Networks; Channels-Digital microwave, fiber optic transmission; DSL, and SONET.

BTEE ZC416 Mobile Telecommunication Networks 4

History: 2G and 3G Network Architecture. LTE: Architecture, protocols, air interface, deployment strategy, coverage and capacity planning, 5G Network architecture, air interface and protocols. Other Wireless architecture.

BTEE ZC418 Satellite Communication 3

Introduction, historical developments, and research trends, Satellite orbits, orbit elements, orbital effects, satellite link parameters, uplink, and downlink budget, modulation, multiplexing, and error control coding, multiple access techniques, very small aperture terminal (VSAT), mobile sat (MSAT), the global positioning system (GPS), and differential GPS (DGPS) and recent trends in satellite communications.

BTEE ZC414 Introduction to Edge Computing 4

Edge architecture, edge to edge and edge to cloud communication, Sensor networks and related protocols, Distributed caching, Reliability, availability and energy efficiency in edge computing, Pipeline, Performance issues like latency and Data flow for Big data analytics.

BTEE ZC320 Introduction to IoT 4

Introduction to IoT; Sensors and Actuators for IoT; Programming IoT endpoints; IoT infrastructure and platforms; Industry applications of IoT; IoT application development; Communications and networking in IoT; Data management in IoT; Security issues in IoT; Emerging technologies.

BTEE ZC317 Communication & Networking Technologies for IoT 4

Wireless Communication & Network protocols – 802.11, BLE, NFC, LORA, Zigbee; Wireless Sensor and Ad hoc networks, Cross-Layer protocol optimization; Industrial and Automotive Networks, VANETS, Security issues and QoS in IoT Systems.

BTEE ZC412 Digital Image Processing 3

Introduction to multidimensional signal processing-- 2-D convolution and filtering, discrete-time Fourier, filter design 2-D sampling and reconstruction transform, human visual system, Brightness perception, Temporal properties of vision, 2-D Block transforms-- Walsh-Hadamard, Karhunen Loeve, Discrete Hartley, Filter Banks, and Wavelets, etc., Image Compression, Image Enhancement.

BTEE ZC419 Sensor Technologies 4

Sensor fundamentals and applications, shock & vibration sensors, pressure sensor, temperature sensor, bio & chemical sensors, capacitive & inductive sensors, flow & level sensors, Humidity sensor, IMU sensor, ultrasonic sensor, Sensing using EM waves - Radars & Lidars for distance measurement, Camera sensors - pinhole model, signal conditioning techniques, Sensor fusion techniques: Kalman and Extended Kalman filters.

BTEE ZC415 Machine Learning for Edge 4

Data pre-processing, Deep neural networks, Convolutional Neural Networks, Recurrent Neural Network, Generative Adversarial Networks, Reinforcement Learning, Sensor fusion techniques, Model compression - use cases and techniques, model deployment on the edge. Power, memory and latency considerations.

BTEE ZC321 Semiconductor Devices and Technologies 4

MOS Transistor Theory, MESFET Technology, MOS Fabrication, and Layout, VLSI Design Flow, Steps in 2D planar, 3D transistor-based nanofabrication, LSI, VLSI, ULSI era. Process nodes: definition, scaling, trends. Standard cell-based design and fabrication interconnect RC Delay Model, Linear Delay Model, processor constraints and verification, and statistical variations in fabrication and impact, yield: Manufacturing yield, Parametric yield.

BTEE ZC417 Modern Processor Architectures 3

Introduction to Multicore Architecture, threading in multicore architecture, Tiled Chip Multi-Core Processors & Network-on-Chip, Examples of Multicore architecture, Simultaneous multi-threading processor, Memory architectures and future memory technologies, Super Scalar architecture, GPU: Introduction, Architecture, graphics pipeline, optimization, GPU performance trend, and recent developments, GP-GPU, architecture for DNN computing systems, and cloud TPU architecture.

BTEE ZC420 SoC Design & EDA 4

Introduction to ASICs: Full custom, Semi-custom, and Programmable ASICs, ASIC Design flow, SOC: SOC design flow, Processor sub-systems, peripherals, bus systems, accelerators, IPS of SoC architecture, ARM- based case study, introduction to network on chip architectures and design methods, Digital system design optimization and trade-offs, EDA tools-Techniques and algorithms.

BTEE ZC413 FPGA-Based System Design 4

Overview of FPGA architectures and technologies: FPGA Architectural options, coarse vs. fine-grained architectures, Logic block architecture: FPGA logic cells, timing models, power dissipation I/O block architecture: Input and output cell characteristics, clock input, Timing, Power dissipation, Programmable interconnect, Partitioning, Placement, and routing, Applications - Embedded system design using FPGAs, DSP using FPGAs, Commercial FPGAs, Implementation of simple digital circuits using FPGA hardware, Dynamic architecture using FPGAs, reconfigurable systems application case studies.

BTEE ZC312 Communication Systems 4

Analysis and design of communication systems; analog and digital modulation and demodulation, frequency conversion, multiplexing, noise and distortion; spectral and signal-to-noise ratio analysis, probability of error in digital systems, spread spectrum. Introduction to basic principles of design and analysis of modern digital communication systems**.**

BTEE ZC215 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

BTEE ZC217 Digital Electronics and Microprocessors 4

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

BTEE ZC218 Signals and Systems 3

This course is intended to provide a comprehensive coverage of Signals and Systems, a fundamental subject of Electrical Engineering. The topics covered are: Continuous-time and discrete time signals and systems, convolution, properties of linear time-invariant (LTI) systems, Fourier series, Fourier transform, Z transform, Laplace transform; System analysis, frequency response, analog filters, Sampling and reconstruction.

BTEE ZC411 Computer Networks 4

Introduction: components of a modern computer network, packet switched network and its metrics, layered architecture of protocols and historical perspective; Application Layer: principles, examples: Web and HTTP, Email, DNS, Peer-to-Peer applications, socket programming; Transport Layer: Services, the concept of connection less, connection oriented and reliable transport, TCP congestion control; Network Layer: addressing mechanism in networks, router architecture, intra and inter-AS routing protocols, multicast and broadcast; Link Layer: error detection and correction, medium access, MAC addressing, Ethernet, switches, Point to point protocol and link virtualization; Physical Layer: signals, medium, and transmission methods, QoS: forward error correction, scheduling and policing mechanism in the networks.

BTEE ZG516 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum systems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

BTEE ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

BTEE ZG514 Optical Communication 4

Optical communication systems and components; optical sources and transmitters (basic concept, design and applications); modulators (electro-optic, acousto-optic and laser modulation techniques; beam forming; focusing and coupling schemes to optical repeaters; optical amplifiers; optical field reception; coherent and non-coherent lightwave systems; fibre optic communication system design and performance; multichannel lightwave systems; long haul communications; fibre optic networks.

BTEE ZG512 Machine Learning 4

Introduction to Machine Learning, Various kinds of learning, Supervised Learning, Unsupervised Learning, Model Selection; Bayesian Learning, MAP Hypothesis, MDL Principle, Bias Variance Decomposition, Bayes Optimal Classifier, Naive Bayes Classifier; Linear Models for Regression, Linear Models for Classification; Non-Linear models, Decision trees; Instance Based Learning, KNN Algorithm, CBR Learning; Support Vector Machines, VC Dimension; Neural Networks, Perceptron Learning, Back Propagation Algorithm; Introduction to Genetic Algorithms.

BTEE ZG511 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

BTEE ZC318 Computer Architecture 4

Processor performance criteria, performance benchmarks, arithmetic circuits, CPU design - instruction set architecture, instruction execution, Single and Multicycle implementation, Pipeline design, Hazards, methods of overcoming hazards, Branch prediction, Memory subsystems including cache optimization, Instruction level Parallelism.

BTEE ZG515 Real-Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

BTEE ZC425T Project Work 16

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD.

On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

BTSSE ZC212 Basic Electronics Circuits 4

Semiconductors - operation of diodes; Transistors; Biasing techniques and applications of diodes and transistors. Introduction to amplifiers and applications; Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; coders & decoders; memory design.

BTSSE ZC217 Introduction to Progressive Web Apps 4

Fundamentals of PWA: basics of HTML5, CSS, JavaScript; Comparison of PWAs with Mobile and Web apps; Service worker concept and lifecycle; Web App Manifest: Configuration and installation; Responsive design; Push notifications; App Shell Architecture; Cache management; Progressive enhancement; UX engagement; Testing, debugging, API integration, and deployment aspects of PWA.

BTSSE ZC218 Introduction to Scripting 4

Building scripts that control a sequence of programme steps in developing, testing, and deploying software; basics of Python scripting; using Python to automate tasks such as system administration, testing & quality assurance, task scheduling, data processing, configuration management and deployment.

BTSSE ZC317 Incremental Software Development 4

Practice-oriented course: Explore existing codebases; code analysis; code refactoring; optimization; system tracing and debugging, reengineering: modernize existing systems; software development in Agile and Continuous Integration environments.

BTSSE ZC312 Compilers and Code Automation 4

Interpreters vs. Compilers; Front-end and Back-end of a compiler; Intermediate Representation and Intermediate Languages; Virtual Machines and Just-in-time Compilers; Phases and Components of a compiler - Preprocessing, Scanning, Parsing, Syntactic and Semantic Analysis, Code Generation; Code Generation from Flowcharts and Models / UML Diagrams (Class Diagrams, Object Diagrams, and Sequence Diagrams). Business Process Modeling and Process Automation - BPML; Translating BPML to code; Domain Specific Languages - Macros and Syntax Extensions; Preprocessing and Macro-processing, Syntax Generation. Generative Programming. Modern code generation tools - Case studies.

BTSSE ZC311 Cloud Systems and Services 4

Basics of Cloud Computing; Cloud Service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS); Virtualization Technology: Hypervisors, Containers, and Serverless computing; Cloud provisioning for scalability: Horizontal scaling, vertical scaling and auto-scaling; Infrastructure provisioning: Infrastructure-as-Code, tools; Identity and access management: user identity, authentication, authorization, role-based access control; Cloud deployment: strategies, cloud migration, multi-cloud deployment; Cloud security and monitoring.

BTSSE ZC325 Software Testing and Automation 4

Introduction to software testing: methodologies and best practices; Software testing life cycle; Test planning and test strategy; Test case design; Testing techniques: black box, white box, regression, smoke etc.; Test automation: frameworks & tools, Types: unit testing, integration testing, regression, performance, security, GUI, cross-browser etc.

BTSSE ZC433 Security Practices in SDLC 4

Software engineering principles and best practices for designing secure systems; secure software development lifecycle (SDLC); secure software architecture and design - design principles, threat modeling, risk analysis; secure coding practices; techniques for software protection (such as code obfuscation, tamper-proofing and watermarking) and their limitations; secure software testing - techniques and tools for verification of software security; secure software deployment and maintenance - configuration management, deployment and patching process; secure software operations - logging, monitoring, incident response; secure software project management - security metrics and measurements.

BTSSE ZC435 Software Deployment 4

Continuous integration and continuous delivery; Scaling: automating infrastructure and infrastructure as-code; Use of virtual machines and containers for deployment; Micro-services; Application lifecycle management: deployment pipeline and application deployment, continuous deployment pipeline; Stack management - life cycle of stack and events, resource and event monitoring, auto healing; Security: security of deployment pipeline, policy-as-code.

BTSSE ZC417 Full Stack Web Development 4

Modern Web application architectures; Frontend and backend technologies; Web application frameworks; key patterns in Web development; Hands-on exposure to full stack Web development using some of the existing development frameworks; Design and implementation of end-to-end functional Web applications.

BTSSE ZC414 Data Analytics and Visualization 4

Learning types of data analytics; Data types; Data preparation – cleaning, aggregation, sampling, transformation, data quality, statistical description of data, the context of data visualization, graphical perception techniques for visual encoding and interaction; Choosing an effective visual and lessons in storytelling; Exploratory Data Analysis; Designing dashboard; Solving various visualization problems using tools like Tableau and Python.

BTSSE ZC411 Applied Data Mining and Machine Learning 4

Importance of Machine Learning; Types of Machine Learning- Supervised Machine Learning and unsupervised machine learning; Feature engineering; Supervised learning algorithms - linear regression, logistic regression, Naïve Bayes Classifier, Decision tree, K-Nearest Neighbours, Neural Networks, Ensemble learning, SVM; Unsupervised learning/data mining algorithms – clustering, association analysis, anomaly detection; Model selection and assessment; Machine learning workflow.

BTSSE ZC424 Introduction to Search Engines 4

Learning basics of text-based search engines; Information retrieval concepts; Statistical aspects of the text, text indexing, boolean and vector space retrieval models, ranked retrieval, text-similarity metrics; Text mining; Application of information retrieval techniques for web search, crawling, and link analysis.

BTSSE ZC437 Systems Programming for Constrained Devices 4

Profiling systems software; Characteristics and limitations of constrained devices; Systems software for constrained devices - Challenges (Processing Power, Memory, Energy / Battery Consumption, Bandwidth), Design considerations and programming strategies; Examples and case studies (such as browsers, databases, crypto, compression, and device drivers).

BTSSE ZC416 Distributed Systems 4

General introductory concepts in the design and implementation of distributed systems (e.g., Cloud Computing, Grid Computing, Cluster Computing) such as scheduling in multiprocessors, memory hierarchies, synchronization, concurrency control, fault tolerance including checkpointing, rollback recovery, distributed memory message passing, distributed shared memory programming models, memory consistency model, asynchronous computation, naming, distributed file systems, process, data and communication distribution, service registration, discovery and lookup, lifecycle management of distributed objects, event handling, logical time, global state and snapshot.

BTSSE ZC415 Distributed Programming 4

Shared Memory Programming vs. Distributed (Memory) Programming: Processes and Message Passing, Blocking and Non-blocking send and receive operations, cost of communication and impact on speedup; Programming Patterns and Frameworks: map-reduce, Failure recovery and resilience, In-memory distributed programming and the Spark platform: RDDs and Programming using RDDs, Lineage vs. Persistence. Messaging patterns: Broadcast, All-all broadcast, and scatter-gather. Common Data distribution models or patterns. Distributed Graph Data and Processing: Vertex cuts vs. Edge cuts. Querying Graph databases.

BTSSE ZC319 Introduction to IoT 4

Introduction to IoT; Sensors and Actuators for IoT; Programming IoT endpoints; IoT infrastructure and platforms; Industry applications of IoT; IoT application development; Communications and networking in IoT; Data management in IoT; Security issues in IoT; Emerging technologies.

BTSSE ZC422 Introduction to Augmented and Virtual Reality 4

Focuses on concepts, technologies, and applications of augmented reality (AR) and virtual reality (VR). Students will learn about the underlying principles, development tools, and design considerations for creating immersive AR and VR experiences and interactive and engaging AR/VR applications.

BTSSE ZC434 Social Network Analysis 4

Network as a tool for modeling complex social, technological, and biological systems; Emergence of online social networks and large-scale data availability in social sciences; Structure and analysis of massive network data; Information spreads through society; Robustness and fragility of networks; Algorithms for the World Wide Web; Prediction and recommendation in online social networks; Representation learning for large networks.

BTSSE ZC216 Introduction to Computing Systems 3

This course teaches a beginner what a computer is and how it can be programmed. The course starts with basic building blocks required to understand the structure of a computer: numbers, bits, structures to implement operations on numbers, and structures to control the execution of commands by a computer. The course progresses to introduce logic gates, combinational and sequential circuits. It introduces a simple processor design with a small instruction set architecture and basic assembly programming with that processor.

BTSSE ZC213 Discrete Structures for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

BTSSE ZC314 Data Structures & Algorithms 4

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; analysis of algorithms; Linear data structures – stacks, arrays, lists queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees.

BTSSE ZC313 Computer Organization & Architecture 4

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; Virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies; This course covers the fundamentals of computer organization and architecture from a programmer's perspective.

BTSSE ZC215 Environmental Studies 3

Environment, human population, and industrialization; natural resources and the impact of man-made activities on them; structure and function of ecosystem, population ecology, biodiversity and its conservation, environmental pollution, social issues and the environment, and environmental impact assessment.

BTSSE ZC324 Software Engineering 4

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

BTSSE ZC436 Software Design Principles 4

Software Development lifecycle; Role of high level and low level design in lifecycle. Object-Oriented Abstraction and Object Oriented Design. Design for Reuse and Design for Change – Refactoring. Design Patterns - History of Patterns in Building Architecture and Relevance to Software Design, Evolution of Software Design Patterns and Impact of Using Design Patterns in Lifecycle. Crosscutting Concerns and Aspects – Aspect Oriented Design. High-level design vs. Low-level design. Basic Architectural Elements and Styles – Layered Architectures and Event-Driven Architectures, MVC architecture in User Interfaces.

[Design as an activity will be an integral part of teaching and learning as well as evaluation for this course.]

BTSSE ZC323 Operating Systems 4

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, inter process communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules, select laboratory experiments related to creating different elements of operating system and/or implementation of select scheduling, memory management and I/O related algorithms/schemes, using system calls for creating file system specific command, creating simple file system etc. via online laboratory facility.

BTSSE ZC315 Database Systems & Applications 4

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, inter process communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output

systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules, select laboratory experiments related to creating different elements of operating system and/or implementation of select scheduling, memory management and I/O related algorithms/schemes, using system calls for creating file system specific command, creating simple file system etc. via online laboratory facility.

BTSSE ZC413 Computer Networks 4

Introduction: components of a modern computer network, packet switched network and its metrics, layered architecture of protocols and historical perspective; Application Layer: principles, examples: Web and HTTP, Email, DNS, Peer-to-Peer applications, socket programming; Transport Layer: Services, the concept of connection less, connection oriented and reliable transport, TCP congestion control; Network Layer: addressing mechanism in networks, router architecture, intra and inter-AS routing protocols, multicast and broadcast; Link Layer: error detection and correction, medium access, MAC addressing, Ethernet, switches, Point to point protocol and link virtualization; Physical Layer: signals, medium, and transmission methods, QoS: forward error correction, scheduling and policing mechanism in the networks.

BTSSE ZC211 Algorithm Design 3

Effective construction and analysis of algorithms. Understanding, application, and implementation of algorithm design techniques like divide-and-conquer, greedy, dynamic programming, and back-tracking. Worst case and average case analysis of algorithms. Basic notions of complexity classes – P, NP, and NP-complete and Reduction.

BTSSE ZC318 Information Security 3

Program security, Web security, Database security, Protection in operating systems, Cloud security fundamentals; Privacy and Anonymity in computing; Legal and ethical issues in security, Secure programming and Trusted systems design; policy, administration and procedures; auditing; physical security; content protection.

BTSSE ZG512 Cloud Native Development 3

Basics of cloud computing. Different types of services; Virtual machines vs Containers deployment; Characteristics of cloud native application; Elements to build cloud-native applications; Cloud native architecture and micro-services; Design, decomposition of applications to micro-services; Developing micro-services; Interactions with data services and databases.

BTSSE ZG511 Advanced Topics in Software Engineering 4

Recent and emerging topics in software engineering will be discussed in detail with the help of latest publications, software product information and industry practice.

BTSSE ZC321 Modern Databases 4

Different types of content - Structured vs. Unstructured vs. Semi-structured data, notion of Atomicity (or Consistency) ACID vs. BASE; Strong vs. Weak Consistency model; Serializability; Eventual Consistency; CAP Theorem and Implications; Solution models and Design Examples (some of MongoDB, REDIS, Cassandra, Neo4j); Document stores, Key-Value Stores, Column stores, Graph stores and languages for their query processing, In-memory databases, and cloud databases (E.g, Amazon RDS); Exposure to application development.

BTSSE ZC425 Introduction to Statistical Inference 3

Parametric point estimation; Unbiasedness; Consistency; Uniform minimum variance unbiased estimator; Method of moments; Maximum likelihood estimation and its properties; Lower bounds for the variance of an estimator; Sufficiency; Factorization theorem; Best equivariant estimators; Tests of hypotheses; Neyman-Pearson lemma; uniformly most powerful (UMP) tests; Likelihood ratio tests; Chi-square tests; Methods for finding confidence intervals.

BTSSE ZC322 Multi-Core Programming and GPGPU Programming 3

Multi-threaded Programming. Review of multicore processors and caching. Shared Memory Programming in the multi-core context. – Use of Locks for Synchronization. Shared Memory data structures - Synchronization issues and models, Lazy synchronization, Design of shared memory data structures. Review of GPGPU architecture and GPGPU programming model. Programming with many-core processors and NUMA. CUDA Programming.
Pre-requisite: BCS ZC216 Computer Systems and Performance

BTSSE ZC320 Microprocessors and Interfacing 4

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams ; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system . This course will have laboratory component.

BTSSE ZC316 Human Computer Interaction 3

Principles of human-computer interaction; Evaluation of user interfaces; Usability engineering; Task analysis, user-centered design, and prototyping; Conceptual models and metaphors; Software design rationale; Design of windows, menus, and commands. Voice and natural language I/O; Response time and feedback; Color, icons, and sound; Internationalization and localization; User interface architectures and APIs.

BTSSE ZC430 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codecs, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

BTSSE ZC418 Fundamentals of Finance and Accounts 3

Introduction to basic accounting principles for measuring and communicating financial data, single and double entry, ledgers, journals, trading, profit and loss and appropriation accounts, trial balance and balance sheet; cash flow statements, risk-return trade off notions, security analysis, structure of capital market, primary and secondary market, introduction to financial system and its components, financial market reforms.

BTSSE ZC431 Principles of Economics 3

Nature and scope of economic science, its relationship with other social sciences; quantification of economic variables, theories of consumer behaviour and of the firm: linear economic models; market structures; social accounting and basic elements of economic planning.

BTSSE ZC426 Investment Management 3

To be developed

BTSSE ZC421 Information Law and Cyber Law 3

Information related crimes and Cyber-crimes and methods to contain them; National and International laws and IT acts. Economic considerations related to the use and management of digital data; Legal and policy issues, rights, responsibilities, and potential liabilities of parties in information exchange and digital transactions; Cyber laws; Introduction to intellectual property, IPR, legal and technical aspects; Digital rights management: Tools, Standards and Techniques.

BTSSE ZC429 Legal Software 4

To be developed

BTSSE ZC420 Health Systems Management and Environmental Health 4

To be developed

BTSSE ZC432 Public Health & Diseases 4

Tropical diseases – their geography, identification, treatment methods, medicines, design of standard protocols and immunization processes including planning and execution; infections due to ticks and mites; bacterial, parasitic and viral infections- types and their classification, host–parasite relationships, their mode of proliferation, mechanisms of infestation, carriers, preventive methods and processes; understanding the public health problems related TB, AIDS, leprosy, GI infections and other communicable diseases.

BTSSE ZC419 Health Informatics 4

To be developed

BTSSE ZC423 Introduction to Digital Manufacturing 4

To be developed

BTSSE ZC427 IoT for Manufacturing 4

To be developed

BTSSE ZC412 Automotive Software 4

To be developed

CBDA ZG511 The Hadoop Framework 1

Distributed computing environments for Big Data; Distributed storage and processing of Big Data using the MapReduce programming model; High-level programming for the environment.

CBDA ZG521 ETL & Batch Processing with Hadoop 2

Fundamentals of Data Warehousing and ETL, ETL vs. ELT, Data Lakes; Data Ingestion – Data Ingestion for structured and unstructured data, Data ingestion in the context of distributed and map-reduce execution platforms; Event processing – flows, tools and technologies for event processing, complex event processing applications; Workflow Management - workflow specifications and processing, tools, and interfaces with distributed platforms.

CBDA ZG531 Big Data Analytics using Spark 3

Introduction to Streaming Data – characteristics and sources, Processing of Streaming Data – components and architecture of a typical real-time / streaming processing system; Analytics Tasks – Regression, Classification, and Clustering; Tools and Platforms for implementing Analytics Tasks; Regression – definition, use-case and example, using a tool to implement regression; Classification – definition and use-cases; representing classes using a tree; Overcoming tree limitations with Random Forest; using a tool to implement a classifier; Clustering – definition and use-cases, notion of similarity, k-means clustering and hierarchical clustering, using a tool to implement a clustering solution; Case studies of Analytics.

CBDA ZG541 Capstone Project 2

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project that demonstrates application of knowledge and skills acquired through the program. This is an unstructured open-ended course where under the supervision of a mentor, the student will carry out the project and must submit a project report and an artifact (such as a design, system, or software) as a culmination of his / her endeavor and investigation.

CBDE ZG511 Foundations of Big Data Systems 2

Understanding Big Data – Big Data Sources and Applications, Characteristics, Processing Requirements and Constraints; Structured and Unstructured Data. Storing and Exchanging Big Data – Review of Data Structure Design, Data Structures for exchanging large volumes of data, Search trees and Queries including range search. Algorithm Design for Big Data – Review of Divide-and-Conquer, Design of Distributed Algorithms using Divide-and-Conquer, Select Design Patterns for Distributed Algorithms including Map and Reduce.

CBDE ZG521 Platforms for Big Data 2

Distributed Computing Environments for Big Data – Clusters and Map-Reduce Execution, In-memory vs. Persistent Data Stores, Distributed FileSystems for Map-Reduce based processing, NoSQL databases, and high- level programming using parallel data flows. Programming environment and constructs for distributed in-memory processing. Data Store on the Cloud - introduction to Cloud as a platform for storage and execution, concept of virtualization and its usage in the context of deploying storage and applications on the cloud, simple object store and databases on cloud.

CBDE ZG531 Processing Big Data - ETL & Batch Processing 2

Data Warehousing – fundamentals of Data Warehousing and ETL, ETL vs. ELT, Data Lakes, Batch Processing. Data Ingestion – Data Ingestion for structured and unstructured data, Data ingestion in the context of distributed and map-reduce execution platforms. Event processing – flows, tools and technologies for event processing, complex event processing applications. Workflow Management - workflow specifications and processing, tools, and interfaces with distributed platforms. Batch processing on the Cloud – elastic processing and models.

CBDE ZG541 Processing of Real-Time Data and Streaming Data 1

Introduction to Streaming Data – characteristics and sources. Processing of Streaming Data – components and architecture of a typical real-time / streaming processing system. Stream Processing – sourcing and modeling, abstractions, platforms, and programming interfaces used for processing streams, windowing / micro-batching techniques. Case studies and applications.

CBDE ZG551 Big Data Analytics 1

Analytics Tasks and Cases – Regression, Classification, and Clustering. Tools and Platforms for implementing Analytics Tasks. Regression – definition, use-case and example, using a tool to implement a solution based on regression, visualizing and interpreting the results. Classification – definition and use-cases; classifier models - line, curve, and plane separating classes; representing classes using a tree; probabilistic representation of classes; classifier performance; using a tool to implement a classifier; visualizing results. Clustering – definition and use-cases, notion of similarity, unsupervised grouping, k-means clustering and deciding k, using a tool to implement a clustering solution, visualizing and interpreting results. Case studies of Analytics.

CBDE ZG571 Capstone Project 3

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project that demonstrates application of knowledge and skills acquired through the program. This is an unstructured open-ended course where under the supervision of a mentor, the student will carry out the project and must submit a project report and an artifact (such as a design, system, or software) as a culmination of his / her endeavor and investigation.

CC* ZC447 Data Storage Technology and Networks 4

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Storage arrays, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy

Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids, Storage QoS – Performance, Reliability, and Security issues, Object storage, Storage as a Service, Software defined storage

CC* ZG501 Introduction to Parallel and Distributed Programming 4

Parallel and distributed programming on shared memory model and distributed memory model, SPMD systems, peer-to-peer / client-server / event-driven programs, mutual exclusion, deadlocks, synchronization, debugging and profiling code, secure programming, resource efficiency, use of standard packages - such as OpenMP, OpenMPI.

CC* ZG502 Cloud infrastructure and Systems Software 5

Introduction to Computer Systems, Memory Organization, Processor architectures, Process Management, Process Coordination, Memory Management, Basic concepts of a Cloud Data Center, Cloud resource virtualization, Cloud resource management and scheduling, Performance analysis and benchmarking, Cloud operating systems - Building a private Cloud using OpenStack.

CC* ZG503 Network Fundamentals for Cloud 4

Network fundamentals - OSI model, TCP/IP model, Routing, Switching, Addressing, VLANs; introduction to software defined networking - architecture, SD-WAN, SD-LAN, Openflow; introduction to network function virtualization - architecture, examples and use-cases; data center networking - underlay networks, overlay networks, multiple data center networks; hybrid cloud networking; application layer networking - application load balancers, api gateways, content delivery networking; infrastructure layer networking - VPCs, network load balancers; cloud network services - cloud DNS, cloud NAT, cloud VPNs; container networking - virtual ethernet interfaces, single-host and multi-host container networking, kubernetes networking; cloud network security - network segmentation, next generation firewalls, IPS systems; network measurements and performance.

CC* ZG504 Security Fundamentals for Cloud 4

Cloud security foundations; shared security model; identity, entitlement and access management - authentication techniques, access control methods, entitlement management, federated identities, IAM protocols; cloud infrastructure security; cloud network security - firewalls, IPS, segmentation; cloud storage security; securing hybrid cloud deployments; microservices and container security; secure serverless architectures; cloud data security; security verification - vulnerability assessment and penetration testing; cloud security posture management - threat modeling, risk visualization and assessment, vulnerability management, cloud instrumentation; cloud defense and recovery techniques - security information and event management (SIEM), security orchestration and automated response (SOAR), intrusion detection, incident response, cloud forensics, business continuity planning and disaster recovery techniques; cloud governance, risk and compliance.

CC* ZG505 Cloud Economics 4

Cost drivers and unit economics in a Cloud solution, key terminologies for Cloud expenses, understanding of billing plans and pricing options, cost allocation in an organization, optimization in terms of paying less vs using less, case studies on cost optimization options, impact of containerization in cost allocation, cost conscious solution architecture using case studies, migration decisions, SLA/SLO articulation, Cloud provider strategies for resource allocation.

CC* ZG506 API-driven Cloud Native Solutions 5

Analyze, Design, Develop and Deploy cloud native applications in innovative areas such as Artificial Intelligence/Machine Learning (AI/ML), IoT, Data Analytics etc.; Build an end to end complex application; Extensive usage of well-known PaaS/APIs; Demonstration of compliance with relevant, industry adapted best practices; Deployment using modern strategies; Presentation of the milestones and outcomes in appropriate forms; Periodic review of progress of the project by faculty.

CC* ZG507 DevOps for Cloud 5

Introduction to DevOps; need and evolution; culture - process, people and technology; agile methodology for DevOps; containerization with Docker, container orchestration with kubernetes; continual service - continuous integration and continuous delivery / deployment; version control, configuration management; DevOps and Cloud - use of virtual machines and containers for multi-cloud deployment, automated cloud migration in DevOps, stack management - life cycle of stack and events, resource and event monitoring, auto healing; cloud DevSecOps in practice; Infrastructure automation with GitOps - infrastructure-as-code (IaC) and building CI/CD pipelines; DataOps - pipeline environment, orchestration and continuous integration; MLOps - pipelines, strategies, challenges and containerization.

CC* ZG508 Design and Operation of Data Centers 5

Data Center Design: Principles (Scalability, Reliability, and Elasticity), Components - Computing Infrastructure (Processing, Storage, and Networking) and Physical Infrastructure (Power, Cooling, and Physical Security); Servers – Server Hardening, Server Optimization, Server Deployment and Consolidation, Converged and Hyper-Converged Infrastructure. Application monitoring and maintenance. Networking for data centers – device hardening, bandwidth aggregation, traffic management, redundancy, network isolation, deployment of internal security and peripheral security; Contingency Planning & Disaster Recovery: Backup, recovery, and redundancy /replication technologies and approaches. Data Center Architecture: Private, Public, and Hybrid models; Distributed Data Centers; Introduction to Software Defined Data Centers. Costing and Pricing– Costing and Cost Optimization, Pricing and Economics of Data Center Operation.

CC* ZG515 Data Warehousing 5

Need and evolution of data warehousing; Goals, benefit, and challenges of data warehousing; Architecture; Approaches-Data Marts/ODS/DataLakes/DataLakeHouse; Data warehouse design; ETL, ELT, EtLT and Data Quality; OLAP & Multidimensional Analysis, Business Intelligence; Query performance enhancement techniques; Metadata management; Infrastructure and Physical design process; Data lake design: ingestion, storage (conventional / multi-modal / data-dumps), processing (batch / incremental / streaming, in-memory); Deployment: on-premise, cloud, hybrid; Cloud Data Warehousing: Topologies, Provider Selection, Configuration, Management; Migration from on-prem to cloud DW; Real Time data warehousing.

CC* ZG522 Big Data Systems 5

What is big data - are existing systems sufficient?; Data Warehouse v/s Data Lakes; Hadoop – Components; Storage - Relational DBs/ NoSQL dbs / HDFS / HBase / Object Data stores - S3; Serialization; Interfaces - Hive/ Pig; Stream Processing; Spark; Mahout.

CC* ZG526 Distributed Computing 5

The course focuses on the fundamental principles and models underlying all aspects of distributed computing. It addresses the principles underlying the theory, algorithms and system aspects of distributed computing. The course covers topics such as Logical and Vector clocks, Global state and Snapshot recording algorithms, Basic distributed algorithms, Message Ordering and termination detection, Distributed Mutual Exclusion & Deadlock detection, Consensus and Agreement Algorithms, Peer-to-Peer computing and Overlay graphs, Cluster Computing, consistency models, Paxos algorithm, example distributed databases.

CC* ZG527 Cloud Computing 5

Introduction to Cloud Computing, Virtualization Techniques and Types, Infrastructure as a Service, Container Technology, PaaS and SaaS, Capacity management and Scheduling in cloud computing, Issues and Challenges: Availability, Multi-Tenancy, Security and SLA, Overview of Cloud data storage, Programming models / architectural styles, Deployment and operations.

CC* ZG532 Introduction to Data Science 5

Data Analytics, Data and Data Models, Data wrangling, Feature Engineering, Classification and Prediction, Association Analysis, Clustering, Anomaly Detection, exploratory / explanatory data analysis with visual storytelling, Ethics for Data Science.

CC* ZG538 Infrastructure Management 4

Introduction to Systems Management of IT Infrastructure and ITSM; Introduction to Site Reliability Engineering (SRE): basic concepts and applicability, relation to traditional ITSM and DevOps, SRE view of a production Cloud environment; Core principles of SRE: using error budgets, risk assessment, identifying SLO metrics to manage application SLAs, monitoring distributed systems, approaches to automation, release engineering and change management, simplicity as the means to reliability; Techniques to make a service reliable: observability, alerting on time series data, incident response and management, root cause analysis, testing for reliability, capacity planning, load balancing at various levels and handling overloads or cascading failures; Special considerations for managing large scale systems: distributed consensus for reliability, distributed scheduling of periodic compute jobs, managing data processing pipelines, management of Virtual Resources, automated resource management - Infrastructure as Code.

CC* ZG556 Stream Processing and Analytics 5

Real Time , Streaming Data & Sources, Real time streaming system architecture , Characteristics of a Real Time Architecture and Processing ; Configuration and Coordination Systems: Distributed State and Issues, Coordination and Configuration using Apache Zoo Keeper; Data Flow Management : Distributed Data Flows , Various Data Delivery and Processing Requirements, N+1 Problem, Apache Kafka (High-Throughput Distributed Messaging); Processing Stream Data with Storm; Overview of Data Storage – Requirements: Need for long-term storage for a real time processing framework, In-memory Storage, No-Sql Storage Systems, Choosing a right storage solution; Visualizing Data :Requirements, Principles and tools; Bounds of Random variables, Poisson Processors, Maintaining Simple Statistics from Data Streams, Sliding Windows and computing statistics over sliding windows, Data Synopsis (Sampling, Histograms, Wavelets, DFT), Exact Aggregation, Timed Counting and Summation, Multi Resolution Time Series Aggregation, Stochastic Optimization; Statistical Approximation to Streaming Data: Probabilities and Distributions, Sampling Procedures for Streaming Data, Approximating Streaming Data with Sketching, Registers and Hash Functions, Working with Sets, The Bloom Filter, Distinct Value Sketches, The Count-Min Sketch; Clustering techniques for Streaming Data; Classification methods : Decision Tree (VFDT); Evaluating stream processing algorithms; Case Studies in Designing solutions to streaming data

CC* ZG566 Secure Software Engineering 5

Best practices for designing secure systems, software engineering principles for designing secure systems, criteria for designing secure systems; analysis of system properties and verification of program correctness; use of formal methods and verification for security; tools for verification of security properties; techniques for software protection (such as code obfuscation, tamper-proofing and watermarking) and their limitations; analysis of software based attacks (and defenses), timing attacks and leakage of information, and type safety.

CC* ZG583 Scalable Services 5

Software principles related to scalability. Architectures for Scaling. Microservices - design, service discovery, load balancing, API management. Deployment - container configurations and orchestrations, automated deployments of microservices, integration with CI/CD pipelines. Performance: Scaling and load balancing with containers and microservices, Ensuring QoS and SLAs.

CC* ZG586 Edge Computing 5

Introduction, What Is Edge Computing, Edge, Fog and Cloud, edge to edge and edge to cloud communication, Sensor networks and related protocols, Key Techniques that Enable Edge Computing, Definition, Benefits, Edge Computing Systems, Multi Access Edge Computing, To Edge or Not to Edge, The Cloud Part of MEC, The Edge Part of MEC, The Access Part of MEC, Challenges and Opportunities in Edge Computing, Service Management, Privacy and Security, Application Distribution, Edge Computing Tools, Virtualization, Resource Management, Edge Analytics, Conceptual Framework for Security and Privacy in Edge Computing, Overview of Security, Privacy, and Threats in Edge Computing, Framework for Security and Privacy in Edge Computing, case study and use cases, Edge computing and the Hybrid and Distributed Cloud.

CFSE ZG511 Overview of Full Stack Engineering 2

Overview of the modern application landscape; Typical structure of an end-to-end application: components and connections; Design considerations and implementation choices; Case study for each of the topics discussed.

CFSE ZG521 Web Development5

Components of front-end web application development: User interfaces, rendering, Document Object Model, Event and State handling; Languages/tools such as HTML, CSS, JavaScript, AJAX; Web apps development frameworks; Components of back-end web development: Web Server essentials; Server Side scripting; REST architecture; Database interactions; Integration with code repositories.

CFSE ZG531Mobile Application Development 2

Mobile application building blocks such as the screens (UI), background services; Communication between the application components; Application development using native multi-platform development; Interaction of applications with Internet resources, REST APIs, databases; Unit testing of applications; Integration with code repositories.

CFSE ZG541Cloud Native Development 3

Basics of cloud computing. Different types of services; Virtual machines vs Containers deployment; Characteristics of cloud native application; Elements to build cloud-native applications; Cloud native architecture and micro-services; Design, decomposition of applications to micro-services; Developing micro-services; Interactions with data services and databases.

CFSE ZG551Agile and DevOps 3

Overview of Agile methodology: Scrum, Test driven development, DevOps, Continuous Integration/Continuous Delivery (CI/CD); Code repository: Multi-user, distributed development, version control; Continuous inspection of code quality; Build and build tools; Automated Testing; Integration tools; Implementing CI/CD.

CFSE ZG561Deployment of Micro-services 2

Containerizing applications by creating container configuration files and build processes; Manage deploying, scaling, and updating applications with micro-services using container management platforms such as Kubernetes; Configure and launch auto-scaling, self-healing clusters; Best practices for container management, when architecting and developing new micro-services.

CFSE ZG571Capstone Project 4

Full stack applications demonstrating the UI, server, and database components of an end-to-end multi-user application; Usage of one or more well-known development frameworks; Demonstration of scalability and reusability by applying design concepts such as microservices and container-based deployment on the cloud; Demonstration of compliance with principles of agile and CI/CD.

CGM* ZC411 Marketing 3

Definition and scope, fundamentals of consumer behaviour, competitive behaviour, demand estimation, new product introduction, channels of distribution, advertising and other sales promotion, positioning, marketing regulation, market research, basics of industrial marketing.

CGM* ZC421 Financial and Management Accounting 3

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, fundamentals of financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, basics of cost accounting.

CGM* ZC431 Quantitative Methods 3

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation,testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods,fundamentals of time series analysis, index numbers, decision theory, applications of various statisticalsoftware and spreadsheets.

CGM* ZC414 Managerial Economics 3

Fundamental concepts, supply, demand, market mechanism; theory of demand (consumer behaviour);production costs (theory of firm); market structures (perfect competition, monopoly, monopolisticcompetition, oligopoly); circular flow of income, fundamentals of money and banking, employment, interest,inflation; basic concepts relating to economics of information, adverseselection, moral hazard problem,market failure, externalities, public goods.

CIOT ZG511 IoT Technology and Applications 3

Introduction to IoT and Cyber-Physical Systems; IoT Enabling Technologies; Different Levels of IoT Systems; IoT Design Methodology; Introduction to IoT Platforms and End Devices, Introduction to IoT Network and Cloud Services; IoT Applications - Design Challenges; Basic Architecture and Components.

CIOT ZG521 Hardware Architectures for IoT 4

This course covers the concepts necessary for designing IoT device hardware and developing optimal firmware to meet the demands of IoT applications which include time critical response, low power consumption, fault tolerance etc. Topics include - Low power processor and microcontrollers – architecture, programming & interfacing; IoT platforms; Memory architectures- Cache, Memory Management and Memory protection, Speed Vs power optimizations; On-board / On-chip buses and I/O interfaces.

CIOT ZG531 Communication and Networking Technologies in IoT 3

Wireless Communication & Network protocols – 802.11, BLE, NFC, LORA, Zigbee; Wireless Sensor and Ad hoc networks, Cross-Layer protocol optimization; Industrial and Automotive Networks, VANETS, Security issues and QoS in IoT Systems.

CIOT ZG541 Sensors, Actuators, and Signal Processing 3

Sensing Technologies for remote data gathering; Sensors and actuators of varied complexity; Signal Acquisition, Processing and Conditioning; Sensor fusion, Smart Sensors and interface to the internet; Introduction to advanced Sensing technologies-HCI in IoT, BCI in IoT; Control of actuators via Internet.

CIOT ZG551 Software and Programming in IoT4

Operating Systems for IoT applications; Building Android applications; Web server implementation and deployment; Commonly used software tools and technologies for IoT

CIOT ZG561 Data Management in IoT 2

This courses covers topics in management of data in the context of the Internet of Things. Specific topics include Data sources in IoT and Data Types in IoT, Data-centric IoT products, Flow of Data, Challenges in managing IoT Data; Data Models and Data acquisition in Wireless Sensor Networks (WSNs), Query Processing and Query Optimization in WSNs, Sensor Data Cleaning and Storage, Embedded Database Systems; Data Acquisition in RFID Networks – RFID data cleaning and data preparation; Stream Processing – Event Processing, Event Processing in RFID, Mining Data Streams – Clustering, Classification, Frequent Pattern Mining, Change Detection, Dimensionality Reduction, Forecasting; Big Data Management in IoT – Big Data Storage and Processing, Distributed Processing – Issues and solutions. Case studies.

CIOT ZG571 Capstone Project 3

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project that demonstrates application of knowledge and skills acquired through the program. This is an unstructured open-ended course where under the supervision of a mentor, the student will carry out the project and must submit a project report and an artifact (such as a design, system, or software) as a culmination of his / her endeavour and investigation.

CMP* ZC411 Managing People & Organizations 3

Fundamental concepts and principles of management as applied to a variety of organizations; elementary study of managerial roles, styles, activities and decision making; relationship with organizational effectiveness; basic concepts relating to planning activities, manpower development; basic concepts relating to organizational behaviour.

CMP* ZC426 Operations Management 3

Fundamentals of production systems; product and process design; facility location & layout; operations scheduling and control; productivity of operations; fundamentals of inventory planning & independent demand systems; MRP; basic concepts relating to quality management; Japanese approach to operations management (JIT, TPM, continuous improvement).

CMP* ZC437 Lean Manufacturing 4

Fundamentals of continuous improvement, value added and waste elimination, elements of lean production:small lot production, setup time reduction, maintaining and improving equipment, pull production systems,focused factories and group technologies, work cells and cellular manufacturing, standard operations, qualityof design, systems for eliminating defects, basics of production planning and control systems: scheduling forsmooth flow, synchronizing and balancing process, planning and control in pull production.

CMP* ZC422 Total Quality Management 3

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous processimprovement; supplier partnership; performance measures; statistical process control; ISO 9000;benchmarking; quality function deployment.

CNSS ZG511 Sanitation Technology 5

This course aims to give the participants a review of the fundamentals as well as the latest technological developments applied in the field of sanitation. Urban Drainage and Sewerage, Carbon, nitrogen and phosphorus removal & recovery; sludge treatment, Site evaluation; toilets; onsite sanitation systems; emptying and transport; established and transferring technologies for dewatering, stabilization, pathogen inactivation and nutrient management, urban low

cost drainage, Innovation processes, Intro & Exercise technology selection tool / decision support system; discuss outcomes

CNSS ZG512 Sanitation and Public Health 5

This course will have four modules – Introduction to Sanitation, Sanitation system and services, Public Health and Analysis of sanitation flow. Background on urban sanitation, Material flow analysis, Monitoring frameworks, Shit Flow Diagrams, Human Health Hazards and Waste, Review and Assessment of Transmission Routes, Review and Assessment of Transmission Routes, Disease Cycles – Lifecycles & Vectors, Control Measures, Risk Evaluation Tools, Urban development trends, demography, Urban sanitation planning & programming

CNSS ZG513 Sanitation Governance, Behavioral Change and Advocacy 5

This particular course will have two modules – Sanitation Governance and Behaviour change & Advocacy. Water & sanitation governance: definitions, debates, controversies, Power relations among actors in the local and global levels: Gender, class & race relations and power asymmetries, Practices of coordination & decision, making around contested water distribution, Case studies on regulatory frameworks around the world – how is sanitation managed: where, how and why, Everyday sanitation from different perspectives. Behaviour with reference to Societal and cultural aspects, Types: Knowledge, motivations and reactions, Reinforcements: Norms and behaviour Settings

CNSS ZG515 Emergency Sanitation & Leadership 5

This course will have two modules – Emergency Sanitation and Leadership. The evolution of humanitarian aid: historical events and the humanitarian system as it stands today. Overview of the international legal framework (Refugee law, International Humanitarian Law-IHL, International Disaster Relief Law-IDRL), code of conduct and guiding principles of humanitarian action. Standards applied by relief agencies and global cluster, Sphere, WASH cluster. Disaster cycle, risk reduction/ response/ recovery/ development, emergency response phases. Overview of relief organizations, their mandates, their commitments and priorities in emergencies.

CS ZC444 Real-Time Systems 3

Introduction to real-time systems, clock synchronization, task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time databases, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

CS ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

CS ZG525 Advanced Computer Networks 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

CS ZG551 Advanced Compilation Techniques 5

Generic Code Optimization Techniques - loop optimization, inlining, and other transformations. Impact of architectures on code generation and optimization: RISC architectures, VLIW architectures, special-purpose architectures. Architecture-specific code optimizations – register allocation, instruction scheduling. Code Optimizations under real-time / embedded constraints - cacheless / diskless memory models, bounded time responses. Garbage Collection Techniques. Virtual Machines and Just-in-Time Compilation techniques - HotSpot-like optimizations. Implementation of exception handling, concurrency, and generic jumps (like call/cc).

CS ZG623 Advanced Operating Systems 5

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution,agreement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, threads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

CSI* ZC132 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

CSI* ZC163 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

CSI* ZC213 Probability & Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

CSI* ZC252 Discrete Structures for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

CSI* ZC263 Digital Electronics &Microprocessors 4

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

CSI* ZC311Information Security 3

Program security, Web security, Database security, Protection in operating systems, Cloud security fundamentals; Privacy and Anonymity in computing; Legal and ethical issues in security, Secure programming and Trusted systems design; policy, administration and procedures; auditing; physical security; content protection.

CSI* ZC313 Object Oriented Programming & Design 4

Object oriented concepts and design, abstraction, architecture and design patterns, GUI programming and frameworks, design of object oriented solutions using UML, design for concurrency, implementation of solutions using object oriented languages like C++ or Java; Language level mapping and realization of object oriented constructs, realization and performance issues versus abstraction and usability.

CSI* ZC327 Systems Programming 4

Batch processing; Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces with focus on contemporary open source operating system-specific programming; laboratory experiments or programming assignments involving Unix/Linux System-specific Programming including shell-scripting via online laboratory facility.

CSI* ZC337 Database Systems &Applications 4

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS, database programming experiments involving use of SQL, database creation etc. via online laboratory facility.

CSI* ZC353 Computer Organization &Architecture4

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; Virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies; This course covers the fundamentals of computer organization and architecture from a programmer's perspective.

CSI* ZC363 Data Structures & Algorithms 4

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; analysis of algorithms; Linear data structures – stacks, arrays, lists queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees.

CSI* ZC364 Operating Systems 4

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, inter process communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules, select laboratory experiments related to creating different elements of operating system and/or implementation of select scheduling, memory management and I/O related algorithms/schemes, using system calls for creating file system specific command, creating simple file system etc. via online laboratory facility.

CSI* ZC424 Software Development for Portable Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and accessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

CSI* ZC447 Data Storage Technology and Networks 4

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Storage arrays, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids, Storage QoS – Performance, Reliability, and Security issues, Object storage, Storage as a Service, Software defined storage

CSI* ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

CSI* ZC463 Cryptography 3

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

CSI* ZC467 Computer Networks 4

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols, Laboratory experiments / assignments related to simulation of network protocols, programming simple network applications, implementing select routing algorithms via online laboratory facility.

CSI* ZG511 IT Infrastructure Projects & Processes 3

Course description to be developed

CSI* ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

CSI* ZG514 Data Warehousing 5

Need and evolution of data warehousing; Goals, benefit, and challenges of data warehousing; Architecture; Approaches-Data Marts/ODS/DataLakes/DataLakeHouse; Data warehouse design; ETL, ELT, EtLT and Data Quality; OLAP & Multidimensional Analysis, Business Intelligence; Query performance enhancement techniques; Metadata management; Infrastructure and Physical design process; Data lake design: ingestion, storage (conventional / multi-modal / data-dumps), processing (batch / incremental / streaming, in-memory); Deployment: on-premise, cloud, hybrid; Cloud Data Warehousing: Topologies, Provider Selection, Configuration, Management; Migration from on-prem to cloud DW; Real Time data warehousing.

CSI* ZG515 Introduction to DevOps 4

Continual Service - continuous integration and continuous delivery; Scaling: automating infrastructure and infrastructure-

as-code; DevOps and Cloud: platform-as-a service and DevOps, use of virtual machines and containers for deployment, Micro-services; application lifecycle management: deployment pipeline and application deployment, continuous deployment pipeline; stack management - life cycle of stack and events, resource and event monitoring, auto healing; Security: security of deployment pipeline, policy-as-code.

CSI* ZG518 Database Design & Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

CSI* ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum systems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

CSI* ZG522 Design and Operation of Data Centers 5

Data Center Design: Principles (Scalability, Reliability, and Elasticity), Components - Computing Infrastructure (Processing, Storage, and Networking) and Physical Infrastructure (Power, Cooling, and Physical Security); Servers – Server Hardening, Server Optimization, Server Deployment and Consolidation, Converged and Hyper-Converged Infrastructure. Application monitoring and maintenance. Networking for data centers – device hardening, bandwidth aggregation, traffic management, redundancy, network isolation, deployment of internal security and peripheral security; Contingency Planning & Disaster Recovery: Backup, recovery, and redundancy /replication technologies and approaches. Data Center Architecture: Private, Public, and Hybrid models; Distributed Data Centers; Introduction to Software Defined Data Centers. Costing and Pricing– Costing and Cost Optimization, Pricing and Economics of Data Center Operation.

CSI* ZG523 Introduction to Data Science 3

Context and use of Data Science. High-dimensional data, graphs, vectors in high dimensional space and large matrices; Algorithms for massive data problems, sampling techniques. Techniques for extracting information/patterns from data

CSI* ZG524 Middleware Technologies 4

Evolution of Middleware Technologies: Transaction Processing, Remote Procedure Calls, Message-Oriented-Middleware, Object Request Brokers, Web services and REST; Forms of Middleware: Enterprise Middleware, Web Middleware, and Cloud / Services Middleware; Middleware Elements: communication protocols, middleware protocols, data representation, server process control, naming and directory services, security, system management; Select case studies such as MS .NET, J2EE. Service Oriented Architecture: Loosely Coupled Systems, Business processes, Tiers, Architectural Choices; Resiliency in Middleware: resiliency techniques, hardware failures, communication failures, software failures; Performance and scalability in Middleware; Security in Middleware; Implementation Aspects: business process implementation, enterprise integration, web and database middleware (e.g. NoSQL middleware) change management. Case studies of Enterprise application architecture (EAI) - Eg. Tibco, Websphere.

CSI* ZG525 Advanced Computer Networks 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

CSI* ZG526 Web Technologies 4

Introduction to the World Wide Web. Web Application Architecture –2-tier and 3-tier architectures, RESTful applications, Web Services, and mash-ups; Hyper-Text Transfer Protocol (HTTP) and Web Servers – Case studies e.g. Apache and IIS; Deploying and tuning web servers. Web Application Front Ends: Markup (HTML and XML), Styling (CSS), and Scripting (Client Side and Serve Side Scripts, Objects and Document Object Models – APIs for parsing documents, Event Handling and Asynchronous Scripting). Application Deployment on the Web: Dynamic Back-ends, Database Connectivity, Unstructured Data and NoSQL. Web Security – Typical Security Solutions for the Web.

CSI* ZG527 Cloud Computing 5

Introduction to Cloud Computing, Virtualization Techniques and Types, Infrastructure as a Service, Container Technology, PaaS and SaaS, Capacity management and Scheduling in cloud computing, Issues and Challenges: Availability, Multi-Tenancy, Security and SLA, Overview of Cloud data storage, Programming models / architectural styles, Deployment and operations.

CSI* ZG528 Cyber Physical Systems 4

Course description to be developed.

CSI* ZG532 Introduction to Data Science 5

Data Analytics, Data and Data Models, Data wrangling, Feature Engineering, Classification and Prediction, Association Analysis, Clustering, Anomaly Detection, exploratory / explanatory data analysis with visual storytelling, Ethics for Data Science.

CSI* ZG533 Service Oriented Computing 4

Course description to be developed.

CSI* ZG538 Infrastructure Management 4

Introduction to Systems Management of IT Infrastructure and ITSM; Introduction to Site Reliability Engineering (SRE): basic concepts and applicability, relation to traditional ITSM and DevOps, SRE view of a production Cloud environment; Core principles of SRE: using error budgets, risk assessment, identifying SLO metrics to manage application SLAs, monitoring distributed systems, approaches to automation, release engineering and change management, simplicity as the means to reliability; Techniques to make a service reliable: observability, alerting on time series data, incident response and management, root cause analysis, testing for reliability, capacity planning, load balancing at various levels and handling overloads or cascading failures; Special considerations for managing large scale systems: distributed consensus for reliability, distributed scheduling of periodic compute jobs, managing data processing pipelines, management of Virtual Resources, automated resource management - Infrastructure as Code.

CSI* ZG582 Telecom Network Management 5

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

CSI* ZG656 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

DE* ZC415 Introduction to MEMS 4

Overview, history and industry perspective; working principles; mechanics and dynamics, thermos fluid engineering; scaling law; microactuators, microsensors and microelectromechanical systems; microsystem design, modeling and simulation; materials; packaging; microfabrication: bulk, surface, LIGA etc; micromanufacturing; microfludidics; microrobotics; case studies.

DE* ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

DE* ZG512 Finite Element Methods 5

Element properties, Iso parametric elements, Finite element methods and analysis, Applications in design including continuum mechanics, Dynamic systems, Heat conduction and Electrical potentials, etc. will be taken up.

DE* ZG613 Tribology 5

Introduction, lubricants and lubrication, surface texture, bearing materials, fundamentals of viscous flow, reynolds equation and applications, thrust bearings, journal bearings, squeeze-film bearings, hydrostatic bearings, gas bearings, dry and starved bearings, selecting bearing type and size, principles and operating limits, friction, wear and lubrication.

DE* ZG514 Fracture Mechanics 5

Introduction, energy release rate, stress intensity factor and complex cases, an elastic deformation at the crack tip, elastic plastic analysis through J-integral, crack tip opening displacement, test methods, fatigue failure, numerical analysis, mixed mode crack initiation and growth.

DE* ZG515 Computational Fluid Dynamics 5

Philosophy of computational fluid dynamics (CFD), governing equations of fluid dynamics, mathematical behavior of partial differential equations, basics of the numeric: basic aspects of discretization, grids with appropriate transformations, and simple CFD techniques, applications, numerical solutions of quasi-one-dimensional nozzle flows, numerical solution of a two-dimensional supersonic flow, incompressible couette flow, and supersonic flow over a flat plate, advanced topics in CFD.

DE* ZG521 World-Class Manufacturing 5

The world-class manufacturing challenge, developing a world-class manufacturing strategy, just-in-time, total quality, total employee involvement, world-class information systems, managing the change, methods and procedures; improved brainstorming methods, using the check-total quality - the first steps, getting people involved, monitoring world-class performance.

DE* G522 Advanced Composites 5

Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fibre reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibres, concept of microfibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture thoughness and fatigue; properties of fibre reinforcement and production technology of composites.

DE* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

DE* ZG525 Mechanical System Design 5

Concept of system design; modeling of structural and kinematic systems, and determination of system characteristics; reliability of systems; design of machine elements for specified reliability; concepts of optimization; techniques of design optimization for linear and non-linear problems.

DE* ZG531Concurrent Engineering 5

Introduction of concurrent engineering and need, concurrent engineering tools, advances in design and manufacturing engineering, design for manufacture, design for assembly, rapid prototyping, simulation, concurrent approaches to design, manufacturing and other aspects of engineering.

DE* ZG532 Quality Assurance and Reliability 5

Quality planning and control, economics of quality control, Specifications, tolerances and process capability studies, total quality control concepts in quality circles, quality incentives. Fundamental concepts of reliability engineering, Failure analysis, Reliability versus quality control, Systems reliability evaluation, reliability allocation, maintainability, and designing for reliability. Illustrative examples of design ensuring reliability to be taken up.

DE* ZG535 Advanced Engineering Mathematics 5

Boundary value problems; wave equations; nonlinear partial differential equations; calculus of variations; Eigen value problems; iteration problems including forward and inverse iteration schemes – Graham Schmidt deflation – simultaneous iteration method – subspace iteration – Lanczo's algorithm – estimation of core and time requirements.

DE* ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

DE* ZG542 Machine Tool Engineering 5

Design principles of machine tools; stiffness and rigidity of separate construction elements and their combined behaviour under load; design of stepped and stepless drives; electrical, mechanical and hydraulic drives; design of bearings and sideways; machine tool controls; machine tool dynamics; recent developments in machine tool design.

DE* ZG544 Design for Additive Manufacturing 5

Fundamentals of computer aided design, part modeling and analysis using contemporary tools, design for manufacturing & assembly particularly in additive manufacturing, design considerations for additive manufacturing, support structures in metal-based systems and lightweight structures.

DE* ZG545 Advanced Control Engineering 5

Modeling and classification of dynamical systems, properties and advantages of feedback systems, time-domain analysis, frequency-domain analysis, stability and performance analysis, state space analysis, controller design and root locus plot, compensator design and bode plot, non-linear plant control, model predictive control systems.

DE* ZG546 Model Based System Design 5

Review of numerical methods, dynamic programming, data interpolation and statistical analysis, modeling, linearization of nonlinear systems, modeling and simulation of mechanical, electronic and electric drive systems, hardware in the loop (HIL), model in the loop (MIL), simulation and real-time control, design of engineering structures for minimum weight and

maximum strength, dynamic models of multibody systems and analysis, thermal efficiency optimization using mathematical models, design of experiment methods to create models of physical systems.

DE* ZG548 Design for Industrial Internet of Things 5

IoT overview and technologies, smart devices and smart products, cyber-physical systems, smart devices and control system, integrating smart concepts into existing products, programming using IoT, implementing a small IoT project, wireless communication and technologies, case studies.

DE* ZG561 Mechanisms & Robotics 5

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

DE* ZG611 Dynamics & Vibrations 5

Steady and transient Vibration of single and multi-degree freedom systems. Systems with distributed mass and elasticity. Non-linear and self-excited vibrations, structural damping, Random vibrations, vibration analysis, vibration control - reduction, isolation and vibration absorbers.

DE* ZG612 Advanced Finite Element Modelling & Analysis 5

Creation of FEA models, performing analysis and interpreting the results for the following cases using industrial examples and case studies, including selection of elements, boundary conditions and loading, static analysis (plane stress & plane strain), nonlinear analysis, dynamic (modal , harmonic transient analysis), thermal analysis (conduction, convection, mixed boundary conditions), coupled (thermal + structural), fluid flow analysis, fatigue creep and fracture, crash analysis.

DE* ZG621 Computer Aided Analysis and Design 5

The course aims at developing complete self-reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

DE* ZG631 Materials Technology & Testing 5

Study of characteristics and technology of metals, plastics, rubbers, ceramics, polymers, composites, optical fibres and other modern engineering materials and their application with particular reference to Railways. Destructive and non-destructive testing techniques and their applications in Railways.

DE*ZG641 Theory of Elasticity and Plasticity 5

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.

DM ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

DM ZG521 Design for Additive Manufacturing 5

Fundamentals of computer aided design, part modeling and analysis using contemporary tools, design for manufacturing & assembly particularly in additive manufacturing, design considerations for additive manufacturing, support structures in metal-based systems and lightweight structures.

DM ZG531 High Precision Manufacturing 4

Introduction to high precision manufacturing processes. Process and design considerations of both conventional and non-conventional processes in micro and nano manufacturing. Applications of high precision manufacturing in the fields such as semiconductor devices, medical devices. Common quality defects in high precision manufacturing. Emerging trends in the field.

DM ZC472 Precision Engineering 3

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and micro finishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerancing.

DM ZG612 Advances in Materials, Composites & Plastics 4

Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fiber reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibers, concept of microfibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture toughness and fatigue; properties of fibre reinforcement and production technology of composites. Plastics and their processing technology including injection moulding, blow moulding etc. Mathematical modeling and simple computational techniques for the mechanics of composites and plastics. Applications of plastics and composite in automotive and aerospace structures. Advanced metals and alloys including titanium, aluminum and magnesium, Ceramic and metal alloys (CERMETS) including Aluminum based alloys and other ceramic components.

DM ZC622 Industrial IoT 4

Workplace safety, industrial revolution 4.0, connected factories, smart industrial devices and products, cyber physical system in manufacturing, connecting industrial devices and equipment with each other and with internet, data acquiring and collection, communication technologies, RFID, QR codes and cellular technologies, protocols, hardware in IoT, software (IDE), cloud platform, connectivity and networking in IIoT, smart eyes on shop floor, integrating smart into existing equipment, programming using IoT, case study and implementation.

DM ZG6631 Additive Manufacturing Process 5

Overview of additive manufacturing process, its importance to industries and its rapid development. Process, development and optimization for group of additive manufacturing technologies with special focus on metal based systems. Application of additive manufacturing technology in different settings for a given application. Additive manufacturing process from CAD file import till post processing and finishing. Emerging trends in additive manufacturing.

DM ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

DM ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

DM ZG522 Behavioral Operations 4

Human behavior & cognition and their impacts on operating systems and processes. Heuristics used by operations managers to make spot decisions, their analysis using behavioral decision making literature with their potential implications for OM settings. The traditional operational issues (rational anomalies) such as bullwhip effect, explanation using behavioral operations theories. The impact of cognitive biases and methods of dealing with them in factory settings. Cognitive overload, decision making under uncertainty and ethical blindness in profession, which are relevant for modern digital factories.

DM ZG532 Big Data Analytics in Manufacturing 4

Big Data and its applications in manufacturing. Five V's of big data, analysis of structured and unstructured data in various forms, uncovering hidden patterns and unknown correlations for better operational decisions. Key technologies used in storing, manipulating, and analyzing big data. Tools for statistical analysis and data visualization. Open source frameworks for data analysis.

DM ZG533 Manufacturing Planning & Control 5

Planning and control of manufacturing operations; material flow planning; product and process planning; demand forecasting and forecasting models; facility location; plant layout planning and design; machine cells; capacity planning; designing work methods; material handling; line balancing; aggregate planning; inventory models and systems for independent demand; materials requirements planning; elements of monitoring and production control; current developments in operations management.

DM ZG534 Sustainable Manufacturing 5

Introduction to sustainable manufacturing, sustainable manufacturing design, practice and matrices, life cycle management and assessment, end of life (EOL) strategies, implementation framework, sustainable business models, waste minimization, case studies.

DM ZG535 Cyber Security in Manufacturing 4

Overview of cyber security for industry 4.0 landscapes with an emphasis on design and manufacturing application. Technological foundation of cyber security within manufacturing domain, existing threats faced by industry 4.0 sectors along with the existing solutions. Implementation of risk mitigation measures in industry.

DM ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychol giccl, physiological considerations in design decision making; legal factors, engineering ethics and society.

DM ZG561 Mechanisms & Robotics 5

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

DM ZG629T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

DSE* ZC415 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

DSE* ZC416 Mathematical Foundations for Data Science 4

Vector and matrix algebra, systems of linear algebraic equations and their solutions; Eigenvalues, eigenvectors and diagonalization of matrices, multivariate calculus, vector calculus, Jacobian and Hessian, multivariate Taylor series, gradient descent, unconstrained optimization, constrained optimization, nonlinear optimization, stochastic gradient descent, dimensionality reduction and PCA, optimization for support vector machines.

DSE* ZC418 Introduction to Statistical Methods 4

Basic probability concepts, Conditional probability, Bayes Theorem, Probability distributions, Continuous and discrete distributions, Transformation of random variables, estimating mean, variance, covariance, Hypothesis Testing, Maximum likelihood, ANOVA – single factor, dual factor, time series analysis: AR, MA, ARIMA, SARIMA, sampling based on distribution, statistical significance, Gaussian Mixture Model, Expectation Maximization.

DSE* ZC420 Data Visualization 3

Information overload and issues in decision making. Design of visual encoding schemes to improve comprehension of data and their use in decision making; presentation and visualization of data for effective communication. elementary graphics programming, charts, graphs, animations, user interactivity, hierarchical layouts, and techniques for visualization of high dimensional data & discovered patterns.

DSE* ZC426 Real Time Analytics 4

Motivation and challenges of real-time, distributed, fault-tolerant data processing, distributed messaging architecture (Apache Kafka), Real time data processing platform: Storm, Storm basic programming skills, linking Spouts, and connecting to the live Twitter API to process real-time tweets, multi-language capability of storm (with Python scripts), Case study: Networking fault prediction. This course also helps a student to analyze and understand Big-data using visuals. Topics include, Design principles, Perception, color, statistical graphs, maps, trees and networks, high dimensional data, data visualization tools.

DSE* ZC444 Artificial Intelligence 3

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving. The course also aims at understanding its implementation using LISP and PROLOG languages.

DSE* ZC465 Machine Learning 4

Introduction to Machine Learning, Various kinds of learning, Supervised Learning, Unsupervised Learning, Model

Selection; Bayesian Learning, MAP Hypothesis, MDL Principle, Bias Variance Decomposition, Bayes Optimal Classifier, Naive Bayes Classifier; Linear Models for Regression, Linear Models for Classification; Non-Linear models, Decision trees; Instance Based Learning, KNN Algorithm, CBR Learning; Support Vector Machines, VC Dimension; Neural Networks, Perceptron Learning, Back Propagation Algorithm; Introduction to Genetic Algorithms.

DSE* ZG515 Data Warehousing 5

Need and evolution of data warehousing; Goals, benefit, and challenges of data warehousing; Architecture; Approaches- Data Marts/ODS/DataLakes/DataLakeHouse; Data warehouse design; ETL, ELT, EtLT and Data Quality; OLAP & Multidimensional Analysis, Business Intelligence; Query performance enhancement techniques; Metadata management; Infrastructure and Physical design process; Data lake design: ingestion, storage (conventional / multi-modal / data-dumps), processing (batch / incremental / streaming, in-memory); Deployment: on-premise, cloud, hybrid; Cloud Data Warehousing: Topologies, Provider Selection, Configuration, Management; Migration from on-prem to cloud DW; Real Time data warehousing.

DSE* ZG516 Computer Organization & Software Systems 5

Programmer model of CPU; Basic concept of buses and interrupts; Memory subsystem organization; I/O organization; Concept of assembler, linker & loader; Types of operating systems; Concept of process; OS functions: Process scheduling, Memory management, I/O management and related issues.

DSE* ZG517 Systems for Data Analytics 5

Fundamentals of data engineering - data engineering vs data science; Data processing concepts - partitioning, replication, grouping and sorting, data locality; Flynn's taxonomy; Task vs Data Parallelism; Databases, parallel vs distributed databases, architecture – performance; Distributed computing architecture; Processing frameworks - batch, map-reduce, stream processing, parallel processing, real time processing; Cloud fundamentals - virtualization, batch-transactional-continuous workloads, execution models and examples- AWS , Azure etc..

DSE* ZG519 Data Structures and Algorithms Design5

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues) – Implementation using Arrays and Linked Lists; Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, Quick Sort and Randomization). Unordered Collections: Hash tables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Algorithm Design: Greedy Algorithms and Dynamic Programming. Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees). Introduction to Complexity Classes (P and NP) and NP-completeness. NP-Hard problems. Designing Algorithms for Hard Problems – Back tracking, Branch-and-Bound, and Approximation Algorithms.

DSE* ZG521 Graphs - Algorithms and Mining 5

Basic concepts of graphs and digraphs connectivity, reachability and vulnerability; Trees, tournaments and matroids; Planarity; Routing and matching problems; Representations; Various algorithms; applications, introduction to graph mining, Graph Pattern Mining, Graph Classification, Graph Compression, graph model, graph dynamics, social network analysis, visualization, summarization, graph clustering, link analysis, applications of graph patterns.

DSE* ZG522 Big Data Systems 5

What is big data - are existing systems sufficient?; Data Warehouse v/s Data Lakes; Hadoop – Components; Storage - Relational DBs/ NoSQL dbs / HDFS / HBase / Object Data stores - S3; Serialization; Interfaces - Hive/ Pig; Stream Processing; Spark; Mahout.

DSE* ZG524 Deep Learning 4

Common Architectural Principles of Deep Networks; Building Blocks of Deep Networks; Convolutional Neural Networks (CNNs); Recurrent Neural Networks; Recursive Neural Networks; Building Deep Networks with ND4J; Applications to Sequence Data, Anomaly Detection; Tuning Deep Networks; Vectorization.

DSE* ZG526 Probabilistic Graphical Models 4

HMM, Markov Random Field, Bayesian networks, Representation, Learning, Inference; Dynamic Bayesian Networks and Temporal Bayesian networks, applications.

DSE* ZG527 Ethics for Data Science 4

Nature of data - data as a by-product of computing, operations data (e.g., sales/marketing), surveillance data (business or government), data collected for research; Ethics - What are ethics, need for ethics, Ethical concerns in computing and analytics. Why data science needs ethics? ; Issues - political/social, liberty and justice, fairness and equality, business competitiveness, privacy, anonymity, and security; Data Ownership, Informed Consent, Security Risks (Privacy, Anonymity, Integrity, and Provenance); Ethical methods for sourcing/collecting data, and for storage/ distribution of data. Data validation. Algorithmic Fairness and Case Studies; Solutions to address ethical issues for government, corporations/organizations, research, public use of data, social norms, legal compliance, and case studies. Data ethics in specific domains - e.g. health care, finance, and social studies/research.

DSE* ZG528 Optimization Techniques for Analytics 5

Role of optimization in different types of analytics, Introduction to Linear Programming, LP Model and graphical solution, Primal Simplex method, Dual Simplex and Post Optimality Analysis, Revised Simplex method with examples, Application of linear programming in transportation, assignment problems, Integer linear programming, mixed integer programming, complexity analysis, branch and bound techniques, goal programming, Network models - critical path method and PERT, Dynamic programming, game theory, additional meta heuristic techniques, 2-3 case studies from relevant industry domains.

DSE* ZG529 Data Management for Machine Learning 4

Data Models and Query Languages: Relational, Object-Relational, NoSQL data models; Declarative (SQL) and Imperative (Map Reduce) Querying; Data Encoding: Evolution, Formats, Models of dataflow; Machine learning workflow; Data management challenges in ML workflow; Data Pipelines and patterns; Data Pipeline Stages: Data extraction, ingestion, cleaning, wrangling, versioning, transformation, exploration, feature management; Modern Data Infrastructure: Diverse data sources, Cloud data warehouses and lakes, Data Ingestion tools, Data transformation and modelling tools, Workflow orchestration platforms; ML model metadata and Registry, ML Observability, Data privacy and anonymity.

DSE* ZG530 Natural Language Processing 4

Natural Language Understanding and Generation, N-gram and Neural Language Models, Word to Vectors / Word Embedding (Skip gram/CBOW, Glove, BERT/ XLM, MURIL), Part of Speech Tagging, Hidden Markov Models, Parsing -

Syntactic, Statistical, Dependency, Word Sense Disambiguation, Semantic Web Ontology.

DSE* ZG531 Design of Experiments for Data Science 4

Introduction and importance of Experimental Design, Testing of Hypothesis, Designs with One Source of Variation, Multiple Comparison Testing, Interaction Effect, Factorial Experiment, Fractional Factorial Designs & Confounding, Latin Squares and Graeco-Latin Squares, Fractional-Factorial Designs, Taguchi Design, Designs with Random Effects, Optimal Designs and Model Uncertainty, Design for Nonlinear Model, Sequential Designs.

DSE* ZG532 Introduction to Data Science 5

Data Analytics, Data and Data Models, Data wrangling, Feature Engineering, Classification and Prediction, Association Analysis, Clustering, Anomaly Detection, exploratory / explanatory data analysis with visual storytelling, Ethics for Data Science.

DSE* ZG537 Information Retrieval 4

Organization, representation, and access to information; categorization, indexing, and content analysis; data structures for unstructured data; design and maintenance of such data structures, indexing and indexes, retrieval and classification schemes; use of codes, formats, and standards; analysis, construction and evaluation of search and navigation techniques; search engines and how they relate to the above. Multimedia data and their representation and search.

DSE* ZG554 Distributed Data Systems 4

Distributed File Systems - File System Models; Replication and Synchronization - Caching; Failure & Recovery; File System Security. Distributed Databases - Distributed Data Sources and Updates; Database Connectivity; Concurrency Control and Distribution mechanism; Distributed indexing schemes. Database security. Data on the Web - Web as a distributed data repository. Data Collection and Use Crawlers, Search Engines, and Indexing Schemes. Information Retrieval Techniques. Data Exchange - Hierarchical Data Models, XML, and query languages. Semi-structured / Unstructured data - querying and synchronization. Pervasive Data - Data distribution and access for non-computing devices, small computing devices, embedded computing devices and sensory devices.

DSE* ZG555 Data visualization and Interpretation 5

Visualization as a Discovery tool, Visualization skills for the masses, The Visualization methodology, Visualization design objectives, Exploratory vs. explanatory analysis, Understanding the context for data presentations, 3 minute story, Effective Visuals, Gestalt principles of visual perception, Visual Ordering, Decluttering, Story Telling, Visualization Design; Taxonomy of Data Visualization Methods: Exploring Tableau, Dashboard and Stories, Bullet graphs, Pareto charts, Custom background images; Dashboard : Dashboard categorization and typical data, Characteristics of a Well-Designed Dashboard, Key Goals in the Visual Design Process; Power of Visual Perception: Visually Encoding Data for Rapid Perception, Applying the Principles of Visual Perception to Dashboard Design.

DSE* ZG556 Stream Processing and Analytics 5

Real Time , Streaming Data & Sources, Real time streaming system architecture , Characteristics of a Real Time Architecture and Processing ; Configuration and Coordination Systems: Distributed State and Issues, Coordination and Configuration using Apache Zoo Keeper; Data Flow Management : Distributed Data Flows , Various Data Delivery and Processing Requirements, N+1 Problem, Apache Kafka (High-Throughput Distributed Messaging); Processing Stream Data with Storm; Overview of Data Storage – Requirements: Need for long-term storage for a real time processing framework, In-memory Storage, No-Sql Storage Systems, Choosing a right storage solution; Visualizing Data :Requirements, Principles and tools; Bounds of Random variables, Poisson Processors, Maintaining Simple Statistics from Data Streams, Sliding Windows and computing statistics over sliding windows, Data Synopsis (Sampling, Histograms, Wavelets, DFT), Exact Aggregation, Timed Counting and Summation, Multi Resolution Time Series Aggregation, Stochastic Optimization; Statistical Approximation to Streaming Data: Probabilities and Distributions, Sampling Procedures for Streaming Data, Approximating Streaming Data with Sketching, Registers and Hash Functions, Working with Sets, The Bloom Filter, Distinct Value Sketches, The Count-Min Sketch; Clustering techniques for Streaming Data; Classification methods : Decision Tree (VFDT); Evaluating stream processing algorithms; Case Studies in Designing solutions to streaming data

DSE* ZG557 Artificial and Computational Intelligence 5

Agents and environments, Task Environments, Working of agents; Uninformed Search Algorithms: Informed Search. Local Search Algorithms & Optimization Problems: Genetic Algorithm; Searching with Non-Deterministic Actions, Partial Information and Online search agents, Game Playing, Constraint Satisfaction Problem, Knowledge Representation using Logics: TT-Entail for inference from truth table, Proof by resolution, Forward Chaining and Backward Chaining, Inference in FOL, Unification & Lifting, Forward chaining, Backward Chaining, Resolution; Probabilistic Representation and Reasoning : Inference using full joint distribution, Representation of Conditional Independence using BN, Reinforcement Learning; Difference between crisp and fuzzy logic, shapes of membership function, Fuzzification and defuzzification, fuzzy logic reasoning; Decision making with fuzzy information, Fuzzy Classification; Connectionist Models: Introduction to Neural Networks, Hopfield Networks, Perceptron Learning, Back propagation & Competitive Learning, Applications of Neural Net: Speech, Vision, Traveling Salesman; Genetic Algorithms - Chromosomes, fitness functions, and selection mechanisms, Genetic algorithms: crossover and mutation, Genetic programming.

DSE* ZG568 Applied Machine Learning 4

Need for machine learning. Prediction and classification methods. Use cases in application domains. Interpretation of results. Limitations of various techniques. End to end Machine learning - data collection, data preparation, model selection.

EA ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions anddescription, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning andoperationof FMS.

EA ZC451 Internetworking Technologies 3

Introduction to internetworking concepts; the internet architecture; goals and key issued related to internetworking technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security, case studies.

EA ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image& video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based

approaches, multimedia processors, performance quantification; case studies, vision 2010.

EBCT ZG511Overview of e-Business 3

E-Business Environment and Opportunities: Background; E-Business evolution; E-Business environment; Diverse opportunities in E-Business; E-Businesses on the Internet. Categories of E-Business - B2B/E2EI, B2C, C2C; Overview of E-Business implementation technologies. E-Business Models - Enterprise portal, CRM, ERP, Supply Chain Planning(SCP), Transport Management System(TMS), Warehouse Management System(WMS), Content Management. E-Business Products- Development products; integration products; generic tools; performance analyzer tools; content management tools; component generator tools. Electronic Transaction and Security – Online payment system and security issues; Secure Transport Protocols, Secure Transactions, Secure Electronic Payment Protocol (SEPP), Secure Electronic Transaction (SET); Security features – certificates for authentication (SSL, third party certifications); security on Web servers and Enterprise Network. Emerging E-Businesses Scenario- Changing economic considerations; Emerging business opportunities and revenue models; emerging technologies; Social aspects.

ED* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs –Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

ED* ZC211 Electrical & Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single-phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

ED* ZC231 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

ED* ZC232 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

ED* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

ED* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigen values, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

ED* ZC241 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio-visual aids; editing.

ED* ZC245 Fluid Mechanics and Machines 4

Introduction and fundamental concepts, fluid statics, kinematics and dynamics of fluid flow, inviscid flows, pipe flow and network design, open channel flow, incompressible viscous flow, laminar boundary layers, turbulent flows, essentials of compressible flow, dimensional and model analysis, orifice, venturi, notches and weirs, hydraulic turbines, centrifugal and reciprocating pumps, fluid couplings and torque convertors, compressors.

ED* ZC251 Engineering Measurements 4

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

ED* ZC261 Mechanical Technology 4

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

ED* ZC311 Manufacturing Process 4

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

ED* ZC321 Mechanics of Solids 3

Fundamental principles of mechanics; introduction of mechanics of deformable bodies; forces and moments transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion; stresses and defections due to bending; stability of equilibrium.

ED* ZC322 Kinematics & Dynamics of Machines 3

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, cam design, gear trains, synthesis of linkages. Dynamics of machines: static force analysis, dynamic force analysis (planar), dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes, free and forced vibrations.

ED* ZC324 Mechatronics & Automation 4

Mechatronics design approaches, interfacing, instrumentation and control systems, modeling of mechanical and electromechanical systems, sensors and actuators, introduction to automation, pneumatics and hydraulics in automation, pneumatic circuits for automation, PLC programming and interfacing with pneumatic and hydraulic systems, introduction to MEMS, modeling and simulation of MEMS, CNC machines, automated material handling, introduction to FMS.

ED* ZC325 Fluid Power Systems 4

Introduction to Fluid power, advantages of fluid power, applications, Introduction to Pneumatics, Air preparation and Components, Pneumatics Circuits and Applications, Electro pneumatics, Electrical Controls for fluid power circuits, , Physical properties of hydraulic fluids, Energy and Power in Hydraulic Systems, Frictional Losses in Hydraulic Pipelines, Hydraulic Pumps, Hydraulic Cylinders and Cushioning

Devices, Hydraulic Motors, Hydraulic Valves, Hydraulic Circuit Design and Analysis, Ancillary Hydraulic Devices, Hydraulic Conductions and Fittings, Maintenance of Hydraulic Systems, Use of PLC programming for interfacing pneumatics and Hydraulic Circuits.

ED* ZC332 Mechanical Engineering Design I 4

Introduction to mechanical engineering design, stress and strain, deflection and stiffness, introduction to materials and manufacturing, failures resulting from static loading, failures resulting from variable loading, design of mechanical elements: screws, fasteners, permanent joints, nonpermanent joints and mechanical springs. Practice of machine part and assembly drawings using Pro/Engineer or similar solid modeling environment.

ED* ZC342Mechanical Engineering Design-II 4

Lubrication and journal bearings, rolling contact bearings, introduction to gearing, spur helical, bevel and worm gears, clutches, brakes, couplings, flywheels, belts, chains, wire rope,shafts and axles. Practice of machine part and assembly drawings using Pro/Engineer or similar solid modeling environment.

ED* ZC423T Project Work 20

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

ED* ZC433Mechanical Vibrations & Acoustics 4

Introduction, single degree-of-freedom systems: free and forced vibration problems, concept of resonance and damping, vibration isolation, multi-degree-of-freedom systems: modeling of multi-degree-of freedom systems, eigen value problem and calculation of normal modes of a system, forced response using modal superposition techniques, introduction to acoustics - terminology used in acoustics and definitive of fundamental quantities 1D wave, equation (plane waves) & 3D wave equation, formulation and fundamental solution to the equations, measurement of noise & vibration – vibration measurement principles.

ED* ZC434, Quality Control, Assurance &Reliability 4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

ED* ZC436 Computer Aided Design 4

CAD software and CAD hardware. Mathematical modeling of parametric curves, surfaces and solids, and their computer simulation on spreadsheets and using specialized solid modeling packages. CAD/CAM data exchange. Introduction to finite element analysis and FEM practice on a specialized CAE package. Rapid prototyping. Hands-on in assignments and CAD project.

ED* ZC441 Automotive Vehicles 3

Internal combustion engines; vehicle performance; analysis and design of vehicle components. Experimental or theoretical investigation of problems selected from the field of automotive vehicles.

ED*ZC452 Composite Materials and Design 4

Introduction to composites, concepts of reinforcement, strengthening mechanisms, fibrous reinforcements, matrix materials, micromechanical aspects of composites, manufacturing methods, composite production design methods design of tensile members, pressure vessels, storage tanks, and other chemical process equipment made of FRP, design of joints, damage of composites by impact, FRP grids, recent development in manufacturing of composites and technologies. Simulation of mechanics of composite materials using suitable software tools.

ED* ZC453 Product Design & Development 4

Introduction to product design and development, product development planning and process tools, technical and business concerns, understanding customer needs, function modeling, product teardown and experimentation, benchmarking and engineering specifications, product architecture, concept generation, concept selection, concept embodiment, modeling of product metrics, design for X, physical prototypes, physical models and experimentation, robust design, case studies.

ED* ZC454 Reverse Engineering and Rapid Prototyping 4

Introduction to reverse engineering, methodologies and techniques for reverse engineering, reverse engineering hardware and software, selecting reverse engineering system, introduction to rapid prototyping, relationship between reverse engineering and rapid prototyping. Reverse engineering in automotive engineering, aerospace engineering, medical device industry. Legal aspects and barriers for reverse engineering. Practice of virtual and physical rapid prototyping of simple models.

ED* ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

EE* ZG511 Environmental Chemistry 5

Fundamentals of Physical Chemistry, Water Chemistry, Water pollution, Green Chemistry, Fundamentals of Analytical Chemistry, Atmospheric Chemistry and air pollution, Energy and climate change, Toxic compounds, Metals, soils, sediments and waste disposal, Case studies

EE* ZG512 Environmental Biotechnology 5

Principles, concepts and applications of Biotechnology to the management of environmental problems, Microbial technologies for waste management, Bioremediation of toxicants, Microbial systems for detoxification, Microbial technologies for waste management, Biochemical kinetics and engineering, Concept of rDNA technology, Regulation and ethics

EE* ZG513 Applied Transport Phenomena 5

Introduction to fluid, heat and mass transport, Newton's laws of viscosity, Fourier's laws of heat conduction, Fick's laws of diffusion, Continuity equation, Concept of laminar and turbulent flow, Convective heat and mass transfer, Introduction to transport equations for fluid, heat and mass transport, Sedimentation, Packed beds, Fluidization, Pumps and compressors, piping networks, Heat and mass transfer

equipment related to environmental systems, Dimensionless numbers and their significance

EE* ZG514 Environmental Sampling and analytical methods 5

Principles of sample collection and data analysis / interpretation, Gravimetric methods, titrimetric methods, electrochemical methods, Spectrometric methods of analysis, Chromatographic methods of analysis, Sampling techniques for air and water pollution, Biological methods of analysis, Interpretation of data in environmental monitoring

EE* ZG515 Environmental Management Systems 5

Study of environmental policies, Environmental laws, Environmental regulations and permit procedures; ISO series; Life Cycle analysis; Environmental audit; Environmental impact assessment, Risk assessment, Hazardous waste management, Integrating environmental and safety management; Case studies.

EE* ZG521 Physico – Chemical treatment principles & design for wastewater systems 4

Pollutant classification, Source selection process, Selection of treatment chain, Plant siting, Physical treatment methods like screening, sedimentation, filteration, etc., Chemical treatment principles like precipitation, coagulation, ozonation etc., adsorption, Novel processes like membranes, electrodialysis, etc., Design of physico-chemical systems for wastewater treatment, Case studies.

EE* ZG522 Biological treatment principles & design for wastewater systems 4

Fundamentals of biological treatment, Biochemistry and kinetics of biochemical processes like oxidation, nitrification & denitirification, Dephosphatization, Acedogensis and methogenasis, Aerobic and anaerobic treatment processes, Basic description of equipment and design methodologies, Design of reactors and configurations; Case studies for industrial and wastewater treatment.

EE* ZG523 Environmental Statistics 4

Introduction to probability and Statistics, Probability concepts and probability distributions, Fundamentals of data analysis, Uncertainty in Measurement, Precision and accuracy, Reproducibility/repeatability, Types of errors, Error propagation, Confidence intervals, Hypothesis testing for equality of mean and standard deviation: t-test, chi-square test and F-test, Errors in hypothesis testing, Experiment design and analysis of variances, Autocorrelation, cross-correlation and sensitivity analysis in data sets, Linear least-squares regression. Precision of parameter estimates, Coefficient of determination; Interpreting statistical results, documentation and recommendations, Theory of attributes, Time series analysis, Case studies

EE* ZG532 Pumps and Automation Systems 4

Pumps and Pumping stations: Need of pumping, classification and type of pumps, Pumping power, Head and capacity of pump, site selection pump specification and selection; Distribution system: Type of distribution system, different layout of distribution system, methods of supplying water, pressures in distribution system, distribution resources and its capacity, type of reservoirs & accessories; Valves and Fittings: Different type of valves, hydrants, meters, stop cock & water tap, pipe fittings, leakage & waste of water factors, affecting losses & wastes. Introduction to Automation: Sensors and actuators for pumping, basic control concepts, micro controllers and PLC's, Introduction to SCADA and HMI interface; Pump Drivers: Basics of AC motors, Types, starting methods, types coupling, motor and coupling selection; Water Automation systems: Automatic switching systems, control of Submersible Pumps, timer based control, level based control, Tank to Tank Flow Automation System.

EE* ZG533 Industrial Pollution Abatement 4

Different types of wastes generated in an industry, their effects on living and non-living things; environmental regulatory legislations and standards and climate changes; quantification and analysis of wastewater and treatment; different unit operations and unit processes involved in conversion of highly polluted water to potable standards; atmospheric dispersion of air pollutants, and operating principles, design calculations of particulate control devices; analysis and quantification of hazardous and non-hazardous solid wastes, treatment and disposal.

EE* ZG534 Urban Water Management 4

The urban water cycle (description, social imperatives, environmental considerations, and economic challenges); water supply (availability, service levels, and technical options); free basic water, demand management, loss control, use of recycled water; sewage (public health considerations, service levels and technical options, the dry-versus-wet sanitation debate, social acceptance, and grey water management); drainage (service levels and technical options, sustainable urban drainage systems (SUDS), urban litter management, urban rivers, risk management, and groundwater issues); management (water sensitive urban design, introduction to asset management, GIS as a water management tool, and sustainability indicators).

EE* ZG611 Energy generation and management in waste treatment Plants 4

Energy audit and minimization in waste treatment facilities; Novel energy conservation technologies, Estimation of energy potential of waste; Selection of energy generation technologies coupled with waste treatment, e.g. incinerators, pyrolysis units, bio-digesters and purification and enrichment of off gases from these units; Utilization of fuel &fertilizer value of gases & liquids from bio-digesters and pyrolysis units; Energy generation from waste sludge.

EE* ZG612 Environmental remote sensing and GIS4

Principles of remote sensing, Components of GIS: Hardware, Software and Organization Context, Types of Maps; Spatial and Non Spatial, Types of Projections, Editing the Raster and Vector data structures, Analysis using raster and Vector Data, Data Retrieval, Data Reclassification, Data Overlaying and Buffering; Data Output; Pollution data gathering in GIS area under consideration through terrestrial and aerial stations, unmanned aerial vehicles (UAV) equipped with imaging and spectroscopic probes; Pollution mapping coupled to GIS through wireless network; Water body pollution monitoring instruments coupled to GIS through wireless network, Thermal and microwave remote sensing, Space imaging, Case studies on various applications of GIS for environmental management.

EE* ZG613 Environmental systems modeling 4

Introduction to air quality models, Atmospheric stability and turbulence, Gaussian dispersion models, single source and multisource models, Transport and fate of pollutant in aquatic systems, Introduction to modeling of river, lake and estuarine hydrodynamics, Stratification and eutrophication of water bodies, Dissolved oxygen model for water streams, Computational methods in environmental modeling and simulation, Transport and fate of pollutants in soils and ground water, Applications of public domain models and software; Case studies.

EE* ZG614 Air Pollution Control Technologies 4

Introduction to air pollution, Atmospheric diffusion of air pollutants, Particulate control, Gaseous pollutant control, Methods for monitoring and control, Selection and design of control equipments, Meteorological aspects of air pollution, Applications and case studies

EE* ZG621 Solid Waste Management 4

Introduction to solid waste management: Sources and classification, Composition and Properties of Solid Waste and emerging e-waste, Onsite handling, storage and processing

including segregation, Collection of solid waste, Transfer and transport, Recycling, Incineration pyrolysis and composting, Processing technique and equipment, Recovery of resources, conversion products, and energy, Biomedical and hazardous waste, Electronic waste, Regulatory framework, categorization, generation, collection, transport, treatment and disposal, Leacheate collection and treatment, Bioleaching and bioremediation; Case studies.

EE* ZG622 Environmental Process Engineering 4

Origin, Nature and composition of solid, liquid and gaseous emissions from various processes in Industries, institutions and human habitats, Assessment of pollution potential through study of process chemistry and process engineering, Understanding block flow diagrams (BFD), Process Flow Diagrams (PFD) and Piping and Instrumentation Diagram (P&ID) and Process Pollution Flow Diagram (PPFD), Maximum Attainable Control Technologies (MACT) and Best Available Control Technologies (BACT), Reasonably Available Control Technology (RACT) and Lowest Attainable Emission Rate (LAER), List of equipment and processes for BACT/RACT/LAER and their description, Estimating thermo-physical and thermodynamic data for pollutants, Use of software in Environmental Process Engineering Equipment design and datasheet generation, Technical audit of Existing process technology, Environmental carrying capacity calculations; Interpretation of field/on-site and laboratory data, Case studies.

EE* ZG623 Environmental Impact and Risk Assessment4

Introduction to Environmental Impact Assessment (EIA), Environmental assessment framework, Impact assessment methodologies; Air and water quality Impact analysis (AQIA / WQIA), Energy and noise impact analysis (EnIA / NIA), Vegetation, wild life and socio-impact analysis, Environment risk assessment, Environmental Impact statement.

EE* ZG624 Advanced Water Treatment Technology and Water Supply Systems 4

The course will cover estimation of water demand, characterization of water quality (physical, chemical and biological), different unit operations for treatment of water (screening, sedimentation, coagulation, filtration, disinfection etc.), nature of emerging contaminants (types of contaminants and sources, physical & chemical characteristics and their health hazard), advanced techniques for water purification (includes advanced process such as reverse osmosis, desalinization process, membrane filtration etc., and advanced material such as nanomaterial, composite material etc.), water distribution system, pumping at the mains, water leakage and their detection, water auditing.

EE* ZG625 Advanced Wastewater Engineering 4

The course will cover design of sewer system (including pumping of swage, sewer hydraulic, layout and construction), Characterization of waste (physical, chemical and biological characteristics), Natural attenuation, Wastewater unit operation (preliminary treatment, secondary or biological treatment), Sludge disposal, Industrial waste and their characterization (physical, chemical characteristics, health hazard), Advanced wastewater treatment (nature of waste, application of nanotechnology, biotechnology, and other advanced material etc.), Solid waste management (source and nature of waste, disposal method, recycle and reuse, guideline and legislation); Water and wastewater sampling and laboratory analysis.

EEE ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers andDSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

EEE ZG571 Optical Communication 4

Optical communication systems and components; optical sources and transmitters (basic concept, design and applications); modulators (electro-optic, acousto-optic and laser modulation techniques); beam forming; focusing and coupling schemes to optical repeators; optical amplifiers; optical field reception; coherent and non-coherent light wave systems; fibre optic communication system design and performance; multichannel light wave systems; long haul communications; fibre optic networks.

EEE ZG572 Satellite Communication 5

Review of microwave communications and LOS systems; the various satellite orbits like GEO, MEO, LEO; the satellite link analysis and design; the communication transponder system like INSAT, INELSAT etc; the earth segment and earth station engineering; the transmission of analog and digital signals through satellite and various modulation techniques employed; the multiple access techniques like FDMA, TDMA, CDMA, DAMA, etc; the INSAT program; salient features of INSAT – systems and services offered; satellite services offered by INTELSAT, INMARSAT and future satellites like IRIDIUM etc; future trends in satellite communications.

EEE ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

EEE ZG582 Telecom Network Management 5

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

ENGG ZC111Electrical & Electronics Technology 4

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single-phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

ENGG ZC232Engineering Materials 4

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

ENGG ZC241Mechanical Technology 4

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

ENGG ZC242 Maintenance & Safety 3

Objectives, functions, and types of maintenance; defects due to wear; lubrication and surfacing techniques to reduce wear; maintenance of different equipment's and their elements; spares planning; overhauling; TPM; safety and safety management; environmental safety; chemical safety; occupational health management; control of major industrial hazards; managing emergencies; employee participation in safety; HRD for maintenance and safety.

ES* ZC111 Probability & Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables;

mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

ES* ZC115 General Physics I 3

Units, Physical Quantities and Vectors; Motion along a straight line; Motion in two and three dimensions; Newton's Laws of Motion; Applying Newton's Laws; Work and Kinetic Energy; Potential Energy and Energy Conservation; Momentum, Impulse and Collisions; Rotation of Rigid Bodies; Dynamics of Rotational Motion; Equilibrium and Elasticity; Fluid Mechanics; Gravitation; Periodic Motion; Mechanical Waves; Sound and Hearing

ES* ZC116 English Language Practice 3

Writing Grammar and usage, sentence completion, jumbled sentences, emphatic word order, vocabulary building, message organization, paragraph development techniques and note taking. Reading: Skimming, scanning, rapid reading, analytical reading, factual reading, and aesthetic reading. Listening: Content listening, critical listening, aesthetic listening, empathetic listening, listening to short conversations, stories, lectures.

ES* ZC117 Chemistry-I 3

Structure of atoms; formation of molecules and related bonding theories with the help of quantum chemistry; properties of solid, liquid and gas; chemical thermodynamics and its applications to solutions, equilibrium and electrochemical systems and chemical kinetics.

ES* ZC118 General Physics II 3

Electric Charge and Electric Field; Gauss's Law; Electric Potential; Capacitance and Dielectrics; Current, Resistance and Electromotive Force; Direct Current Circuits; Magnetic Fields and Magnetic Forces; Sources of Magnetic Field; Electromagnetic Induction; Inductance; Alternating Current; Electromagnetic Waves; Nature and Propagation of Light; Geometric Optics; Interference; Diffraction

ES* ZC119 General Physics III 3

Temperature and Heat; Thermal Properties of Matter; The First Law of Thermodynamics; The Second Law of Thermodynamics; Relativity; Photons - Light waves behaving as particles; Particles behaving as Waves; Quantum mechanics I - Wave functions; Quantum Mechanics II - Atomic Structure; Molecules and Condensed Matter; Nuclear Physics; Particle Physics and Cosmology.

ES* ZC131 Engineering Mathematics - I 3

Differential and integral calculus in one dimension, vector algebra, calculus of several variables, partial derivatives, directional derivatives, maxima and minima in higher dimensions, constrained maxima and minima using Lagrange multipliers, vector calculus – properties of grad, div and curl, line, surface and volume integrals, Green's, Gauss and Stokes theorems, Complex variables – Continuity and Differentiability, analytic functions, harmonic functions, Cauchy Riemann equations.

ES* ZC142 Computer Programming 4

Basic Model of a Computer; Problem Solving-Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files.

ES* ZC212 Engineering Mathematics - II 3

First order ordinary differential equations, Second order linear differential equations: initial conditions, boundary conditions, Applications of differential equations, Computer implementation of Euler's method, Runge-Kutta methods and Finite difference method for two point boundary value problem, Sturm-Liouville problem, Laplace transforms, Fourier series, Classification of second order partial differential equations, Analytical solutions of heat, wave and Laplace equations using method of separation of variables. Numerical experiments will be carried out/performed using MATLAB.

ES* ZC120 Chemistry - II 3

Industrially important reactions; homogeneous and heterogeneous catalysis; important materials and its applications, especially polymer materials; alternative energy applications; wide range of characterization tools of molecules and materials for industrial applications.

ES* ZC217 Materials Science - I 3

Fundamentals of materials: elastic moduli; atomic bonding; crystalline structure; imperfections; application of elastic deformation; Strength of materials: yield strength, tensile strength & ductility; modification of properties; Failure: fracture; fatigue; creep; corrosion; friction & wear; Properties of materials: thermal, electrical, magnetic; Material selection: functional, environmental, cost & availability.

ES* ZC218 Introduction to Thermodynamics & Applications 4

Fundamental concepts, thermodynamic properties, equations of state, laws of thermodynamics and their application to industrial systems, entropy and its significance, basics concepts of thermodynamics applied to chemical reactions, reaction equilibrium and combustion calculations.

ES* ZC219 Materials Science - II 3

Metal structures; phase diagrams; structural change; kinetics; alloys; carbon steel; alloy steels; metal processing – materials science perspective; ceramics; cement & concrete; polymers; composites; wood; material characterization supported by lab.

ES* ZC220 Introduction to Economics 3

Big ideas in economics; Functioning of economy; Scarcity and choice; Consumer behaviour; Firm behaviour; Competitive markets; Labour markets; Unemployment; Capital market; Banking and non-banking financial institution; Central banking; Economic growth; Inflation; Monetary policy; Fiscal Policy.

ES* ZC225 Environmental Studies 3

Environment, human population, and industrialization; natural resources and the impact of man-made activities on them; structure and function of ecosystem, population ecology, biodiversity and its conservation, overview of natural resources, environmental pollution, social issues and the environment, and environmental impact assessment.

ES* ZC227 Basic Electrical and Electronics Engineering 4

Passive circuit elements; network theorems and analysis; introduction to single and three phase systems; DC/AC machines; electrical installation; semiconductors - operation of diodes, bipolar junction transistors and field effect transistors.

ES* ZC232 Fundamentals of Engineering Measurements 4

Introduction to measurement techniques; the basic concept of units, static & dynamic performance characteristics and error analysis; the construction and design of measuring devices and circuits; measuring instruments and their applications; Instrument design aspects, techniques and specifications of electronic instruments; types of transducers used in instrumentation and measurement particularly for Temperature, Pressure, Flow and level variables.

ES* ZC234 Linear algebra & Optimisation 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

ES* ZC319 Mechanisms 4

Overview of the various means to effectively convert force into desired motion, Classical mechanisms, mechanisms of mechatronics devices; concept of Mechanical Advantage; Physics of mechanisms such as, inclined planes, jacks, levers, linkages, gears, chains, pulleys, genevas, cams, and clutches; Safety mechanisms; Torque, speed, tension & limit control mechanisms; Free and forced vibrations; vibration control; Hydraulic & pneumatic mechanisms; Bio-mechanics.

ES* ZC320 Introduction to Industrial Instrumentation 4

Importance and objectives of process control; process modelling; system dynamics (first order and second order); control structures: ON-OFF control, Proportional Integral and Derivative control; tuning; analog signal conditioning; PID implementation; actuators and final control elements; other control configurations; Piping and Instrumentation Diagram; Programmable Logic Controllers.

ES* ZC321 Manufacturing Sciences 4

Principles, methods and equipment; product disassembly studies; science and engineering principles of metal casting, metal forming, joining, and metal cutting; common defects and the physics behind them.

ES* ZC333 Introduction to Transport Phenomena 3

Introduction and basic concepts in fluid mechanics; fluid statics and fluid kinematics; dimensional analysis; mass, momentum and energy balance; internal flows, external flow, pressure loses and flow devices; basics of heat transfer: conduction, convection and radiation; convective heat transfer coefficients radiation view factor; and heat transfer equipment. Introduction to mass transfer; molecular diffusion; mass transfer coefficient.

ES* ZC334 Numerical & Computational Methods 3

Numerical solution of differential equations including fundamentals: roots of single nonlinear and simultaneous (Matrix) equations, least squares fitting and statistical goodness, interpolation, finite differences, differentiation, integration, eigen solutions. Engineering problem solving using MATLAB; Working with Variables: creating variables, data import from external sources, data entry, scalars, vector and matrix data, vector and matrix arithmetic, plotting and visualization. Lab component: Exercises drawn from engineering industry, solved using the various tools and methods learnt in the course.

ES* ZC335 Integrated Engineering Science 3

This is a cross-disciplinary course, aims to integrate the various engineering science concepts and practices learned in the earlier semesters. The course adopts a problem-based learning approach, wherein industry scale problems from the specialization streams are drawn and discussed with a particular emphasis on the environmental and ethical dimensions.

ES* ZC336 Contemporary Manufacturing Processes 4

Manufacturing process, attributes and equipment: Investment & die castings; metal forming and machining. The classroom learning is augmented with virtual labs. Additive manufacturing: The distinctive features; technology; methods; applications. Students will execute team project designing and developing simple products using additive process. Non-traditional manufacturing: Classifications; applications and limitations.

ES* ZC337 Digital Electronics & Microcontrollers 3

Introduction to Digital Systems: Combinational circuits: Logic gates; decoders; encoders; Mux/Demux; Sequential Circuits: Latches & Flip-flops; Design of combinational and sequential circuits; Microcontrollers; Controller architecture; Assembly programming; Peripheral devices – Parallel & Serial I/O interfacing.

ES* ZC338 Digital Manufacturing 4

Manufacturing, a historic perspective; Internet of Things & associated technologies: Smart sensors and actuators, smart things/ devices, connected factories, cobots, material & information flow; Digital transformation: preparing and aligning organizations for digital transformation and cyber physical production systems; development, characteristics and framework; Case studies and examples of digital factories. Students will gain hands-on experience of various IOT devices and manufacturing systems through remote lab experiments.

ES* ZC339 Engineering Design and drawing 4

The course introduces the subject with a real-life illustrative project, deducing the product design process, concept to model to detailed design to manufacturing to disassembly. The course then proceeds in developing simple models using engineering modelling tools. The student will undertake a team project to design and model a simple product or assembly using modelling software.

ES* ZC340 Introduction to Supply Chain Management 3

Overview of the supply chain concept, its elements and interactions; integrated view of the supply chain; global supply chains, benefits and challenges; make-buy-outsourcing decisions; forecasting, aggregate planning and scheduling, materials requirement planning, inventory management systems, distribution systems.

ES* ZC345 Maintenance for productivity and safety 3

The major industrial disasters, their causes and consequences, learnings from the history, predictive and preventive maintenance practices, statistical measure of equipment uptime, TPM as an integrated approach to maintenance.

ES* ZC346 Manufacturing Systems Design & Analysis 4

Historical evolution of manufacturing systems, mass production and its attributes, the need for new production system; Toyota way, how Toyota went about discovering, designing, developing and deploying the Toyota production systems, the challenges; Tool and techniques: JIT, Pull, Kanban, level production, 5S, throughput & takt, SMED, Jidoka. Finally, the course concludes by providing an integrated view of Toyota Production Systems. The concepts are illustrate using simple models.

ES* ZC347 Quality Control & Metrology 4

Overview of quality control, quality management and dimensional metrology; Quality control: Statistical basis of sampling & process control; Quality management: Principles & practices including quality system standards; Metrology: Measurement system nomenclature, measurement of distance, form and surface; calibration.

ES* ZC348 Robotics and Automation 3

Fundamentals of automation and robotics such as types of automation, history of robotics, robot anatomy, end-effectors and sensors. Application of basic mathematics in the motion analysis and control of robots using forward and inverse kinematics and control theory. Fundamentals and applications of machine vision and artificial intelligence. Programming the robot for performing simple tasks using motion, end-effector and sensor commands. Social issues, future and the applications of robotics.

ES* ZC229T Project 5

Apply the knowledge of the foundation in the workplace to design/ improve an existing process or product as a team; demonstrate team working & communication skills, and ethical & environmental concerns in addition to critical thinking abilities; the student's actual day-to-day task involvement would constitute the central thread of the learning process. The evaluation will recognize this aspect by demanding day-to-day engagement and productivity of the student.

ES* ZC498T Capstone Project 10

Real life problems encompassing design, analysis, and improvement projects obtained from the workplace/ third party vendors; jointly mentored by the industry experts and faculty; to learn and demonstrate the various skills and competencies gained throughout the program with a particular emphasis on team-working, communication, planning, ethics and environmental concerns. Presentation of the progress and results in appropriate forms; Periodic review of progress of the project.

ES ZC263 Digital Electronics and Microprocessors4

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

ES ZC343 Microprocessors & Microcontollers3

Introduction to microprocessors and microcontrollers. Architecture of 8086 microprocessors; Assembly directives, Assembly language programs with algorithms, Memory interfacing and timing diagrams; Architecture of 8-bit microcontrollers; Assembly language programming for microcontrollers; Interfacing I/O devices; System design examples.

ES*ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

ES* ZC424 Software for Embedded Systems 3

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis– Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

ES* ZC441 Robotics 3

The objective of this course is to make the students familiar with Robotics, the main components of kinematics, sensors, transmission and drives, control systems, intelligence and vision, geometric modelling and reasoning, assembly planning, grasping, collision avoidance, mobile robots, force strategies, uncertainty analysis, and representation of visual world.

ES* ZC447 Data Storage Technologies and Networks 4

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Storage arrays, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids, Storage QoS – Performance, Reliability, and Security issues, Object storage, Storage as a Service, Software defined storage

ES* ZC481 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

ES* ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

ES* ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

ES* ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

ES* ZG514 Mechanisms & Robotics 5

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

ES* ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum systems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

ES* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

ES* ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

ES* ZG525 Avionics Systems 5

Civil avionics systems, fly-by-wire technology, flight control systems, engine control systems, fuel systems, hydraulic systems, electrical systems, pneumatic systems, environmental control systems, navigational systems, emergency systems, rotary wing systems, advanced systems, system design and development, avionics technology, environmental conditions, flight management systems, vehicle health management systems, communication protocols, hardware certification process, software certification process,

certification considerations for highly integrated / complex aircraft systems.

ES* ZG526 Advanced Computer Networks 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

ES* ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

ES* ZG532 Testability for VLSI 5

BIST, boundary sean, stuck-at faults, test generation algorithms for combinatorial logic circuits and sequential circuits, logic simulation and fault simulation, synthesis for test, built in self-test, pseudo-random test techniques, other test methods - IDDQ testing, boundary scan etc.

ES* ZG545 Control & Instrumentation for Systems 5

The regulation and control problem with reference to power electronic converters. Converter models for feedback: basic converter dynamics, fast switching, piece-wise linear models, discrete-time models. Voltage mode and current mode controls for DC-DC converters, comparator based control for rectifier systems, proportional and proportional-integral control applications. Control design based on linearisation: transfer functions, compensation and filtering, compensated feedback control systems. Hysteresis control basics, and application to DC-DC converters and inverters. General boundary control: behaviour near a boundary, and choice of suitable boundaries. Basic ideas of fuzzy control techniques, and performance issues. Sensors for power electronic circuits, speed and torque transducers.

ES* ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi-processing and distributed systems.

ES* ZG554 Reconfigurable Computing 5

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and Switch Networks. Design and Synthesis of Combinational and Sequential Elements. Placement and Routing. Pipelining and other Design Methodologies. Fine-grained and Coarse-Grained FPGAs. Static and Dynamic Reconfiguration. Partitioning. Hardware/Software Portioning and Partial Evaluation; Systolic Architectures.

ES* ZG556 DSP Based Control of Electric Drives 3

State space and transfer matrix representations, representation of nonlinear systems by update of parameters, output feedback and state feedback control, basic notion of state estimation. Sampling of signals, discrete representation of signals, z-transforms. Nature of discrete time poles and zeros. A/D and D/A converters as system elements. FIR and IIR behaviour, noise and its nature. AR, MA, and ARMA models of systems. The Fourier transform and what it conveys. Processing requirements of a DSP, floating point DSP's: the TMS320C3x family. Memory organization, interrupt systems, and I/O interface with the TMS320C3x family. The TMS320C31 as an embedded controller, drive control features. Applications in vector and direct torque control of synchronous motors, vector and direct torque control of induction motors, torque control of SRM's.

ES* ZG571 Optical Communication 5

Optical communication systems and components; optical sources and transmitters (basic concept, design and applications); modulators (electro-optic, acousto-optic and laser modulation techniques; beam forming; focusing and coupling schemes to optical repeaters; optical amplifiers; optical field reception; coherent and non-coherent lightwave systems; fibre optic communication system design and performance; multichannel lightwave systems; long haul communications; fibre optic networks.

ES* ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

ES* ZG611 Advanced Control Systems 5

Review of State variable modelling of linear continuous, linear discrete and nonlinear control systems; Time varying systems; Time domain solution; Controllability and observability; Stability; direct method of Lyapunov; Modal control; Optimal Control System; Calculus of variation, Minimum principle, dynamic programming, search techniques, Ricatti equation, Stochastic processes and Stochastic estimation and control; Adaptive Control system.

ES* ZG612 Fault Tolerant System Design 5

Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems, configurations, design aspects etc.

ES* ZG613 Advanced Digital Signal Processing 5

Review of stochastic processes, models and model classification, the identification problem, some field of applications, classical methods of identification of impulse response and transfer function models, model learning techniques, linear least square estimator, minimum variance algorithm, stochastic approximation method and maximum likelihood method, simultaneous state and parameter estimation of extended kalman-filter, non-linear identification, quasi linearization, numerical identification methods.

ES* ZG621 VLSI Design 5

Introduction to NMOS and CMOS circuits; NMOS and CMOS processing technology; CMOS circuits and logic design; circuit characterization and performance estimation; Structured design and testing; Symbolic layout systems; CMOS subsystem design; System case studies.

ES* ZG625 Safety Critical Embedded System Design 4

Architecture / Design practices for Safety critical systems; DO178B standards. Methodology of Certification and Qualification for DO178B, Modelling real time systems (UML-RT, and the tools), Reliable, common system bus – VME, ASCB, SafeBus, MultiBus II etc. Safety critical system busses & protocols, ARINC 429, 629, Mil-1553B & 1773, Ethernet based switched network for safety critical applications, Real time and safety standard and certifications, Reliability Maintainability & Safety of Embedded Systems. FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

ES* ZG641 Hardware Software Co-Design 4

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

ES* ZG642 VLSI Architecture 4

Overview of CISC processor architectures; Instruction set architecture of CISC processor; hardware flow-charting methods; implementing microprocessor logic from hardware flowcharts; RISC instruction set architecture; pipelined execution of RISC instructions; pipeline execution unit design; control hazards; design of memory hierarchy.

ES* ZG651 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

ET ZC234 Manufacturing Processes 4

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

ET ZC323 Mechatronics and Automation 4

Introduction to mechatronics, sensors and transducers, pneumatic and hydraulic actuation systems, mechanical actuation systems, electrical actuation systems, digital logic, microprocessors and programmable logic controllers; Introduction to automation, features of numerical control machine tools, numerical control part programming, control loops for numerical control systems, computerized numerical control, adaptive control systems, industrial robots, automatic identification and data capture, automated production lines and automated assembly systems.

ET ZC341Instrumentation & Control 3

Measurement systems, transducers, feedback control, components: electrical, hydraulic, pneumatic; Signal conditioning and processing, controllers, display, recording, direct digital control, programmable logic controllers, PC based instrumentation.

ET ZC342Materials Management 4

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; appraisal and control; just in time (JIT); automation in materials management.

ET ZC344Instrumentation & Control 4

Generalized measurement system and performance characteristics, Transducers - principles and applications, Signal conditioning circuits – bridges, amplifiers, data converters, filters; Process control – control schemes, controllers, multi-loop control configuration, Control valves; Programmable Logic Controllers, DCS and SCADA, Simulation, Case Studies.

ET ZC352 Energy Management 4

Energy management principles; energy conservation; energy auditing; analysis; formulation of energy management options; economic evaluation, implementation & control; energy conservation techniques – conservation in energy intensive industries; steam generation, distribution systems, and electrical systems; integrated resource planning; demand-side. management; cogeneration; total energy schemes; thermal insulation; energy storage; economic evaluation of conservation technologies; analysis of typical applications.

ET ZC362Environmental Pollution Control 3

Air and water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies.

ET ZC348 ADDITIVE MANUFACTURING 4

Introduction to Additive Manufacturing, CAD for Additive Manufacturing; Material Science Aspects in Additive Manufacturing, Different materials used in AM, Use of multiple materials, multifunctional and graded materials in AM, Role of solidification rate; Various Additive Manufacturing Processes Powder- based AM processes involving sintering and melting, Printing processes (droplet based 3D printing), Fused deposition modelling (FDM), Laminated object manufacturing, Stereolithography, Micro and nano additive manufacturing processes; Modelling in Additive Manufacturing Transport phenomena models: temperature and fluid flow, molten pool formation, Various case studies modelling of fusion based AM process, powder bed melting based process, droplet based printing process; Applications of Additive Manufacturing in Aerospace, Automotive, Electronics industries and Biomedical applications

ET ZC349 IoT in MANUFACTURING 4

Safe work practices and workplace safety, Industrial revolution 4.0, Forces behind Industry 4.0 (IoT, big data and cloud computing, robotics and artificial intelligence), Connected factories (what is connected factory and criteria for connected factory), Smart devices and smart products, cyber physical system, definition; cps in manufacturing, Connecting devices with each other and with internet, Data acquiring and collection, Communication technologies (WIFI, IEEE 802.15.41), RFID, QR codes and cellular technologies, Protocols, Hardware in IoT, Software (IDE), Cloud platform, Smart devices and control system, Connectivity and networking in IoT, Smart eyes on shop floor, Integrating smart into existing, Programming using IoT, Case study and implementation.

ET ZC412Production Planning & Control 4

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

ET ZC413 Engineering Design 4

The Engineering Design Process, Current Practices in Engineering Design, Establishing Need, Design Proposal, Formulating the Problem, Structuring the Search for a Solution: Design Goals and Specifications; Applying and Protecting Technical Knowledge, Abstraction and Modeling, Synthesis in Engineering Design, Ethics and Product Liability Issues, Hazard Analysis and Failure Analysis, Design Analysis - Alternative Designs, Prioritizing the Design Goals, Decision Matrix and Economic Analysis, Implementation - Transforming a Design Concept into Reality, Materials Selection in Design, Common Fabrication Materials, Materials Testing, Manufacturing Processes, Communicating the Design, Case Studies.

ET ZC414 Project Appraisal 3

Overview of project and project phases; project formulation aspects in terms of market studies, technical studies, financial studies, economic studies, environmental studies, etc.; project evaluation aspects in terms of commercial profitability

prospects, national economic profitability prospects; issues of project preparation in project implementation.

ET ZC415 Manufacturing Excellence 4

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility.

ET ZC419 Electric & Hybrid Vehicles 4

Introduction to sustainable transportation; Types of vehicles; HEV-Architecture, types, modes of operation; Forces, Power and torque calculations; EV- Architecture, subsystems and components, drive train and configurations; EV systems-motors types, speed control, torque equations for induction motor, BLDC, PMSM; Power electronics fundamentals, Switch selection, DC chopper topology, Inverter topology, Controllers for motors; ESS for EVs; Battery energy storage system; Fundamentals of BMS, Architecture, Sensors, and implementation aspects; Battery charging system-Types and standards; Fuel cell systems-Fundamentals and Architecture; Energy flow modeling and calculation.

ET ZC423 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

ET ZC426 Plant Layout & Design 4

Factors affecting plant layout, Types of layout, procedure for plant layout, techniques and tools for planning layout, quantitative layout analysis, material handling equipment, improving and revising existing layout, evaluation of layout, plant location, evaluation of location, design of layout, computer applications in layout design.

ET ZC434 Quality Control, Assurance &Reliability3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

ET ZC442 Advanced Driver Assistance Systems 4

Automotive safety systems, assist and autonomous systems, automotive sensors and actuators for ADAS (stereo and mono cameras ultrasonic sensors, LIDAR, RADAR), fundamentals of machine vision, data fusion for ADAS, mechatronics for ADAS, human – machine interface for ADAS, telematics and infotainment, ADAS system, legal and ethical aspects of ADAS, real time systems and development, advanced driver assistance systems, advanced computer systems, automated driving applications and systems.

ET ZC443 Connected Cars 4

Fundamentals of IOT - Architecture, Sensors, Cloud and the trade-off between polling and storage requirements, Structure and implementation of CAN networks, CAN message, priority & arbitration and the control hardware involved in the network, data analytics by creating a simple data model using OBD tools, ethical and legal aspects of connected car applications including data theft, privacy and security vulnerabilities, building of predictive analytic model based on in-vehicle data.

FIN ZC415 Financial and Management Accounting 4

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

FIN ZG512 Global Financial Markets and Products 4

Capital markets; stock markets, bond markets, derivative markets; operations of these markets from a global perspective; Overview and features of key financial products, equities, fixed income securities and derivatives; bond features, indenture, coupon, maturity, YTM, zero coupon, valuation, duration, convexity; Equities, product features, basic valuation concepts; derivatives, forwards, futures, options, swaps, commodity derivatives, cost of carry, concepts, basic features, payoff, put call parity, basic option strategies; relevant case studies, simulations, modeling.

FIN ZG513 Management of Banks & Financial Institutions 4

Overview and operation of financial institutions and banks; Commercial banking, Investment banking; Define, quantify, and manage various types of risks faced by financial institutions; asset liability management - overview, strategies; off balance sheet activities of banks; sovereign risk; deposit insurance; capital adequacy; study current best practices using selected case studies; bank management failures; insights from collapse of Lehman Brothers; introduction to bank regulation; international considerations; relevant case studies, simulations, modeling.

FIN ZG514 Derivatives and Risk Management4

Overview of Financial Markets. Introduction to derivatives. Definition of future, forward, option and swap. Difference between various players of derivative market, their motives and types of position they can hold. Mechanics of future, option & swap markets. Hedging strategies. Option Pricing and understanding of various factors affecting option price. Calculations of Greeks. Introduction to interest rates, yield, term structure and forward rates. Mechanics of Bond Market. Review of concept of compounding and time value of money. Difference between floating rate and fixed income bonds. Price quotes and accrued interest. Pricing of Bonds. Computation of yield. Bond Price volatility. Duration, Modified Duration and convexity. Factors affecting Bond Yields and the Term Structure. Concept of Risk. Perspective of Risk from view point of individuals, companies & financial institutions. Commercial Banks and risks faced by them. Different types of Insurance and risk faced insurance companies. Introduction to various risks: Market Risk, Credit Risk, Operational Risk, Liquidity risk & Model Risk. Concept of Value at Risk.

FIN ZG518 Multinational Finance 4

Effective financial decision making in a multinational corporation; issues in global financial management, international monetary system, balance of payments, foreign exchange markets, international parity conditions, foreign currency options, transaction exposure, operating exposure, translation exposure, sourcing capital globally, foreign investment decisions, basics of multinational taxation, transfer pricing, principles of multinational capital budgeting, and managing multinational operations . Extensive use of case studies and simulations to connect theory with practice.

FIN ZG519 Business Analysis and Valuation 4

Theory of finance, value maximization, stakeholder theory, and corporate objective function: value creation – ways and means, business analysis: The techniques of strategy and competitive analysis, value chain analysis for competitive advantages, business valuation – approaches and methods, the dark side of valuation: strategic investment decisions.

FIN ZG520 Security Analysis and Portfolio Management 4

Introduction to investment and securities; profile of financial assets; new issue market or primary market, initial public offerings (IPO); secondary market; framework of risk & return;

fundamental analysis- economy, industry; company analysis; stock evaluation models; multiple holding period and multiple growth rate; bond analysis and bond management strategies; technical analysis; efficient market theory; portfolio management; Markowitz model; Sharpe's Single Index model; capital asset pricing model; financial derivatives, options & futures.

FIN ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

FIN ZG522 Mergers, Acquisitions, and Corporate Restructuring 4

Basics of M&A (corporate finance, strategy, economics), merger types, trends; theories underlying M&A; legal aspects; evaluating an acquisition target; valuation of mergers and acquisitions, MVA, relative valuation, multiples, DCF, FCFF, FCFE; M&A deal structuring; synergy analysis; break-up valuation; sensitivity analysis; terms of merger; financing considerations; capital structure decisions; structuring and valuing of Leveraged Buy-out (LBO) transaction; financing considerations; exit strategies; extensive use of relevant case studies, simulations, modeling.

FIN ZG523 Market Risk Management 4

Market risk measurement and management in foreign exchange markets, debt markets, equity markets, commodities markets; application of Value-at-Risk (VaR) to market risk management, VaR methods, VaR mapping, stress testing, multi factor VaR, limitations of VaR, alternative metrics to VaR, expected shortfall; market risk in bank trading strategies; market risk management in fixed income securities, duration, convexity, advanced term structure models, mortgage backed securities, pre-payment risk, burnout, modeling pre-payment risk; volatility smiles, exotic options; measuring and managing corporate risk, cash flow exposures; extensive use of relevant case studies, simulations, modeling.

FIN ZG524 Credit Risk Management 4

Default, charge-off, bankruptcy; loan restructuring, loan moratorium; counterparty credit risk, measurement, management; credit risk modeling, quantitative models, Probability of Default, Exposure at Default, Loss Given Default, Expected and Unexpected losses; qualitative framework, five Cs of credit; application of Value-at-Risk (VaR) to credit risk management, i.e. Credit VaR, default risk measurement and management in Fixed Income securities, and securitization; extensive use of relevant case studies, simulations, modeling.

FIN ZG525 Operational Risk Management 4

Topics covered include: operational risk measurement, management framework; internal loss data, external loss data; key risk indicators; scenario analysis, stress testing; risk appetite; reputational risk and operational risk; application of value-at-risk (VaR) to operational risk management; liquidity risk, definition, measurement and management; liquidity adjusted VaR; liquidity and leverage; legal risk, compliance risk; fraud risk (internal and external); model risk; enterprise risk management; extensive use of relevant case studies, simulations, modeling.

FIN ZG526 Advanced Risk Models 4

Advanced VaR models, expected shortfall, stressed VaR, historical simulation, delta/ gamma models, full revaluation, risk factor selection, volatility clustering, structured Monte Carlo analysis, stress testing, scenario analysis, back testing; country and sovereign risk models; management of country and sovereign risks, external and internal credit ratings methodology and framework; expected and unexpected loss framework and related metrics; extensive use of relevant case studies, simulations, modeling.

FIN ZG527 International Regulatory Framework for Banks 4

Three pillars of the Basel II framework; key elements of risk management in banks; various methodologies used to calculate capital and provision requirements under Basel III framework, capital conservation buffer, counter cyclical capital buffer; liquidity coverage ratio, NSFR, leverage ratio; implications for the management of credit risk, market risk and operational risk; basic approach, standardized approach, advanced approach, etc.; extensive use of relevant case studies relating to bank failures and 2008 financial crisis.

FIN ZG528 Venture Capital & Private Equity 4

This course will lay a strong foundation in core concepts, features and characteristics of the venture capital and private equity markets; specialized services provided by VC's and PE funds; stages in VC investing; deal flow; deal sourcing, evaluation; risk return tradeoff of VC/ PE investments; valuation of VC/ PE transactions; structuring and execution of deals; exit options, distributions; Course will make extensive use of case studies to understand industry best practices and current trends.

HHSM ZG513 Biostatistics & Epidemiology 4

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like mean, median, mode, standard deviation, kurtosis, correlation coefficient; probability distributions; sampling and estimation of parameters; tests of hypothesis; data analysis. Introduction to the principles and methods of epidemiology. Epidemiology of some illustrative infectious diseases (of bacterial, rickettsial and viral origins), sexually transmitted diseases, chronic diseases such as cancer, cardiovascular diseases, neurological disorders etc. Use of biostatistics in epidemiology.

HHSM ZG516 Epidemic & Disaster Management 4

Disaster management; impact and response; relief phase; disaster mitigation in health sector; disaster preparedness; policy development; man-made disasters; international agencies providing health based humanitarian assistance; and strategies for disaster management.

HHSM ZG517Health Care Management 4

Basis of organizational culture and management techniques for efficient administration of health delivery; general principles of HR, materials and operation management; understanding the organizational culture that exists in public, private and non-Govt. sector agencies; management information system.

HHSM ZG614 Hospital Operations Management 4

Operations Management aspects connected with outpatient ward, casualty, operation theatres, diagnostic laboratories, pathology laboratories, pharmacy, diet and nutrition, blood bank, laundry, medical records, security, scheduling and deployment of doctors, nurses and other staff, accounts among others; Equipment planning and management, Materials management, Management of human resources in hospitals, Hospital Management Information Systems, Licensing and legal compliance, Quality and accreditation of hospitals and healthcare organizations. The course will involve onsite visits in a hospital, discussions and presentations on the practical aspects of hospital operations management.

HHSM ZG615 Service Quality Excellence in Healthcare4

Quality in healthcare, Leadership for Quality, Customer satisfaction in healthcare, Continual improvement, cost of quality, Benchmarking, Performance measures, Statistical process control, Experimental design, Quality tools, Lean tools applied in healthcare, Case study in healthcare.

HHSM ZG617 Strategic Management of Healthcare Organizations 4

Strategic management function within contemporary health services organization with focus on organizational strategic planning processes including principles and methods of strategic assessment, strategy formulation, evaluation, implementation, and control, Case studies in healthcare systems.

HHSM ZG631Introduction to Health Systems & Environmental Health 4

Introduction to health systems; functions of health systems; managing health systems; problems of health systems management; Major environmental health problems including quality of water, waste disposal food production and processing, vector control etc. Air pollution and its controlling, Hazards of radiation, municipal and other wastes, Occupational health hazards.

IS ZC313 Object Oriented Programming & Design 4

Object oriented concepts and design, abstraction, architecture and design patterns, GUI programming and frameworks, design of object oriented solutions using UML, design for concurrency, implementation of solutions using object oriented languages like C++ or Java; Language level mapping and realization of object oriented constructs, realization and performance issues versus abstraction and usability.

IS ZC314 Software Development for Portable Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and accessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

IS ZC323Systems Programming 3

Batch processing Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces; other selected topics.

IS ZC327 Systems Programming 4

Batch processing; Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces with focus on contemporary open source operating system-specific programming; laboratory experiments or programming assignments involving Unix/Linux System-specific Programming including shell-scripting via online laboratory facility.

IS ZC328 Software Testing 3

Brief description of importance of software, Life cycle model and process, Basic software testing, all definitions, Types of testing and techniques (CFG, CDG etc.), Black Box & white box Testing Methodologies, Finite State Machine Model, State based Testing, Static Testing and analysis, Test cases, Test Data Generation ,Test selection ,Minimizations and Prioritization, Test adequacy criteria, Software Testing on Web Engineering, Object based Software Testing, Architecture of Testing tool, Software Test Effort Estimation, Testing behavior and process model, Qualitative analysis, Quality factors in software testing, Selection of testing tools.

IS ZC332 Database System & Application 3

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS.

IS ZC337 Database Systems & Applications 4

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS, database programming experiments involving use of SQL, database creation etc. via online laboratory facility.

IS ZC343 Software Engineering 4

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

IS ZC353 Computer Organization & Architecture 4

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; Virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies; This course covers the fundamentals of computer organization and architecture from a programmer's perspective.

IS ZC362 Operating Systems 3

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, inter process communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules.

IS ZC363 Data Structures & Algorithms 4

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; Analysis of algorithms; Linear data structures – stacks, arrays, lists, queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees; Implementation techniques for different data structures including trees, graphs and search structures; Performance evaluation of data structures and algorithms; Implementation issues in large data structures.

IS ZC364 Operating Systems 4

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, inter process communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules, select laboratory experiments related to creating different elements of operating system and/or implementation of select scheduling, memory management and I/O related algorithms/schemes, using system calls for creating file system specific command, creating simple file system etc. via online laboratory facility.

IS ZC365 Human Computer Interaction 3

Principles of human-computer interaction; Evaluation of user

interfaces; Usability engineering; Task analysis, user-centered design, and prototyping; Conceptual models and metaphors; Software design rationale; Design of windows, menus, and commands. Voice and natural language I/O; Response time and feedback; Color, icons, and sound; Internationalization and localization; User interface architectures and APIs.

IS ZC373 Complier Design 4

Introduction to Programming Languages and Compilers, Programming Language Features, Front End of a Compiler, Back End of a Compiler, Special aspects of compilers and runtime.

IS ZC415 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

IS ZC422 Parallel Computing 3

Introduction to parallel computing; Models of parallel computers; Interconnection networks, basic communication operations; Introduction to parallel algorithms; Parallel programming paradigms; issues in implementing algorithms on parallel computers; Parallel programming with message passing interface; Performance analysis; Scalability analysis; Basic design techniques for parallel algorithms; Parallel algorithms for selected topics like sorting, searching and merging, matrix algebra, graphs, discrete optimization problems and computational geometry.

IS ZC423 Software Development for Portable Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and accessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

IS ZC424 Software for Embedded Systems 3

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis– Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

IS ZC425 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

IS ZC444 Artificial Intelligence 3

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving. The course also aims at understanding its implementation using LISP and PROLOG languages.

IS ZC447 Data Storage Technologies and Networks 4

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Storage arrays, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids, Storage QoS – Performance, Reliability, and Security issues, Object storage, Storage as a Service, Software defined storage

IS ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

IS ZC464 Machine Learning 3

Neural networks; neuro-computing theory and applications, knowledge representation; computational learning theory; statistical/probabilistic methods, genetic algorithms; inductive/analytic/reinforcement learning and bayesian networks; selected topics such as alpha-beta pruning in game trees, computer models of mathematical reasoning, natural language understanding and philosophical implications.

IS ZC465 Machine Learning 4

Introduction to Machine Learning, Various kinds of learning, Supervised Learning, Unsupervised Learning, Model Selection; Bayesian Learning, MAP Hypothesis, MDL Principle, Bias Variance Decomposition, Bayes Optimal Classifier, Naive Bayes Classifier; Linear Models for Regression, Linear Models for Classification; Non-Linear models, Decision trees; Instance Based Learning, KNN Algorithm, CBR Learning; Support Vector Machines, VC Dimension; Neural Networks, Perceptron Learning, Back Propagation Algorithm; Introduction to Genetic Algorithms.

IS ZC467 Computer Networks 4

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols, Laboratory experiments / assignments related to simulation of network protocols, programming simple network applications, implementing select routing algorithms via online laboratory facility.

IS ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

IS ZC472 Computer Graphics 3

Generation of dots, lines, arcs and polygons; color graphics, shades and levels; image transformation, windowing and clipping; 2-D and 3-D graphics; data structures, algorithms and optimization methods; case studies using GKS, CORE, etc; graphic languages and compilers.

IS ZC481 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

MATH ZC161Engineering Mathematics I 3

Limit concept; derivatives of elementary functions and their applications; introduction to ordinary and partial differential equations and initial/boundary value problems. Convergence tests for series; power series and interval of convergence; series solution of differential equations. Approximation and error, interpolation; roots of algebraic and transcendental functions, Newton's method.

MATH ZC222Discrete Structure for Computer Science3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semi groups and machines; codes and applications.

MATH ZC232Engineering Mathematics II 3

Algebra of vectors and matrices; Gauss's row-reduction process; applications of simultaneous linear equations and matrix inversion; determinants and Cramer's rule. Numerical differentiation and integration; numerical methods for solving ordinary and partial differential equations.

MATH ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

MATH ZC234 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigen values, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

MBA ZC411 Marketing 4

Definition and scope, consumer behavior, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

MBA* ZC413 Analytics for Competitive Advantage 4

In today's competitive business environment, high performing companies are doing more than just collecting data, storing it and generating reports. They are developing competitive strategies using Business Analytics. In this course we will look at how to use data-driven insights to differentiate a firm's business/ product strategy from other companies that are making the same product or delivering the same service. This course is designed for analysts in any function: marketing, operations, quality, customer service, IT, finance/accounting or human resources. We will use case studies and other experiential components to study the application of data-driven insights in the context of various industries.

MBA ZC415 Financial and Management Accounting 4

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

MBA ZC416 Managerial Economics 4

Fundamental concepts, supply, demand, market mechanism; theory of demand (consumer behaviour); production, costs (theory of the firm); market structures (perfect competition, monopoly, monopolistic competition, oligopoly); circular flow of income, national income accounting, national income determination; money and banking, employment, interest, inflation, economics of information, problem of adverse selection, moral hazard problem, market failure, externalities, public goods.

MBA ZC417 Quantitative Methods 4

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, time series and forecasting, index numbers, decision theory, linear programming, transportation and assignment problems, queuing theory, network problems, simulation; application of statistical software (SYSTAT, SPSS, SIMULA8, etc.) and spreadsheets.

MBA* ZC419 Financial Risk Analytics 4

The course will first cover the basics of Financial Risk and then focus on applications such as: currency, interest rate derivatives, equity markets and products, and commodity markets and products. Major topics include methodologies for measuring and analyzing volatility (a key metric of risk) including EWMA, ARCH & GARCH processes, volatility clusters and the issue of time varying volatility; Extreme value theory; Measuring risk using Value-at-Risk, including computation of VaR by various methods, and stress testing; Monte Carlo simulation, address issues in generating price process (such as Brownian Motion, Ito Process), Cholesky decomposition in computing multi-asset VaR; Currency risk analysis in global investing, interest rate parity (covered and uncovered); Value at risk for fixed income portfolios; Credit Risk Analytics. The topics covered in this course will have inbuilt case studies in financial risk management so as to understand the practical implications of the methodologies covered in the course.

MBA ZG511 Managing People & Organizations 4

Concepts and principles of management as applied to a variety of organizations; study of managerial roles, styles, activities and decision making; relationship with organizational effectiveness; planning activities, leadership & control; manpower development; organizational behavior and theory.

MBA* ZG512Predictive Analytics 4

Basic concepts in predictive analytics / predictive modeling. Two core paradigms for predictive modeling: classification and regression. Identification of important variables and their relation to each another. Basic modeling techniques such as k-nearest neighbors, classification and regression trees (CART), and Bayesian classifiers. Ensemble techniques. Model selection techniques.

MBA ZG513 Enterprise Resource Planning 4

This course aims to highlight the integration of business processes and computer applications across business functions and also demonstrates how organizations are represented in an Enterprise Resource Planning (ERP) system very broadly. This course studies ERP systems, its scope, implementation issues and the organization's motivation for implementation such systems. The topics include ERP concepts, implementation methodologies, evaluation of ERP Systems, detailed processes of ERP implementation, and core ERP functional modules. The students will comprehend the ERP implementation process and will be able to use knowledge gained in an ERP implementation or its utilisations for business functions. Course is designed to be ERP

packages agnostic and learning can be applied to implementation of leading industry ERP packages.

MBA ZG514 Leadership & Managing Change 4

Individuals as leaders, team leadership and organizational leadership. Introduction to managing change, management of change: organizational structure, culture, recruitment, performance management, human resource development, reward management, employee relations and involvement, downsizing, and evaluating and promoting.

MBA ZG515 Consulting & People Skills 4

Facilitation skills, Communication skills, Presentation and Interviewing skills, Analytical Skills, Creativity, Partnership and networking skills, Critical thinking skills, Emotional Intelligence Development, Stress Management, Ethics and respect for the client, Vision and Framing of issues, Synthesizing Skills, Leadership skills.

MBA* ZG516 Introduction to FinTech 4

Overview of FinTech, Current disruptions in Financial Services, Fintech in the Context of the Digital Economy, Landscape of Fintech, Disruptions in Asset Servicing, Disruptions in the Capital Markets, Disruptions in Investment Management, Alternative Data in Portfolio Management, Lending and Crowd funding, Robo-Advisory, Overview of Technologies - Big Data, Machine Learning and AI, Cloud Computing, Future of FinTech

MBA* ZG517 Financial Analytics 4

Different sources of Financial Data, Statistical characteristics of financial data, Distributions of Financial Data, Statistical Applications in Finance, Exploratory Data Analysis, Modelling using Financial Statements Data, Modelling stock price behaviour, Modelling Credit Default using classification algorithms, Introduction to Machine Learning for price forecasting and Portfolio Modelling, Introduction to Monte Carlo simulation, Bootstrapping, Cross validation, Sentiment Analysis in Finance

MBA* ZG518 Multinational Finance 4

Effective financial decision making in a multinational corporation; issues in global financial management, international monetary system, balance of payments, foreign exchange markets, international parity conditions, foreign currency options, transaction exposure, operating exposure, translation exposure, sourcing capital globally, foreign investment decisions, basics of multinational taxation, transfer pricing, principles of multinational capital budgeting, and managing multinational operations . Extensive use of case studies and simulations to connect theory with practice.

MBA ZG519 Business Analysis and Valuation 4

Theory of finance, value maximization, stakeholder theory, and corporate objective function: value creation – ways and means, business analysis: The techniques of strategy and competitive analysis, value chain analysis for competitive advantages, business valuation – approaches and methods, the dark side of valuation: strategic investment decisions.

MBA* ZG520 Security Analysis & Portfolio Management 4

Introduction to investment and securities; profile of financial assets; new issue market or primary market, initial public offerings (IPO); secondary market; framework of risk & return; fundamental analysis- economy, industry; company analysis; stock evaluation models; multiple holding period and multiple growth rate; bond analysis and bond management strategies; technical analysis; efficient market theory; portfolio management; Markowitz model; Sharpe's Single Index model; capital asset pricing model; financial derivatives, options & futures.

MBA ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation- time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

MBA ZG522 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability.

MBA ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

MBA ZG525 Business Process Analysis 4

This course is designed to provide a basic understanding of tools and techniques to model business processes as they are, they are currently enacted, assess the quality of those business processes, and collaborate with the stakeholders to identify improvements. The course will place a special focus on the business analysis function as it relates to developing information technology solutions. The course will identify techniques for ensuring project success every step of the way - from identifying and analyzing potential projects, to making sure the final project product meets the requirements identified.

MBA ZG526 Operations Management 4

Operations strategy; process view vs. functional view in operations; factors in product and process design and selection; facility configuration; demand planning and forecasting; capacity planning; aggregate planning; planning service operations; productivity of operations; inventory planning and independent demand systems; materials requirements planning; quality management; uncertainty and variability; project management; current developments in operations management.

MBA* ZG527Entrepreneurship in FinTech 4

FinTech Themes, Changing landscape in raising capital, FinTech Hubs, Early stage funding, Integrated FinTech Ecosystems, Emerging Markets and Social Impact, Valuation of FinTech Firms, FinTech Solutions - Case Studies, Legal, Regulatory, Data privacy and Ethical aspects of FinTech startups, Capital and Investment for new businesses, Enterprise Innovation.

MBA* ZG528 Venture Capital and Private Equity 4

This course will lay a strong foundation in core concepts, features and characteristics of the venture capital and private equity markets; specialized services provided by VC's and PE funds; stages in VC investing; deal flow; deal sourcing, evaluation; risk return tradeoff of VC/ PE investments; valuation of VC/ PE transactions; structuring and execution of deals; exit options, distributions; Course will make extensive use of case studies to understand industry best practices and current trends.

MBA* ZG529 Machine Learning for Finance 4

Univariate and Multivariate Financial Time series and their characteristics, Applications of Support Vector Machines, Neural Networks and Gradient-Based Optimization, Applications of Tree based ensemble methods (Random Forests, Boosting), Dimension reductions using PCA and Auto Encoders, Feature Engineering, Cross validations, Credit Scoring, Predicting Bankruptcy, Fraud Identification models,

Applications of Clustering Algorithms, Introduction to Sequential Learning.

MBA* ZG530 InsurTech 4

Digital Transformation in Insurance, Insurance of Things, From Insurance Premium to Discrete Event, Telematics, Collaborative Approach, InsurTech Value Chain, Business Models, Practical Robotics in Insurance, Claims Handing, Applications of Technology in Underwriting, New Business Generation and Policy Processing.

MBA ZG531 Statistical Quality Control 5

Sources of Variation: Common and Assignable Causes, Descriptive Statistics, Statistical Process Control Methods, Control Charts for Variables, Control Charts for Attributes, C-Charts, Process Capability, Acceptance Sampling, Operating characteristic curve, Statistical Quality Control in Services.

MBA* ZG532 Deep Learning Application in Finance 4

Review of Machine Learning, Foundations of Neural networks and deep learning, Fundamentals of deep networks, Multilayer Perceptron, Convolutional neural networks (CNN), Recurrent neural networks (RNN) frameworks – LSTM, GRU. Hands on building Deep Learning networks, Auto-encoders, Parameter tuning, Generative Adversarial Networks (GAN), Semantic Segmentation, Unsupervised Learning, Applications of Deep Learning in FinTech.

MBA* ZG533Technology Disruptions in FinTech 4

Big Data in the Financial Services Industry, Internet of Things, Impact of IoT on Businesses, IoT in Financial Services, Cyber Security, Cyber security Categories and Players, Data Privacy and Governance, Cloud Computing, Networks, Mobile Applications and Smart Phones

MBA* ZG534 Sustainable Manufacturing 4

Introduction to sustainable manufacturing, sustainable manufacturing design, practice and matrices, life cycle management and assessment, end of life (EOL) strategies, implementation framework, sustainable business models, waste minimization, case studies.

MBA ZG535 Decision Analysis 4

Introduction to quantitative techniques and statistics, Decision making, intelligence design and choice phases, basic theory of decision making under uncertainty; decision trees, qualification of judgments and preferences, Bayes theorem, the structuring of complex decisions, and multi-attribute utility theory. Statistical estimation and forecasting.

MBA* ZG536 Foundations of Data Science 4

Introduction, Role of a Data Scientist, Statistics vs. Data Science, Fundamentals of Data Science, Data Science process and life cycle, Exploratory Data Analysis, Data Engineering and shaping, Overview of Data Science Techniques and Models, Introduction to Regression, Classification, Shrinkage, Dimension Reduction, Tree-based models, Support Vector Machines, Unsupervised learning, Choosing and evaluating models, Featurization, Overview of Neural Networks, Data mining, and pattern recognition techniques, Documentation, Deployment, and Presentations of the insights.

MBA ZG537 Lean Manufacturing 5

Birth of Toyota production system, house of Toyota production system, stability, standardization, just-in-time, jidoka, involvement, hoshin planning, Toyota culture, Toyota way, Case Studies.

MBA* ZG538Advanced Statistical Methods 4

Point and interval estimation and hypothesis testing, chi-square tests, non- parametric statistics, analysis of variance, regression; linear and multiple linear, correlation, factor models, decision theory, Bayesian statistics and autocorrelation, multivariate regression, randomization and sampling processes, Markov processes with discrete/continuous state space, statistical simulation and pattern recognition, Time Series Analysis.

MBA* ZG539Data Visualization and Communication 4

Need for visualization, Presentation and visualization of data for effective communication, the importance of context and audience, choosing an effective visual, Visualizations of a single number, Visualizations for comparisons, Displaying relative performances, Visualizing survey results, Visualizations for Ranking and Branching, Visualizations for parts of a whole, Visualizing correlations and regression, Visualizing Qualitative Data, Visualizing Trends, Tree-based visualizations, Visualizing Geo Data, Techniques for visualization of high dimensional data & discovered patterns, Common mistakes in dashboards, Visual perception, Create interactive Dashboards and Stories

MBA* ZG540 International Business and Trade 4

Overview of International Business and Globalization, Culture, Governmental and Legal Systems, Economic Systems and Market Methods, Trade and Factor Mobility Theory, Trade Protectionism, Economic Integration and Cooperation, Markets for Foreign Exchange, Factors that Influence Exchange Rates, Global Debt and Equity Markets, Ethics and Social Responsibility, Strategies for International Business, Evaluation of Countries for Operations, Modes of Trading Internationally

MBA ZG541 Consultancy Practice 4

Strategic planning and marketing of consultancy services, client consultant relationships, technology transfers, negotiations, agreements, guarantees, organizing and executing consultancy services, quality in consultancy services, technical audit, government policies such as industrial policy, trade policy, technology policy, patent and trademarks etc.

MBA* ZG542 Entrepreneurship and New Ventures4

Innovation, Entrepreneurship and Intrapreneurship; Creativity & Lateral Thinking; Design Thinking; Effectual Thinking; Market Validation; Development and Evaluation of Business Idea; Introduction to Business Model Generation; Developing Lean Business Model for the Business Idea; Developing Prototype and Evaluating assumptions in Business Model using prototype cheaply; Presentation of Business Model; Raising Finance; NDAs and Term Sheets; Exit Strategies; Scaling up the venture; Developing Business Plan; Business Fair

MBA* ZG543 Family Business Management 4

Nature, Importance and Uniqueness of Family Business – Various Perspectives, Zero sum dynamics and family culture, Family systems perspective, Family Genograms, Family Emotional Intelligence, Family Business interaction factor, Unity and continuity, Family employment policy, Conflict management, Share holder priorities, effective governance of the shareholder–firm relationship, Profile of successful successors - rewards and challenges for latter-generation family members, crafting the next generation career plan, Sources of Value creation, Three states of evolution, Business Rejuvenation matrix

MBA* ZG544 Mergers, Acquisitions, and Corporate Restructuring 4

Basics of M&A (corporate finance, strategy, economics), merger types, trends; theories underlying M&A; legal aspects; evaluating an acquisition target; valuation of mergers and acquisitions, MVA, relative valuation, multiples, DCF, FCFF, FCFE; M&A deal structuring; synergy analysis; break-up valuation; sensitivity analysis; terms of merger; financing considerations; capital structure decisions; structuring and valuing of Leveraged Buy-out (LBO) transaction; financing considerations; exit strategies; extensive use of relevant case studies, simulations, modeling.

MBA ZG545 Product Design and Development 4

Product Development Process and Tools; Scoping Product Development; Understanding Customer Needs; Establishing Product Function; Product Teardown and Experimentation; Benchmarking and Establishing Engineering Specifications; Product Portfolios and portfolio architecture; Product Architecture; Generating Concepts; Concept Selection; Concept Embodiment; Modelling of Product Metrics; Design for Manufacturing and Assembly; Design for Environment; Physical Prototypes, and Models and Experimentation.

MBA* ZG547 Modern Manufacturing 4

Computer Integrated Manufacturing, ASRS, Robotics, Mass Customization, Additive manufacturing, Internet of Things and distributed manufacturing, Managing Global manufacturing systems and Global sourcing.

MBA* ZG548 Manufacturing Strategy 4

Corporate strategy; Missing links in manufacturing strategy; Audit approach; Restructuring; Manufacturing strategy process in practice; Formulation as a process; Operating strategies; Methodology framework; Lean production; Competitive priorities; Strategic value of response time and product variety; Flexibility in context of manufacturing strategy; Manufacturing focus; Business process reengineering; Theory of constraints; Link between strategy and organizational culture; Evolution of manufacturing systems; Operations management strategic perspective.

MBA ZG549 Managing Quality in Services Industry 4

Key Differences between Services Sector and Manufacturing Sector, and the implications for Quality Management, Key quality metrics in services sector, quality measurement scales in service sector (INSTAQUAL, SERVEQUAL, MEQUAL), Concept of Net Promoter Score, Components of quality in services sector, Importance of human element in quality management in services, Establishment of quality management system for services sector, Designing the service encounter, Quality management as driver of innovation in service industry, Business process excellence in services industry, process blueprinting, benchmarking, Applications of Six Sigma in services industry

MBA ZG550 Quality Management Systems 4

ISO 9000 series of standards, formation of ISO (1947), background & development of ISO 9000. ISO 9000 family of standards, selection & use of appropriate model of ISO 9000. Requirements of ISO 9001; System demonstration & documentation, how to organize a formal quality assurance system, other quality system standards, relating ISO 9000 with QS 9000 and ISO 14000, Understanding ISO 16949 and PPAP/APQP/FAI/Configuration Management.

MBA* ZG551 Quality Analytics 4

Systems approach to Quality, Systems engineering- (RAMS Framework, Reliability, Availability, Maintainability, Safety, Testability), Safety engineering and systems safety, Fault tolerant systems, redundancy, Types of failures by attribution: Manufacturing and assembly induced failures, storage induced failures, transport induced failures, maintenance induced failures, human errors, TCO Approach of making decisions, Quality, Simulations, Systematic methodology of Research, Sampling techniques, Research design, Sampling design, Data Collection for measuring quality, Applications of statistics (univariate and bivariate) in quality management, Hazard rate modelling, Applications of Machine Learning and Artificial Intelligence in Quality Management

MBA* ZG552 Business Acumen for Managing Quality4

Aligning quality strategy with the overall business strategy, Quality and the target Customer segment, concept of perceived quality and optimal quality, Economics of Quality, Costs related to quality, Taguchi Loss Function, Quality as a competitive advantage, Defining Quality metrics for BI dashboards, Communicating the product quality to the consumer, Differential Quality SLAs for different segments, Business Ethics and Quality, Managing Quality in the era of Industry 4.0, Quality and Regulation, Introduction to Weights and Measures Act, Consumer Rights and regulatory implications of quality imperfections, Quality for Safety, Health and Environment, How organizations can go safe?

MBA* ZG553 Block Chain and Applications4

Introduction, Evolution of Block chain, Building blocks of block chain, Smart contracts, Block chain Principles, Asset Monetization in Block Chain, Building a block chain network, Use cases of Block chain in different sectors across the world (Manufacturing and Industrial, Government and Public Sector, Consumer Goods and Retail Industry, Food Industry, Crypto currencies in detail), Limitations of existing block chains, Regulatory Aspects, Strategy to implement across the enterprise, Best Practices in implementing Block chain, Different types of Block chain architectures – Hyper Ledger, Ethereum, Future challenges.

MBA* ZG554 Digital Banking and Beyond 4

Traditional Banking landscape, First principles of Banking, Effect of Digital Technology, New Operating Models for Banking, Regulation vs. Innovation, Reframing identity through Technology, Embedded Banking, Banking Chatbots, From products and channels to experiences, Designing Digital banks without branches, Building Relationships through digital banking, Technologies enabling digital banking, Security, New economics of digital bank, Beyond digital banking, Role of AI and Big Data in Banking.

MBA* ZG555 Algorithmic and High Frequency Trading 4

Introduction to Algorithmic trading, Users of Algorithmic Trading, Currently Popular trading Algorithms, Algo trades for individual investors, Optimization, Stock personality clusters, Selecting a Cohort of Trading Stocks, Stock Profiling, Volatility, Alpha Algo strategies, Benchmarks and Performance Measures, Technical Analysis (TA), Heuristics, AI, Artificial Neural Networks and Other Avenues, From the Efficient Market Hypothesis to Prospect Theory, Mean Reversion strategies, Momentum strategies, risk management.

MBA* ZG556 Advanced Risk Models 4

Advanced VaR models, expected shortfall, stressed VaR, historical simulation, delta/ gamma models, full revaluation, risk factor selection, volatility clustering, structured Monte Carlo analysis, stress testing, scenario analysis, back testing; country and sovereign risk models; management of country and sovereign risks, external and internal credit ratings methodology and framework; expected and unexpected loss framework and related metrics; extensive use of relevant case studies, simulations, modeling.

MBA* ZG557FinTech in Wealth Management 4

Introduction, Traditional wealth management industry, Digitization in wealth management, Digitizing client advisory, Robo advisors, Gamification, Digitizing wealth management operations, Digital platforms, products and eco systems, Block chain applications in asset and wealth management, Algorithms of Automated Portfolio Rebalancing, Digital Financial Advisor, Future of Digital Advice, Personalize the Investment Experience, Future of wealth tech.

MBA* ZG558 Financial Risk Management 4

Introduction to Financial Risk Management, Financial Institutions and their trading, Credit Crisis of 2008, Market Risk (Risk Management by traders, Interest rate risk, volatility, Correlation and Copulas, Value at Risk and Expected Shortfall, Historical Simulation and Extreme Value Theory, Model-Building Approach), Credit Risk (Estimating Default Probabilities, CVA, DVA, Credit Value at Risk), Regulation (BASEL I, II and III), Fundamental Review of the Trading Book, Scenario Analysis and Stress Testing, Overview of Operational Risk, Liquidity Risk, Economic Capital and RAROC.

MBA* ZG559 Management of Banks & Financial Institutions 4

Overview and operation of financial institutions and banks; Commercial banking, Investment banking; Define, quantify, and manage various types of risks faced by financial institutions; asset liability management - overview, strategies; off balance sheet activities of banks; sovereign risk; deposit insurance; capital adequacy; study current best practices using selected case studies; bank management failures; insights from collapse of Lehman Brothers; introduction to bank regulation; international considerations; relevant case studies, simulations, modeling.

MBA* ZG560 Global Financial Markets and Products 4

Capital markets; stock markets, bond markets, derivative markets; operations of these markets from a global perspective; Overview and features of key financial products, equities, fixed income securities and derivatives; bond features, indenture, coupon, maturity, YTM, zero coupon, valuation, duration, convexity; Equities, product features, basic valuation concepts; derivatives, forwards, futures, options, swaps, commodity derivatives, cost of carry, concepts, basic features, payoff, put call parity, basic option strategies; relevant case studies, simulations, modeling.

MBA* ZG561 Behavioural Finance 4

Introduction, Rational Market Hypothesis, Foundations of Rational Finance (Expected Utility, MPT, CAPM, EMH), Challenges to rational behaviour, Heuristics, Cognitive Biases, Self-Deception, Prospect Theory, Mental Accounting, Emotional Factors, Challenges to Efficient Market Hypothesis, Investor Behaviour, Market Outcomes, Value Investing, Applications of Behavioural Finance, Introduction to Behavioural Corporate Finance.

MBA* ZG562 Derivatives & Financial Engineering 4

Introduction to derivatives market, forward, futures, options, swaps, Pricing and valuation of derivatives, options trading strategies, Elementary Stochastic calculus, binomial tree model, Black Scholes Merton model, option Greeks, Exotic Options, Volatility Smiles, credit risk, credit derivatives, credit default swaps, collateralized debt obligations, valuation of synthetic CDO, Interest rate Derivatives.

MBA* ZG563 Analytics for HR 4

Leveraging analytic techniques in the context of the challenges faced by the HR and Talent Acquisition and Management functions. Applying analytical techniques to deliver meaningful insights for effectively managing employees for achieving the goals of the organization. Attracting right talent, forecasting future staffing needs, managing attrition and improving employee satisfaction levels. Case Studies, simulations, hands-on exercises using tools like R / Python.

MBA* ZG564 Models in Marketing 4

Introduction to Marketing Models, Models of consumer behavior, industrial buying and firm behaviour, (aggregate) market models (e.g., competition, market entry), strategic marketing models, forecasting methods, new product models, marketing response models (e.g., channels, pricing, advertising, promotion), forecasting models and decision support systems. Case Studies, simulations, hands-on modeling.

MBA* ZG565 Supply Chain Analytics 4

Introduction to supply chain analytics, Data understanding and data preparation, Supply chain performance , Descriptive analytics, Predictive analytics and setting up the problem, Supply chain forecasting, studying holt, winter and ARIMA models, Supply chain Network Planning, Multi echelon network optimization, Supply chain sales and operations planning, Supply chain segmentation, Vehicle routing problems, Supervised and Unsupervised learning, Use of Bayesian networks in supply chain, Simulation and SC models, Supply chain risk management.

MBA* ZG566 Analytics for Marketing 4

Introduction to Marketing Research, Research Methodology, Problem definition, research design formulation, Field work and Data Collection, Data preparation and Analysis, Final report preparation and presentation, Case Studies, simulations, hands-on exercises using tools like R / Python.

MBA* ZG567 Analytics for Retail Industry 4

RFM (measuring customer recency, frequency and monetary) Analysis, churn modeling, retention modeling, shopper analytics, market basket association analysis, customer segmentation and profiling, propensity scoring models to identify prospective customers, best customers, lifetime value modeling, marketing campaign response modeling, cross sell modeling, etc., Case Studies, simulations, hands-on exercises using tools like R / Python.

MBA* ZG568 Operations Research Models 4

Practical application of OR tools. Application areas include: financial planning and portfolio selection, production, supply chain, priority planning and marketing. Linear programming and its applications; programming to achieve a set of goals or targets with applications in finance and production; capital budgeting and project selection; transportation and network models; and portfolio models, Case Studies, simulations, hands-on exercises using tools like R / Python.

MBA* ZG569 Analytics for Investment Banking 4

Modern portfolio theory, Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory (APT), and efficient market theory; Passive investing: indexing; behavioral finance; Active investing: security analysis – fundamental analysis (strategic, financial, marketing tools) and technical analysis; Portfolio management including allocation, rebalancing and risk management; Transaction cost analysis; Fixed-Income and Credit Sensitive Instruments. Case Studies, simulations, hands-on exercises using tools like R / Python.

MBA* ZG570 Financial Risk Models 4

Basics of financial risk, Its applications in the form of derivatives- Currency and interest rate derivatives, equity markets and products, commodity markets and products, Measuring and Analysing Volatility- EWMA, ARCH, GARCH, Volatility clusters and the issue of time-varying volatility, Extreme Value Theory, Correlation and Copula, Introduction to Multivariate Forecasting), VaR Computation, Stress testing, Monte Carlo simulation, address issues in generating price process (such as Brownian Motion, Ito Process), Cholesky decomposition in computing multi-asset VaR; Currency risk analysis in global investing, interest rate parity (covered and uncovered); Value at risk for fixed income Credit Risk Analytics Case Studies, simulations, hands-on exercises using tools like R / Python.

MBA* ZG571 Analytical Models in Finance 4

Modelling and valuation of equity securities, fixed income securities, and derivatives, Introduction to Financial Modelling, and Spreadsheet Essentials, Measuring Risk (Testing market efficiency with regression analysis & pivot tables), Portfolio optimization (Mean-variance portfolio selection, Bond portfolio selection, Term structure estimation, Capital budgeting), Advanced risk analysis (Monte-Carlo simulation, Risk analysis of discounted cash flow models, Monte- Carlo simulation, Business and equity valuation modelling, LBO Analysis Model , Stock Merger Model, etc., Case Studies, simulations, hands-on modelling exercises.

MBA* ZG572 Digital Business Design 4

Design Thinking in Digital Business, Components of ecommerce, Usability and information architecture, Product Design, Product Management, Mastering Disruptive Business Models, Platform Business Models, Network of platform economies, relevant technologies, Innovation through Experimentation: A/B Tests and Minimum Viable Products, building scalable digital businesses

MBA* ZG573 Digital Strategies for Business 4

Digital transformation of conventional enterprises, mastering disruption, Digital Transformation, Culture for Digital Business, Business Process Re-engineering, Frameworks to invent/reinvent business models for a digital world, Big Data and How to Build Data as a Strategic Asset, Translating the lean start-up to enterprise scale innovation, Applications of these frameworks through case studies

MBA* ZG574 Digital Customer Experience Management 4

Customer relationship management, Understanding the customer journey, making plans to improve the user experience, assessing the strategic options for channel selection, Understanding relevant insights into digital customers, Understanding how digital channels are managed effectively in practice, Defining requirements for legal compliance in digital campaigns.

MBA* ZG575 Digital Technologies and Analytics 4

Intro to Industry 4.0, IOT, Cloud Computing, AR, VR, AI, Machine Learning, Foundations of data science, glimpse of blockchain, fintech and crypto-currency, CRISP DM Framework, Applications of data analytics in business, data pre-processing and cleaning, types of data analytics, text analytics topic modeling, realtime analytics, data privacy and protection, legal aspects of data in digital businesses.

MBA* ZG576 Digital Marketing 4

3C Framework, Content Marketing, Web Analytics, Search Engine Marketing, Search Engine Optimisation, Email Marketing, Mobile Marketing, Affiliate Marketing, Social Media Marketing, Mobile Marketing, Marketing Spends Optimization, Pay-per-click, Their advantages and disadvantages, Link building campaigns, Online Reputation Management, Sponsored content, Push notification, In-game advertising, Sharing economies in digital marketing.

MBA* ZG577 Artificial Intelligence and Machine Learning 4

Applications of A.I. techniques to the business and management fields like natural language understanding, image processing, game theory and problem solving, Introduction to Machine Learning, Various kinds of learning, Supervised Learning, Unsupervised Learning, Feature Engineering, Classification, Model Selection; Bayesian Learning, Bayes Optimal Classifier, Naive Bayes Classifier; Linear Models for Regression, Linear Models for Classification; Non-Linear models, Decision trees; KNN Algorithm, Support Vector Machines, Neural Networks, Deep Learning, Text Mining, Association Rule Mining, and Introduction to Genetic Algorithms.

MBA* ZG578 Digital Manufacturing and Logistics 4

Industrial revolution 4.0, connected factories, smart industrial devices and products, cyber physical system in manufacturing, connectivity and communication technologies, RFID, QR codes and cellular technologies, protocols, hardware in IoT, software (IDE), cloud platform, connectivity and networking in IIoT, smart eyes on shop floor, integrating smart into existing equipment, programming using IoT, Digital Supply Chains, Warehousing automation.

MBA* ZG579 Entrepreneurial Finance 4

Principles of entrepreneurship, Changing landscape in raising capital, characteristics of the venture capital and private equity markets, specialized services provided by VC's and PE funds, stages in VC investing, deal flow, deal sourcing, evaluation, risk return trade off of VC/ PE investments, valuation of VC/ PE transactions, structuring and execution of deals, exit options, distributions, Early stage funding, Integrated Financing tech Solutions - Case Studies, Legal, Regulatory, Capital and Investment for new businesses, Enterprise Innovation.

MBA ZG611 Strategic Management &Business Policy4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

MBA ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

MBA ZG634 Strategic Change Management 4

Results-based management, managing for outcomes–objectives and targets; strategy; indicator, performance information; environmental scan and SWOT analysis; planning, budgeting, implementation, review - the (strategic) management cycle Models and theories of planned change, Strategic management: transformational leadership or change management (or learning),Strategic management in a context of joint action and networks, Participation and Empowerment, Teams and Teamwork, Parallel learning structures, OD Interventions, Team Interventions, Intergroup and third party interventions, Structural and Comprehensive interventions, Action research, Socio-clinical and Socio-technical Approaches, Issues in Consultant-Client Relationships, Power Politics and Organization Development.

MBA ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

MBA ZG623TProject 12

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work in Engineering / Management aspects that are considered vital to the sponsoring organization. At the end of the semester, the student should submit a comprehensive Project Report. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and a final seminar & viva-voce.

ME*ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, poly phase circuits,

transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

ME* ZC113 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

ME* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

ME* ZC213 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

ME* ZC231 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

ME* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

ME* ZC234 Maintenance & Safety 3

Objectives, functions, and types of maintenance; defects due to wear; lubrication and surfacing techniques to reduce wear; maintenance of different equipments and their elements; spares planning; overhauling; TPM; safety and safety management; environmental safety; chemical safety; occupational health management; control of major industrial hazards; managing emergencies; employee participation in safety; HRD for maintenance and safety.

ME* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

ME* ZC236 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

ME* ZC241 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio-visual aids; editing.

ME* ZC242 Manufacturing Process 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

ME* ZC251 Mechanical Technology 3

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

ME* ZC261 Mechanics of Solids 3

Fundamental principles of mechanics; introduction of mechanics of deformable bodies; forces and moments transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion; stresses and defections due to bending; stability of equilibrium.

ME* ZC271 Manufacturing Excellence 3

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility.

ME* ZC311 Automobile Technology 3

Introduction; working and construction of IC Engines; its components; cycles; fuel air cycle; diesel cycles; combustion in SI and CI Engines; fuels and combustion; fuel supply systems; scavenging process; engine cooling and lubrication; engine cooling system, friction and lubrication, engine testing and performance; super charging, analytical method of performance and estimation; emission controls; alternate fuels; modern trends in engine development.

ME* ZC312 Automobile Technology-II 3

Vehicle classification; chassis construction; clutches-friction clutches, fluid coupling; gear box-arrangement and design of gear boxes; epicyclical gear box; torque converters, semiautomatic and automatic gear boxes; propeller shaft; universal joint; differential; rear axle suspension systems; front axle and steering mechanisms – power steering mechanism; brakes –mechanical, hydraulic and air brakes; servo and power operated brake systems; wheels and tyres; testing and performance of automobiles; vehicle vibration; and human comfort; auto-electrical systems; ignition system-conventional and electronic system, alternators; charging system; storage batteries; wiper motors; lighting system; electrical vehicles; automobile law.

ME* ZC323 Design of Machine Elements 4

Fundamentals and principles of design; properties of engineering materials; design of simple machine parts; shafts, keys and couplings; power screws; threaded joints, welded and riveted joints, bearings and seals, gears, cams and followers; design of mechanisms.

ME* ZC324 Mechatronics and Automation 4

Introduction to mechatronics, sensors and transducers, Concepts of measurement of electrical and nonelectrical parameters; displacement, force, pressure etc. and related signal conditioning techniques , pneumatic and hydraulic

actuation systems, mechanical actuation systems, electrical actuation systems, digital logic, microprocessors and programmable logic controllers; Introduction to automation, control loops for numerical control systems, adaptive control systems, industrial robots, automatic identification and data capture, automated production lines and automated assembly systems, System design concepts through case studies.

ME* ZC331 Production Planning & Control 3

Types of production systems and problems of planning and control, product planning, forecasting, product demand, process planning, project management, capacities location and layout of facilities, aggregate planning and scheduling, materials requirement, planning, inventory management, systems and recent trends in production management.

ME* ZC332 Operations Research 3

Sampling, simulation, design of experiments and analysis of variance, nonparametric tests; correlation and regression analysis; quality control, reliability; decision theory; queuing theory; deterministic and probabilistic inventory systems.

ME* ZC343 Materials Management 3

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; stores management; material planning, make or buy decisions; scheduling, strategic sourcing, JIT, Kanban system; inventory costing principle; concept of MRP II; vendor development; central excise, customs, importing, sales tax.

ME* ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

ME*ZC418 Lean Manufacturing 3

Fundamentals of continuous improvement, value added and waste elimination, elements of lean production: small lot production, setup time reduction, maintaining and improving equipment, pull production systems, focused factories and group technologies, work cells and cellular manufacturing, standard operations, quality of design, systems for eliminating defects, simplified production planning and control systems: scheduling for smooth flow, synchronizing and balancing process, planning and control in pull production, beyond the production systems: managing the supply chain, activity based costing, performance measurement.

ME* ZC421 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

ME* ZC432 Quality Control, Assurance &Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

ME* ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

MEL* ZC111 Probability & Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal ES* ZGand student's t-distribution; test of hypothesis; correlation and linear regression.

MEL* ZC112 Electrical Sciences 3

Course covers basic passive circuit elements, dependent and independent sources, network theorems, circuit analysis techniques and response of first and second order circuits. Introduction to three - phase circuits, magnetic circuits, transformers, basics of rotating machines. Semiconductors - operation of diodes, zener diodes, bipolar junction transistors and field effect transistors. Biasing techniques and applications of diodes and transistors. Introduction to operational amplifiers and applications. Introduction to Digital Electronics.

MEL* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting(Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations),Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

MEL* ZC214 Electronic Devices 3

Crystal structure and growth of semiconductor, electrical conduction in solids, Elementary quantum physics (Photoelectric effect, uncertainty principle, Schrodinger wave equation and tunneling), energy bands in solids, charge carriers in semiconductors, excess carriers in semiconductors, Fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, metal-semiconductor junctions Bipolar junction transistors, field effect transistors (JFET, HEMT, MOSFET), Special diodes (varactor diode, solar cell, LEDs, Tunnel diode and HBT), dielectric materials and insulation (Polarization mechanisms, frequency dependence, dielectric strength and insulation breakdown).

MEL* ZC215 Digital Design 4

Boolean Algebra & logic minimization; combinational logic circuits: arithmetic circuit design, Design using MSI components; Sequential Logic Circuits: flip flops & latches, registers and counters, Finite state machine; HDL Implementation of Digital circuits; Digital Integrated Circuits; Programmable logic devices; Memory organization; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

MEL* ZC222 Discrete Structures for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

MEL* ZC234 Linear Algebra and Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and

diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

MEL* ZC241 Microprocessor and Interfacing 4

Sequential Circuits and Memory; Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams ; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; Design of processor based system. This course will have a laboratory component.

MEL* ZC244 Microelectronic Circuits 3

Basic microelectronic circuit analysis and design, biasing in discrete and integrated circuit amplifiers, an overview of modeling of microelectronic devices single and two transistor amplifier configurations with passive and active loads; current mirrors & current sources; single-ended and differential linear amplifiers , differential and multistage amplifiers; 2 stage CMOS OPAMP, frequency response of amplifiers; negative feedback in amplifiers, R-C frequency compensation.

MEL* ZC321 Control Systems 3

Modeling and classification of dynamical systems, Properties and advantages of feedback systems, time-domain analysis, frequency-domain analysis, stability and performance analysis, State space analysis, controller design.

MEL* ZC342 Computer Architecture 4

Processor performance criteria, performance benchmarks, arithmetic circuits, CPU design - instruction set architecture, instruction execution, Single and Multicycle implementation, Pipeline design, Hazards, methods of overcoming hazards, Branch prediction, Memory subsystems including cache optimization, Instruction level Parallelism.

MEL* ZC363 Data Structures and Algorithms 4

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; Analysis of algorithms; Linear data structures – stacks, arrays, lists, queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees; Implementation techniques for different data structures including trees, graphs and search structures; Performance evaluation of data structures and algorithms; Implementation issues in large data structures.

MEL* ZC364 Analog Electronics 4

Introduction to operational amplifiers, characteristics of ideal and real operational amplifiers, applications of operational amplifiers, multifunction modules & circuits, true rms converters, Precision and signal conditioning circuits, Waveform Generation: sinusoidal and non-sinusoidal signal generation; Wave shape converters, 555 timer based circuits, Phase lock loop circuits & applications, IC regulators, Output stage and large signal amplifiers, Power amplifiers, Tuned amplifiers, Analog and Digital interface circuits: A/D, D/A Converters.

MEL* ZC382 Communication Systems 4

Analysis and design of communication systems; analog and digital modulation and demodulation, frequency conversion, multiplexing, noise and distortion; spectral and signal-to-noise ratio analysis, probability of error in digital systems, spread spectrum. Introduction to basic principles of design and analysis of modern digital communication systems**.**

MEL* ZC411 Signals and Systems 3

This course is intended to provide a comprehensive coverage of Signals and Systems, a fundamental subject of Electrical Engineering. The topics covered are: Continuous-time and discrete time signals and systems, convolution, properties of linear time-invariant (LTI) systems, Fourier series, Fourier transform, Z transform, Laplace transform; System analysis, frequency response, analog filters, Sampling and reconstruction.

MEL* ZC415 Introduction to MEMS 4

Overview, history and industry perspective; working principles; mechanics and dynamics, thermo fluid engineering; scaling law; micro actuators, micro sensors and micro electromechanical systems; micro system design, modeling and simulation; materials; packaging; micro fabrication: bulk, surface, LIGA etc; micro manufacturing; micro fluidics; micro robotics; case studies.

MEL* ZC444 Artificial Intelligence 3

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving. The course also aims at understanding its implementation using LISP and PROLOG languages.

MEL* ZC464 Machine Learning 3

Neural networks; neuro-computing theory and applications, knowledge representation; computational learning theory; statistical/probabilistic methods, genetic algorithms; inductive/analytic/reinforcement learning and bayesian networks; selected topics such as alpha-beta pruning in game trees, computer models of mathematical reasoning, natural language understanding and philosophical implications.

MEL* ZC477 Modeling of Field Effect Nano-Devices3

Course Description to be developed.

MEL* ZG510 RF Microelectronics 5

Introduction; application of RF electronics in modern systems; basic concepts in RF circuit design, active RF components: various RF diodes and transistors and their circuit models, matching and biasing networks, RF amplifier design: low power, low noise and broadband amplifiers, RF oscillator design; negative resistance oscillator; dielectric resonator oscillators, phase noise. RF Mixers: Balanced mixers; low noise mixers; noise in RF circuits, microwave transmitters and receivers.

MEL* ZG511 Design & Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

MEL* ZG512 Optoelectronic Devices, Circuit & Systems 5

Physics of optical radiation and principles of calculation in radiation physics & optics, fundamental laws of photometry. Interaction between optical radiation and matter. Radiation sources. Parameters of IR detectors and junction photodetectors, parameters common to emitters and receiver, radiation measurements, optoelectronic components, optoelectronic integrated devices, photodetector circuits, methods of modulation and optoelectronic system design and applications.

MEL* ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum systems; second & third generation systems, UMTS, IMT-

2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

MEL* ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

MEL* ZG526 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

MEL* ZG531 Testability for VLSI 5

BIST, boundary sean, stuck-at faults, test generation algorithms for combinatorial logic circuits and sequential circuits, logic simulation and fault simulation, synthesis for test, built in self-test, pseudo-random test techniques, other test methods - IDDQ testing, boundary scan etc.

MEL* ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi-processing and distributed systems.

MEL* ZG554 Reconfigurable Computing 5

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and Switch Networks. Design and Synthesis of Combinational and Sequential Elements. Placement and Routing. Pipelining and other Design Methodologies. Fine-grained and Coarse-Grained FPGAs. Static and Dynamic Reconfiguration. Partitioning. Hardware/Software Portioning and Partial Evaluation. Systolic Architectures.

MEL* ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

MEL* ZG611 IC Fabrication Technology 5

Material properties; Crystal growth and doping; diffusion; oxidation; epitaxy; Ion implantation; Deposition of films using CVD, LPCVD and sputtering techniques; Wet and dry etching and cleaning; Lithographic process; Device and circuit fabrication; Process modeling and simulation.

MEL* ZG613 Advanced Digital Signal Processing 4

Review of stochastic processes, models and model classification, the identification problem, some field of applications, classical methods of identification of impulse response and transfer function models, model learning techniques, linear least square estimator, minimum variance algorithm, stochastic approximation method and maximum likelihood method, simultaneous state and parameter estimation of extended kalmanfilter, non-linear identification, quasi linearization, numerical identification methods.

MEL* ZG621 VLSI Design 5

Introduction to NMOS and CMOS circuits; NMOS and CMOS processing technology; CMOS circuits and logic design; circuit characterization and performance estimation; Structured design and testing; Symbolic layout systems; CMOS subsystem design; System case studies.

MEL* ZG623 Advanced VLSI Design 5

Deep submicron device behavior and models, interconnect modeling for parasitic estimation, Clock signals and system timing--Digital phase locked loop design, memory and array structures, Input/output circuits design, ASIC technology, FPGA technology, High speed arithmetic circuits design, - Parallel prefix computation, Logical effort in circuit design, Low power VLSI Circuits-Adiabatic logic circuits, Multi threshold circuits, Digital BICMOS circuits, Design of VLSI systems.

MEL* ZG625 Advanced Analog and Mixed Signal Design 5

Design of high speed compartors and Op-amps; analog buffers; different architectures of A/D and D/A converters; analog multipliers and dividers; design of PLLS; design methods for switched capacitor filters sample and hold circuits; mixed signal design issues; noise coupling from substrate and its reduction; cross talk and shielding; analog layout techniques for mixed signal designs.

MEL* ZG631 Physics & Modelling of Microelectronic Devices 5

Physics and properties of semiconductor - a review; pn junction diode; bipolar transistor; metal semiconductor contacts; JFET and MESFET; MOSFET and scaling; CCD and photonic devices.

MEL* ZG632 Analog IC Design 5

Basic concepts; BICMOS process and technology; current and voltage sources; Differential and Operational Amplifiers; Multipliers and modulators; phase-lock techniques; D-to-A and A- to-D converters; Micro power circuits; High voltage circuits; Radiation Resistant Circuits; Filter design considerations.

MEL* ZG641 CAD for IC Design 5

Introduction to VLSI design methodologies and supporting CAD tool environment; Overview of `C', Data structure, Graphics and CIF; Concepts, structures and algorithms of some of the following CAD tools; Schematic editors; Layout editors; Module generators; Silicon compilers; Placement and routing tools; Behavioral, functional, logic and circuit simulators; Aids for test generation and testing.

MEL* ZG642 VLSI Architecture 4

Overview of CISC processor architectures; Instruction set architecture of CISC processor; hardware flow-charting methods; implementing microprocessor logic from hardware flowcharts; RISC instruction set architecture; pipelined execution of RISC instructions; pipeline execution unit design; control hazards; design of memory hierarchy.

MEL* ZG651 Hardware Software Co-Design 4

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

MEL* ZG652 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

MGTS ZC211 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial,

personnel, legal and marketing functions; accounting and budgeting, balance sheets.

MM ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

MM ZC441 Human Resource Management 4

Introduction, manpower planning, career and succession planning, procurement of personnel, performance appraisal, job satisfaction and morale, job rotation, employee communication, audit and control, management training and development, wage and salary administration, welfare administration, trade unions and collective bargaining, industrial dispute and worker participation in management.

MM ZC448 ADDITIVE MANUFACTURING 4

Introduction to Additive Manufacturing, CAD for Additive Manufacturing; Material Science Aspects in Additive Manufacturing, Different materials used in AM, Use of multiple materials, multifunctional and graded materials in AM, Role of solidification rate; Various Additive Manufacturing Processes Powder- based AM processes involving sintering and melting, Printing processes (droplet based 3D printing), Fused deposition modelling (FDM), Laminated object manufacturing, Stereolithography, Micro- and nano- additive manufacturing processes; Modelling in Additive Manufacturing Transport phenomena models: temperature and fluid flow, molten pool formation, Various case studies - modelling of fusion based AM process, powder bed melting based process, droplet based printing process; Applications of Additive Manufacturing in Aerospace, Automotive, Electronics industries and Biomedical applications

MM ZC449 IoT in Manufacturing 4

Safe work practices and workplace safety, Industrial revolution 4.0, Forces behind Industry 4.0 (IoT, big data and cloud computing, robotics and artificial intelligence), Connected factories (what is connected factory and criteria for connected factory), Smart devices and smart products, cyberphysical system, definition; cps in manufacturing, Connecting devices with each other and with internet, Data acquiring and collection, Communication technologies (WIFI, IEEE 802.15.41), RFID, QR codes and cellular technologies, Protocols, Hardware in IoT, Software (IDE), Cloud platform, Smart devices and control system, Connectivity and networking in IoT, Smart eyes on shop floor, Integrating smart into existing, Programming using IoT, Case study and implementation.

MM ZC472 Precision Engineering 3

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and microfinishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerancing.

MM ZG512Manufacturing Strategy 4

Corporate strategy; Missing links in manufacturing strategy; Audit approach; Restructuring; Manufacturing strategy process in practice; Formulation as a process; Operating strategies; Methodology framework; Lean production; Competitive priorities; Strategic value of response time and product variety; Flexibility in context of manufacturing strategy; Manufacturing focus; Business process reengineering; Theory of constraints; Link between strategy and organizational culture; Evolution of manufacturing systems; Operations management strategic perspective.

MM ZG513 Maintenance Engineering 5

Introduction, maintenance systems, methods and tools of maintenance analysis, reliability and safety, maintainability, supportability, design for maintenance, maintenance integration computerized maintenance management systems, TPM, world-class maintenance systems, and maintenance effectiveness and performance evaluation.

MM ZG514 Leadership and Managing Change 4

Individuals as leaders, team leadership and organizational leadership. Introduction to managing change, management of change: organizational structure, culture, recruitment, performance management, human resource development, reward management, employee relations and involvement, downsizing, and evaluating and promoting.

MM ZG515 Quantitative Methods 4

Basic concepts in Operations Research; Analytical & Mathematical Modeling Techniques; Model Building; Inventory Control, queuing theory; Linear Programming; Transportation and assignment problems, simulation, index numbers, decision theory, etc.

MM ZG522 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability

MM ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

MM ZG533 Manufacturing Planning & Control 5

Planning and control of manufacturing operations; material flow planning; product and process planning; demand forecasting and forecasting models; facility location; plant layout planning and design; machine cells; capacity planning; designing work methods; material handling; line balancing; aggregate planning; inventory models and systems for independent demand; materials requirements planning; elements of monitoring and production control; current developments in operations management.

MM ZG534 Sustainable Manufacturing 4

Introduction to sustainable manufacturing, sustainable manufacturing design, practice and matrices, life cycle management and assessment, end of life (EOL) strategies, implementation framework, sustainable business models, waste minimization, case studies.

MM ZG535Decision Analysis 4

Introduction to quantitative techniques and statistics, Decision making, intelligence design and choice phases, basic theory of decision making under uncertainty; decision trees, qualification of judgments and preferences, Bayes theorem, the structuring of complex decisions, and multi-attribute utility theory. Statistical estimation and forecasting.

MM ZG537 Lean Manufacturing 5

Birth of Toyota production system, house of Toyota production system, stability, standardization, just-in-time, jidoka, involvement, hoshin planning, Toyota culture, Toyota way, Case Studies.

MM ZG539 Six Sigma 4

History of Six Sigma, Implementing Six Sigma, Becoming a Customer and Market-Driven Enterprise, Customer Expectations and Needs, Linking Six Sigma Projects to Strategies, Attributes of Good Metrics, Using resources wisely, Project Management Using the DMAIC and DMADV Models, The Define Phase, The Measure Phase, Measurement System Analysis, Analyzing Data: Value Streams and Dealing with Variations, Designing Experiments, The Improve Phase, The Control Phase.

MM ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychol giccl, physiological considerations in design decision making; legal factors, engineering ethics and society.

MM ZG611 Strategic Management & Business Policy4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

MM ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

MM ZG627 Managerial Corporate Finance 4

Introduction to corporate finance; financial statements - analysis and interpretation; value creation – ways and means; time value of money; risk and return; understanding and analyzing various cost concepts and behaviour; analysis and impact of leverage; cost of capital; project appraisal and management - emphasis on technology projects (Diamond framework: NTPC - Novelty, Technology, Pace and Complexity); dimensions of adaptive technology project management; measuring and controlling assets employed in a project; project risk analysis; management control of projects; project financing – leasing and hire purchase; management control system - budget preparation; analyzing financial performance reports (variance analysis) and performance measurement system; working capital management – managing operating capital.

MM ZG628T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

MT* ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, poly phase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

MT* ZC213 Engineering Measurements 4

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

MT* ZC221 Computer Programming 4

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

MT* ZC231 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

MT* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

MT* ZC234 Maintenance & Safety 3

Basic maintenance systems and practice; maintenance planning; estimating and budgeting; scheduling maintenance jobs; importance of safety; factors affecting safety; safety aspects of site and plant; hazards of commercial chemical reaction and operation; instrumentation for safe operation; safety education and training; personnel safety; disaster planning and measuring safety effectiveness; future trends in industrial safety; maintenance of components and equipments; new dimensions in maintenance covering plant engineering, tribology, materials technology, terotechnology (life cycle costing) etc.; extensive case studies.

MT* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigen values, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

MT* ZC236 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

MT* ZC241 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio-visual aids; editing.

MT* ZC245 Fluid Mechanics and Machines 4

Introduction and fundamental concepts, fluid statics, kinematics and dynamics of fluid flow, inviscid flows, pipe flow and network design, open channel flow, incompressible viscous flow, laminar boundary layers, turbulent flows, essentials of compressible flow, dimensional and model analysis, orifice, venturi, notches and weirs, hydraulic turbines, centrifugal and reciprocating pumps, fluid couplings and torque convertors, compressors.

MT* ZC251 Mechanical Technology 4

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

MT* ZC261 Mechanics of Solids 3

Fundamental principles of mechanics; introduction of mechanics of deformable bodies; forces and moments transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion; stresses and defections due to bending; stability of equilibrium.

MT* ZC311 Automobile Technology-I 4

Introduction; working and construction of IC Engines; its components; cycles; fuel air cycle; diesel cycles; combustion in SI and CI Engines; fuels and combustion; fuel supply systems; scavenging process; engine cooling and lubrication; engine cooling system, friction and lubrication, engine testing and performance; super charging, analytical method of performance and estimation; emission controls; alternate fuels; modern trends in engine development. Virtual demonstration of automobile parts and assemblies may be demonstrated. Some amount of Pro/Engineer (CREO) modeling of automobile structures may be practiced.

MT* ZC312 Automobile Technology-II 4

Vehicle classification; chassis construction; clutches-friction clutches, fluid coupling; gear box arrangement and design of gear boxes; epicyclical gear box; torque converters, semiautomatic and automatic gear boxes; propeller shaft; universal joint; differential; rear axle suspension systems; front axle and steering mechanisms – power steering mechanism; brakes –mechanical, hydraulic and air brakes; servo and power operated brake systems; wheels and tyres; testing and performance of automobiles; vehicle vibration; and human comfort; auto-electrical systems; ignition system-conventional and electronic system, alternators; charging system; storage batteries; wiper motors; lighting system; electrical vehicles; automobile law. Virtual demonstration of automobile parts and assemblies may be demonstrated. Some amount of Pro/Engineer (CREO) modeling of automobile structures may be practiced.

MT* ZC315 Casting and Welding 4

Casting: fundamentals of casting processes, design of castings, furnaces, foundry mechanization, special casting processes, economics of casting, inspection and defects of casting. Powder metallurgy: introduction, methods of powder production, characteristics and properties of powder, manufacturing methods, furnaces, finishing processes, economics of powder metallurgy. Welding: various welding processes, design for welding, safe practices in welding, inspection and defects of welding, economics of welding, brazing and soldering. Virtual simulation of casting and welding processes.

MT* ZC316 Transport Phenomena 4

Fundamental concepts of fluid flow, concept of momentum transfer, Newton's law of viscosity, Continuity and Bernoulli's equation, concept of pressure drop and drag; Heat transfer: steady state and unsteady state heat conduction; analytical and empirical relations for forced and free convection heat transfer; heat exchanger analysis and design, heat transfer by radiation; Elements of mass transfer; one dimensional compressible flow; associated laboratory on condenser, boiler, economizer, super heater etc.

MT* ZC324 Mechatronics & Automation 4

Introduction to mechatronics, sensors and transducers, Concepts of measurement of electrical and nonelectrical parameters; displacement, force, pressure etc. and related signal conditioning techniques , pneumatic and hydraulic actuation systems, mechanical actuation systems, electrical actuation systems, digital logic, microprocessors and programmable logic controllers; Introduction to automation, control loops for numerical control systems, adaptive control systems, industrial robots, automatic identification and data capture, automated production lines and automated assembly systems, System design concepts through case studies. Virtual demonstration of mechatronics elements, their assembly to obtain devices and products etc.

MT* ZC331 Production Planning & Control 4

Types of production systems and problems of planning and control, product planning, forecasting, product demand, process planning, project management, capacities location and layout of facilities, aggregate planning and scheduling, materials requirement, planning, inventory management, systems and recent trends in production management. Simulations using software tools such as FlexSim or Quest may be conducted.

MT* ZC332 Operations Research 4

Sampling, simulation, design of experiments and analysis of variance, nonparametric tests; correlation and regression analysis; quality control, reliability; decision theory; queuing theory; deterministic and probabilistic inventory systems. FlexSim and Lingo/Lindo based virtual simulations.

MT* ZC342 Machine Design 4

Fundamentals and principles of design, design and selection of machine elements such as shafts, spindle supports, gears, bearings; etc.; design of mechanism; design of machine tool structure; dynamics of machine tools; introduction to CAD, CAM, CIM; Design of jigs and fixtures; press tools for blanking; punching; drawing; combination tools and progressive tools. Machine Drawing of part and assembly drawing using Pro/Engineer (CREO) or similar software tools are to be conducted.

MT* ZC343 Materials Management 4

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; stores management; material planning, make or buy decisions; scheduling, strategic sourcing, JIT, Kanban system; inventory costing principle; concept of MRP II; vendor development; central excise, customs, importing, sales tax. FlexSim/Quest based simulations.

MT* ZC344 Metal Forming and Machining 4

Metal forming: introduction, metal forming machines, metal forming process analysis and design. Machining: introduction, metal cutting machine tools, mechanics of metal cutting, other aspects of machining processes, grinding and finishing operations, non-conventional machining processes and processing of plastics. It may consist of virtual practical work using software tool CNC Simulator-Pro (http://cncsimulator.info/). Similarly, we need to get metal forming process animations in 3DS-Max, Maya or similar software tools. Virtual simulation of metal forming and machining processes.

MT* ZC411 Tool and Fixture Design 3

Tool-design methods, tool making practices, tooling materials and heat treatment, design of cutting tools, gages and gage design, locating and clamping methods, design of drill jigs, design of fixtures, design of sheet metal blanking and piercing dies, design of sheet metal bending, forming and drawing dies, using plastics as tooling materials, tool design for numerically controlled machine tools and automatic screw machines.

MT* ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS. FlexSim/Quest based simulations.

MT* ZC418 Lean Manufacturing 4

Fundamentals of continuous improvement, value added and waste elimination, elements of lean production: small lot production, setup time reduction, maintaining and improving equipment, pull production systems, focused factories and group technologies, work cells and cellular manufacturing, standard operations, quality of design, systems for eliminating defects, simplified production planning and control systems: scheduling for smooth flow, synchronizing and balancing process, planning and control in pull production, beyond the production systems: managing the supply chain, activity based costing, performance measurement. Logistics case studies using software tools such as FlexSim may be conducted.

MT* ZC421 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

MT* ZC432 Computer Aided Manufacturing 3

Introduction, features of NC machine tools, NC part programming, CAM system devices, interpolators for manufacturing systems, control loops of NC systems, computerized numerical control, adaptive control systems, CAD to CAM, CAPP, industrial robots, computer aided production planning & control, computer aided inspection and quality control, CIM systems.

MT* ZC434 Quality Control, Assurance &Reliability4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

MT* ZC448 ADDITIVE MANUFACTURING 4

Introduction to Additive Manufacturing, CAD for Additive Manufacturing; Material Science Aspects in Additive Manufacturing, Different materials used in AM, Use of multiple materials, multifunctional and graded materials in AM, Role of solidification rate; Various Additive Manufacturing Processes Powder- based AM processes involving sintering and melting, Printing processes (droplet based 3D printing), Fused deposition modelling (FDM), Laminated object manufacturing, Stereolithography, Micro- and nano- additive manufacturing processes; Modelling in Additive Manufacturing Transport phenomena models: temperature and fluid flow, molten pool formation, Various case studies - modelling of fusion based AM process, powder bed melting based process, droplet based printing process; Applications of Additive Manufacturing in Aerospace, Automotive, Electronics industries and Biomedical applications

MT* ZC449 IoT in MANUFACTURING 4

Safe work practices and workplace safety, Industrial revolution 4.0, Forces behind Industry 4.0 (IoT, big data and cloud computing, robotics and artificial intelligence), Connected factories (what is connected factory and criteria for connected factory), Smart devices and smart products, cyberphysical system, definition; cps in manufacturing, Connecting devices with each other and with internet, Data acquiring and collection, Communication technologies (WIFI, IEEE 802.15.41), RFID, QR codes and cellular technologies, Protocols, Hardware in IoT, Software (IDE), Cloud platform, Smart devices and control system, Connectivity and networking in IoT, Smart eyes on shop floor, Integrating smart into existing, Programming using IoT, Case study and implementation.

MT* ZC452 Composite Materials and Design 4

Introduction to composites, concepts of reinforcement, strengthening mechanisms, fibrous reinforcements, matrix materials, micromechanical aspects of composites, manufacturing methods, composite production design methods design of tensile members, pressure vessels, storage tanks, and other chemical process equipment made of FRP, design of joints, damage of composites by impact, FRP grids, recent development in manufacturing of composites and technologies. Simulation of mechanics of composite materials using suitable software tools.

MT* ZC471Manufacturing Excellence 4

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility. FlexSim/Quest based simulations.

PCAM* ZC211 Regression 2

Regression as a type of supervised learning technique where the target attribute is a continuous variable; regression models from theoretical and implementation perspectives. Model selection and performance measures; Issues with regression models such as overfitting and the ways of combatting overfitting like ridge and lasso regression; Interpretability/explicability of the models;

PCAM* ZC111 Feature Engineering 1

Feature Engineering as a step to develop and improve performance of Machine Learning models; Data wrangling techniques that help transforming the raw data to an appropriate form for learning algorithms; Data preprocessing techniques such as normalization, discretization, feature subset selection etc. and dimension reduction techniques such as PCA. Different ways of visualizing the data such as Box plots, Contour plots, Heat maps etc.

PCAM* ZC311 Classification 3

Classification is a type of supervised learning techniques where the target attribute takes discrete values; Three types of techniques to solve classification problems – discriminant function, generative, and probabilistic discriminative approaches. Algorithmic perspective of popular classification algorithms - k-NN, Naïve Bayes, Decision Tree, Logistic Regression and SVM. Implementation details of these models along with tuning of parameters. Ensemble methods, bagging, boosting, Random Forest and eXtreme Gradient Boosting. Interpretability/explicability of the models;

PCAM* ZC221 Unsupervised Learning and Association Rule Mining 2

Unsupervised learning algorithms for finding regularities in the absence of explicit labels or supervised outputs; Clustering as an unsupervised learning task to find natural grouping in the data. Various clustering algorithms such as K-Means, EM Algorithm, Single Linkage Algorithm, Complete Linkage algorithm and DBSCAN. Various ways of assessing the quality of clustering and detecting outliers. Typical industrial applications of unsupervised learning algorithms; Introduction to HMM in the context of performing time series prediction; role of EM algorithm in estimating the parameters. Algorithms to learn association or discover dependencies between the data items; Apriori algorithm and different metrics to measure the interestingness of the rules.

PCAM* ZC231 Text Mining 2

Unstructured or semi structured data and their forms; Extracting the relevant text data and identifying patterns therein. Converting documents to vectors using TF-IDF, Parts of Speech Tagging, Topic modelling using LDA, sentiment analysis and recommender systems.

PCAM* ZC241 Deep Learning and Artificial Neural Networks 2

Details of neural networks as well as deep learning architectures. An algorithmic perspective and implementation details of ANN, RNN, LSTM, CNN, RCNN, Faster RCNN, Autoencoders, Generative deep learning models like Boltzmann Machine, Deep Belief Machines and GAN etc.

PCAM* ZC321 Capstone Project 3

Real life problems encompassing a typical data science pipeline obtained from organizations/third party vendors; Jointly mentored by the industry experts and faculty; Comparative study of the relevant techniques covered in the course; Presenting the results in the required format; Fortnightly review of progress of the project.

PCGM* ZC411 Marketing 4

Definition and scope, consumer behavior, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

PCGM* ZC415 Financial and Management Accounting 4

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

PCGM* ZC417 Quantitative Methods 4

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, time series and forecasting, index numbers, decision theory, linear programming, transportation and assignment problems, queuing theory, network problems, simulation; application of statistical software (SYSTAT, SPSS, SIMULA8, etc.) and spreadsheets.

PCGM* ZC416 Managerial Economics 4

Fundamental concepts, supply, demand, market mechanism; theory of demand (consumer behaviour); production, costs (theory of the firm); market structures (perfect competition, monopoly, monopolistic competition, oligopoly); circular flow of income, national income accounting, national income determination; money and banking, employment, interest, inflation, economics of information, problem of adverse selection, moral hazard problem, market failure, externalities, public goods.

PCMP* ZG511 Managing People & Organizations 4

Concepts and principles of management as applied to a variety of organizations; study of managerial roles, styles, activities and decision making; relationship with organizational effectiveness; planning activities, leadership & control; manpower development; organizational behavior and theory.

PCMP* ZG526 Operations Management 4

Operations strategy; process view vs. functional view in operations; factors in product and process design and selection; facility configuration; demand planning and forecasting; capacity planning; aggregate planning; planning service operations; productivity of operations; inventory planning and independent demand systems; materials requirements planning; quality management; uncertainty and variability; project management; current developments in operations management.

PCMP* ZG537 Lean Manufacturing 5

Birth of Toyota production system, house of Toyota production system, stability, standardization, just-in-time, jidoka, involvement, hoshin planning, Toyota culture, Toyota way, Case Studies.

PCMP* ZG522 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability.

PDACS ZC435 Introduction to Autotronics 3

Fundamentals of automotive electronic micro controller, control concepts and control design. Sensors, sensor types, signal conditioning, system modelling, dynamic response of systems, feedback/closed loop controllers. Electronic fuel control systems, actuators: fuel injectors, exhaust gas recirculation, motors and ignition systems.

PDACS ZC436 Automotive Networks and Communications 4

Automotive networking - overview of TCP/IP systems, distributed and network-embedded systems, internal vehicle communication infrastructure including serial wired bus (UART, SPI, I2C) and protocols like LIN, Ethernet and Deterministic Ethernet, CAN, MOST, FlexRay and BroadR Reach; v2x communication like Vehicle to network (V2N), Vehicle to infrastructure (V2I), Vehicle to vehicle (V2V), Vehicle to cloud (V2C), Vehicle to pedestrian (V2P), Vehicle to device (V2D), Vehicle to grid (V2G); IOT in automotive domain, DSRC standards, aerial networks, automotive middleware: AUTOSAR (AUTomotive Open System Architecture) classic and AUTOSAR adaptive; Protocol coexistence, adaptation, control, and heterogeneity.

PDACS ZC437 Cyber Security and Cyber Laws 3

Examination of issues related to network and information security, security policy management, security standards like 21434, UN Regulation No. 155 and UN WP 29, security system interoperation and case studies of some of the major current security systems.

PDACS Z438 Software Engineering for Secure Systems 3

Software engineering principles and criteria for secure systems; analysis of system properties; use of formal methods and verification for security; tools for verification; techniques for software protection and their limitations; analysis of software based attacks and defenses.

PDACS ZC439 Cloud, IoT Security 4

Security Overview, Security Architectures, Security as a Process, Securing the Network, Systems, Internet of Things, Security Requirements in IoT and Current Vulnerabilities, Security Architecture in the Internet of Things, Device Security and Node Authentication, Data Security Schemes for IoT, Cloud Computing Fundamentals, Cloud Computing Software Security, Cloud Computing Risk Issues, Cloud Computing Security Challenges and Architecture.

PDACS ZC440 AI and ML for Cyber Security 3

Machine Learning for Anomaly Detection; Malware detection and classification; Network Intrusion detection and classification; Detection and categorization of domain names; Profiling Network Traffic; Adversarial Machine Learning for Malware detection.

PDACS ZC445 Information Security Project 3

Malware and Malware Identification, Terminate-and-Stay-Resident programs, Identification of signatures/patterns of viruses, Developing Antivirus tools, Single system firewalls and rules, Rootkits and identification of rootkits, Virtual machines, Sandboxes and run-time monitors.

PDACS ZC450 Cyber Forensics and Incident Handling 3

Introduction to Computer Forensics: collection, preservation, analysis, preparation and presentation of computer-based evidence. Structure of Storage Media: Study of different file systems (FAT12, FAT16, FAT32, NTFS, EXT2/EXT3, etc.). Study of digital forensic techniques: Disk forensics, Network forensics and Device forensics. Use of Forensic Tools for file system analysis, registry analysis and network analysis.

PDACS ZC454 Blockchain Technology 3

Blockchain Technology, and its applications, Cryptocurrencies, Distributed Ledger Technology, Decimalized Systems, Blockchain Data Structure, Cryptography for Blockchain, Decentralized Identity Management, Consensus Mechanism, Smart contracts, Ethereum, Ethereum Virtual Machine, Distributed App development, Consortium Blockchain, Hyperledger, Case studies/Enabling Technologies and applications

PDACS ZC463 Cryptography 3

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

PDACS ZG501 Network Security Project 3

Network Intrusion and Intrusion Detection Techniques and Tools; Denial-of-Service attacks and Techniques/Tools for handling them; Network Firewalls and Firewall policies/mechanisms; Network-wide authentication schemes for users/clients/servers; Network-wide storage and storage security models and implementations.

PDACS ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

PDACS ZG519 Automotive Security 4

Security concepts, security attacks and risks, architectures, policy management, mechanisms, understanding the risks and advantages of vehicle to internet (V2I), vehicle to vehicle (V2V), vehicle to IoT (V2IoT) connectivity, issues concerning the security of intelligent transport systems that communicate with the vehicle, telematics, cryptography, security standards, security system interoperation and case studies of the automotive security systems and connectivity technologies, automotive cyber security and autonomous vehicles, connected vehicle driver responsibility, issues around liabilities related to automotive cyber security incidents.

PDACS ZG574 Embedded Network Security 4

Introduction to networked embedded systems, network security fundamentals, internet communication and security protocols, techniques for embedded network security, wireless communication in embedded network security, wireless and cellular network security, WSN and adhoc network security, embedded device attestation techniques, handling attacks from compromised systems, security issues in IoT devices and networks.

PDACS ZG575 Ethical Hacking 3

Techniques and tools for ethical hacking and countermeasures; exploit approaches – social engineering, scanning, footprinting, enumeration, sniffers, buffer overflows, web-hacking including cross scripting, SQL injection, privilege escalation, root kits, search engine highjack, covert channel, binary auditing, services specific hacking like DNS, Email, Web servers, Proxy; techniques of bypassing security mechanisms and hardening systems and networks for countermeasures of security analysis, monitoring and analysis tools including network traffic and system logs.

PDBA* ZC413 Analytics for Competitive Advantage 4

In today's competitive business environment, high performing companies are doing more than just collecting data, storing it and generating reports. They are developing competitive strategies using Business Analytics. In this course we will look at how to use data-driven insights to differentiate a firm's business/ product strategy from other companies that are making the same product or delivering the same service. This course is designed for analysts in any function: marketing, operations, quality, customer service, IT, finance/accounting or human resources. We will use case studies and other experiential components to study the application of data-driven insights in the context of various industries.

PDBA* ZC417 Quantitative Methods 4

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, time series and forecasting, index numbers, decision theory, linear programming, transportation and assignment problems, queuing theory, network problems, simulation; application of statistical software (SYSTAT, SPSS, SIMULA8, etc.) and spreadsheets.

PDBA* ZG512 Predictive Analytics 4

Basic concepts in predictive analytics / predictive modeling. Two core paradigms for predictive modeling: classification and regression. Identification of important variables and their relation to each another. Basic modeling techniques such as k-nearest neighbors, classification and regression trees (CART), and Bayesian classifiers. Ensemble techniques. Model selection techniques.

PDBA* ZG517 Financial Analytics 4

Different sources of Financial Data, Statistical characteristics of financial data, Distributions of Financial Data, Statistical Applications in Finance, Exploratory Data Analysis, Modelling using Financial Statements Data, Modelling stock price behavior, Modelling Credit Default using classification algorithms, Introduction to Machine Learning algorithms for price forecasting and Portfolio Modelling, Introduction to Monte Carlo Bootstrapping, simulation and cross validation, Sentiment Analysis in Finance.

PDBA* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

PDBA* ZG536Foundations of Data Science 4

Introduction, Role of a Data Scientist, Statistics vs. Data Science, Fundamentals of Data Science, Data Science process and life cycle, Exploratory Data Analysis, Data Engineering and shaping, Overview of Data Science Techniques and Models, Introduction to Regression, Classification, Shrinkage, Dimension Reduction, Tree-based models, Support Vector Machines, Unsupervised learning, Choosing and evaluating models, Featurization, Overview of Neural Networks, Data mining, and pattern recognition techniques, Documentation, Deployment, and Presentations of the insights

PDBA* ZG538 Advanced Statistical Methods 4

Point and interval estimation and hypothesis testing, chi-square tests, non- parametric statistics, analysis of variance, regression; linear and multiple linear, correlation, factor models, decision theory, Bayesian statistics and autocorrelation, multivariate regression, randomization and sampling processes, Markov processes with discrete/continuous state space, statistical simulation and pattern recognition, Time Series Analysis.

PDBA* ZG539 Data Visualization and Communication 4

Need for visualization, Presentation and visualization of data for effective communication, the importance of context and audience, choosing an effective visual, Visualizations of a single number, Visualizations for comparisons, Displaying relative performances, Visualizing survey results, Visualizations for Ranking and Branching, Visualizations for parts of a whole, Visualizing correlations and regression, Visualizing Qualitative Data, Visualizing Trends, Tree-based visualizations, Visualizing Geo Data, Techniques for visualization of high dimensional data & discovered patterns, Common mistakes in dashboards, Visual perception, Create interactive Dashboards and Stories.

PDBA* ZG563 Analytics for HR 4

Leveraging analytic techniques in the context of the challenges faced by the HR and Talent Acquisition and Management functions. Applying analytical techniques to deliver meaningful insights for effectively managing employees for achieving the goals of the organization. Attracting right talent, forecasting future staffing needs, managing attrition and improving employee satisfaction levels. Case Studies, simulations, hands-on exercises using tools like R or Python.

PDBA* ZG564 Models in Marketing 4

Introduction to Marketing Models, Models of consumer behavior, industrial buying and firm behaviour, (aggregate) market models (e.g., competition, market entry), strategic marketing models, forecasting methods, new product models, marketing response models (e.g., channels, pricing, advertising, promotion), forecasting models and decision support systems. Case Studies, simulations, hands-on modeling.

PDBA* ZG565 Supply Chain Analytics 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

PDBA* ZG566 Analytics for Marketing4

Introduction to Marketing Research, Research Methodology, Problem definition, research design formulation, Field work and Data Collection, Data preparation and Analysis, Final report preparation and presentation, Case Studies, simulations, hands-on exercises using tools like R/ Python.

PDBA* ZG567 Analytics for Retail Industry 4

RFM (measuring customer recency, frequency and monetary) Analysis, churn modeling, retention modeling, shopper analytics, market basket association analysis, customer segmentation and profiling, propensity scoring models to identify prospective customers, best customers, lifetime value modeling, marketing campaign response modeling, cross sell modeling, etc., Case Studies, simulations, hands-on exercises using tools like R/ Python.

PDBA* ZG568 Operations Research Models 4

Practical application of OR tools. Application areas include: financial planning and portfolio selection, production, supply chain, priority planning and marketing. Linear programming and its applications; programming to achieve a set of goals or targets with applications in finance and production; capital budgeting and project selection; transportation and network models; and portfolio models, Case Studies, simulations, hands-on exercises using tools like R/ Python.

PDBA* ZG569 Analytics for Investment Banking 4

Modern portfolio theory, Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory (APT), and efficient market theory; Passive investing: indexing; behavioral finance; Active investing: security analysis – fundamental analysis (strategic, financial, marketing tools) and technical analysis; Portfolio management including allocation, rebalancing and risk management; Transaction cost analysis; Fixed-Income and Credit Sensitive Instruments. Case Studies, simulations, hands-on exercises using tools like R/ Python.

PDBA* ZG570 Financial Risk Models 4

Basics of financial risk, Its applications in the form of derivatives- Currency and interest rate derivatives, equity markets and products, commodity markets and products, Measuring and Analysing Volatility- EWMA, ARCH, GARCH, Volatility clusters and the issue of time-varying volatility, Extreme Value Theory, Correlation and Copula, Introduction to Multivariate Forecasting), VaR Computation, Stress testing, Monte Carlo simulation, address issues in generating price process (such as Brownian Motion, Ito Process), Cholesky decomposition in computing multi-asset VaR; Currency risk analysis in global investing, interest rate parity (covered and uncovered); Value at risk for fixed income Credit Risk Analytics Case Studies, simulations, hands-on exercises using tools like R/ Python.

PDBA* ZG571 Analytical Models in Finance 4

Modelling and valuation of equity securities, fixed income securities, and derivatives, Introduction to Financial Modelling, and Spreadsheet Essentials, Measuring Risk (Testing market efficiency with regression analysis & pivot tables), Portfolio optimization (Mean-variance portfolio selection, Bond portfolio selection, Term structure estimation, Capital budgeting), Advanced risk analysis (Monte-Carlo simulation, Risk analysis of discounted cash flow models, Monte- Carlo simulation, Business and equity valuation modelling, LBO Analysis Model , Stock Merger Model, etc., Case Studies, simulations, hands-on modelling exercises.

PDEV ZC411 Principles, Analysis and Design of Electric Vehicles 4

Introduction to vehicle dynamics and transmission, introduction to architectures, Introduction to electric drives and, control, Energy storage systems – batteries, fuel cells, ultracapacitors, flywheel – introduction, types, block diagram, sizing, Regenerative braking, energy management techniques for vehicles, Regulations for EVs

PDEV ZC412 Sensors, Communication and Signal Processing 4

Fundamentals of automotive electronic micro controller, control concepts and control design. Sensors, sensor types, signal conditioning, system modelling, dynamic response of systems, feedback/closed loop controllers, digital signal processing applications in automotive systems

PDEV ZG521 Power Electronics and Drives 4

Introduction to power electronic switches, semiconductor switches- SCR, MOSFET, IGBT, DIODE, SiC based devices, introduction to gate drive, power electronic converters - rectifiers (controlled and uncontrolled), DC-DC converters – buck, boost, buck-boost, cuk, isolated converters – design and topologies, Inverters – VSI and CSI (single phase and three phase), PWM techniques, Introduction to drives – Motors for xEVs, comparison of motors and ICE, control strategies

PDEV ZG511 Battery Management Systems 4

BMS systems and applications, Lithium-ion battery fundamentals, Battery definitions – state of charge, state of health, depth of discharge, battery modelling fundamentals, BMS functions, and control aspects, High voltage electronics, communications, SOC measurement methods and algorithms, SOH estimation algorithms, Hardware and software implementation

PDEV ZG513 Model Based System Development 4

Develop a computer model of the plant from the physics of the system, validate the model in open loop (for existing systems), perform initial control design, design a feedback controller based on the model, simulate the closed loop performance of the controller to meet specifications, perform Model In the Loop (MIL) and Software In the Loop (SIL) simulations, deploy the control algorithm on target and develop a Hardware In the Loop (HIL) simulator. Case studies involving automotive fuel lines, powertrain, suspensions, motors, battery management systems etc.

PDEV ZG514 Vehicle Diagnostics and Reliability 4

Designing and building analogue interfaces, regulation and control of power electronic converters; converter models for feedback: basic converter dynamics, fast switching, piece-wise linear models, discrete-time models, OBD II; Voltage mode and current mode controls for DC-DC converters, comparator based control for rectifier systems, P and PI control applications; Control design based on linearization: transfer functions, compensation and filtering, compensated feedback control systems; Hysteresis control basics, and application to DC-DC converters and inverters; Automotive diagnostics, electronic interfaces, sensors and interfacing, introduction to microsystems packaging, microcomputer control systems, reliability, diagnostics, and testing of vehicles.

PDEV ZC442 Advanced Driver Assistance Systems 4

Automotive safety systems, assist and autonomous systems, automotive sensors and actuators for ADAS (stereo and mono cameras ultrasonic sensors, LIDAR, RADAR), fundamentals of machine vision, data fusion for ADAS, mechatronics for ADAS, human – machine interface for ADAS, telematics and infotainment, ADAS system, legal and ethical aspects of ADAS, real time systems and development, advanced driver assistance systems, advanced computer systems, automated driving applications and systems.

PDEV ZG519 Automotive Security 4

Security concepts, security attacks and risks, architectures, policy management, mechanisms, understanding the risks and advantages of vehicle to internet (V2I), vehicle to vehicle (V2V), vehicle to IoT (V2IoT) connectivity, issues concerning the security of intelligent transport systems that communicate with the vehicle, telematics, cryptography, security standards, security system interoperation and case studies of the automotive security systems and connectivity technologies, automotive cyber security and autonomous vehicles, connected vehicle driver responsibility, issues around liabilities related to automotive cyber security incidents.

PDEV ZG621 Safety Critical Advanced Automotive Systems 4

Functional safety, safety in electrical engineering, architecture / design practices for safety critical systems, ISO 26262: Road vehicles – functional safety, IEC 1508 standards; Methodology of certification and qualification for IEC 1508, modelling real time systems (UML-RT, and the tools), reliable, common system bus – VME, ASCB, safeBus, multiBus II etc. Real time and safety standard and certifications, FPGA and ASIC based design, low-power techniques in RT embedded systems on-chip networking; Hardware software partitioning and scheduling, co-simulation, synthesis and verifications, architecture mapping, HW-SW interfaces.

PDEV ZG512 Machine Intelligence in Autonomous Vehicles 4

Overview of AI systems, clustering, intro to machine learning, regression and classification, training of neural networks - steepest descent gradient algorithm, Object classification and localization using Convolutional Neural Networks, Recurrent neural networks, reinforcement learning and generative adversarial networks (GAN).

PDFI ZG517 Financial Analytics 4

Different sources of Financial Data, Statistical characteristics of financial data, Distributions of Financial Data, Statistical Applications in Finance, Exploratory Data Analysis, Modelling using Financial Statements Data, Modelling stock price behaviour, Modelling Credit Default using classification algorithms, Introduction to Machine Learning for price forecasting and Portfolio Modelling, Introduction to Monte carlo simulation, Bootstrapping, cross validation, Sentiment Analysis in Finance

PDFI ZG516 Introduction to FinTech 4

Overview of FinTech, Current disruptions in Financial Services, Fintech in the Context of the Digital Economy, Landscape of Fintech, Disruptions in Asset Servicing, Disruptions in the Capital Markets, Disruptions in Investment Management, Alternative Data in Portfolio Management, Lending and Crowdfunding, Robo-Advisory, Overview of Technologies - Big Data, Machine Learning, and Artificial Intelligence, Cloud Computing, Future of FinTech.

PDFI ZG558 Financial Risk Management 4

Introduction to Financial Risk Management, Financial Institutions and their trading, Credit Crisis of 2008, Market Risk (Risk Management by traders, Interest rate risk, volatility, Correlation and Copulas, Value at Risk and Expected Shortfall, Historical Simulation and Extreme Value Theory, Model-Building Approach), Credit Risk (Estimating Default Probabilities, CVA, DVA, Credit Value at Risk), Regulation (BASEL I, II and III), Fundamental Review of the Trading Book, Scenario Analysis and Stress Testing, Overview of Operational Risk, Liquidity Risk, Economic Capital and RAROC.

PDFI ZG561 Behavioural Finance 4

Introduction, Rational Market Hypothesis, Foundations of Rational Finance (Expected Utility, MPT, CAPM, EMH), Challenges to rational behaviour, Heuristics, Cognitive Biases, Self-Deception, Prospect Theory, Mental Accounting, Emotional Factors, Challenges to Efficient Market Hypothesis, Investor Behaviour, Market Outcomes, Value Investing, Applications of Behavioural Finance, Introduction to Behavioural Corporate Finance.

PDFI ZG562 Derivatives & Financial Engineering 4

Introduction to derivatives market, forward, futures, options, swaps, Pricing and valuation of derivatives, options trading strategies, Elementary Stochastic calculus, binomial tree model, Black Scholes Merton model, option Greeks, Exotic Options, Volatility Smiles, credit risk, credit derivatives, credit

default swaps, collateralized debt obligations, valuation of synthetic CDO, Interest rate derivatives.

PDFI ZC415 Financial and Management Accounting 4

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

PDFI ZG518 Multinational Finance 4

Effective financial decision making in a multinational corporation; issues in global financial management, international monetary system, balance of payments, foreign exchange markets, international parity conditions, foreign currency options, transaction exposure, operating exposure, translation exposure, sourcing capital globally, foreign investment decisions, basics of multinational taxation, transfer pricing, principles of multinational capital budgeting, and managing multinational operations . Extensive use of case studies and simulations to connect theory with practice.

PDFI ZG520 Security Analysis and Portfolio Management 4

Introduction to investment and securities; profile of financial assets; new issue market or primary market, initial public offerings (IPO); secondary market; framework of risk & return; fundamental analysis- economy, industry; company analysis; stock evaluation models; multiple holding period and multiple growth rate; bond analysis and bond management strategies; technical analysis; efficient market theory; portfolio management; Markowitz model; Sharpe's Single Index model; capital asset pricing model; financial derivatives, options & futures.

PDFI ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

PDFI ZG560 Global Financial Markets and Products 4

Capital markets; stock markets, bond markets, derivative markets; operations of these markets from a global perspective; Overview and features of key financial products, equities, fixed income securities and derivatives; bond features, indenture, coupon, maturity, YTM, zero coupon, valuation, duration, convexity; Equities, product features, basic valuation concepts; derivatives, forwards, futures, options, swaps, commodity derivatives, cost of carry, concepts, basic features, payoff, put call parity, basic option strategies; relevant case studies, simulations, modeling.

PDFI ZG559 Management of Banks & Financial Institutions 4

Overview and operation of financial institutions and banks; Commercial banking, Investment banking; Define, quantify, and manage various types of risks faced by financial institutions; asset liability management - overview, strategies; off balance sheet activities of banks; sovereign risk; deposit insurance; capital adequacy; study current best practices using selected case studies; bank management failures; insights from collapse of Lehman Brothers; introduction to bank regulation; international considerations; relevant case studies, simulations, modeling.

PDFI ZG519 Business Analysis and Valuation 4

Theory of finance, value maximization, stakeholder theory, and corporate objective function: value creation – ways and means, business analysis: The techniques of strategy and competitive analysis, value chain analysis for competitive advantages, business valuation – approaches and methods, the dark side of valuation: strategic investment decisions.

PDFI ZG528 Venture Capital & Private Equity 4

This course will lay a strong foundation in core concepts, features and characteristics of the venture capital and private equity markets; specialized services provided by VC's and PE funds; stages in VC investing; deal flow; deal sourcing, evaluation; risk return tradeoff of VC/ PE investments; valuation of VC/ PE transactions; structuring and execution of deals; exit options, distributions; Course will make extensive use of case studies to understand industry best practices and current trends.

PDFI ZG544 Mergers, Acquisitions, and Corporate Restructuring 4

Basics of M&A (corporate finance, strategy, economics), merger types, trends; theories underlying M&A; legal aspects; evaluating an acquisition target; valuation of mergers and acquisitions, MVA, relative valuation, multiples, DCF, FCFF, FCFE; M&A deal structuring; synergy analysis; break-up valuation; sensitivity analysis; terms of merger; financing considerations; capital structure decisions; structuring and valuing of Leveraged Buy-out (LBO) transaction; financing considerations; exit strategies; extensive use of relevant case studies, simulations, modeling.

PDFI ZG556 Advanced Risk Models 4

Advanced VaR models, expected shortfall, stressed VaR, historical simulation, delta/ gamma models, full revaluation, risk factor selection, volatility clustering, structured Monte Carlo analysis, stress testing, scenario analysis, back testing; country and sovereign risk models; management of country and sovereign risks, external and internal credit ratings methodology and framework; expected and unexpected loss framework and related metrics; extensive use of relevant case studies, simulations, modeling.

PDFT* ZC417 Quantitative Methods 4

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, time series and forecasting, index numbers, decision theory, linear programming, transportation and assignment problems, queuing theory, network problems, simulation; application of statistical software (SYSTAT, SPSS, SIMULA8, etc.) and spreadsheets.

PDFT* ZC419 Financial Risk Analytics 4

The course will first cover the basics of Financial Risk and then focus on applications such as: currency, interest rate derivatives, equity markets and products, and commodity markets and products. Major topics include methodologies for measuring and analyzing volatility (a key metric of risk) including EWMA, ARCH & GARCH processes, volatility clusters and the issue of time varying volatility; Extreme value theory; Measuring risk using Value-at-Risk, including computation of VaR by various methods, and stress testing; Monte Carlo simulation, address issues in generating price process (such as Brownian Motion, Ito Process), Cholesky decomposition in computing multi-asset VaR; Currency risk analysis in global investing, interest rate parity (covered and uncovered); Value at risk for fixed income portfolios; Credit Risk Analytics. The topics covered in this course will have inbuilt case studies in financial risk management so as to understand the practical implications of the methodologies covered in the course.

PDFT* ZG516 Introduction to FinTech 4

Overview of FinTech, Current disruptions in Financial Services, Fintech in the Context of the Digital Economy, Landscape of Fintech, Disruptions in Asset Servicing, Disruptions in the Capital Markets, Disruptions in Investment

Management, Alternative Data in Portfolio Management, Lending and Crowdfunding, Robo-Advisory, Overview of Technologies - Big Data, Machine Learning and AI, Cloud Computing, Future of FinTech.

PDFT* ZG517 Financial Analytics 4

Different sources of Financial Data, Statistical characteristics of financial data, Distributions of Financial Data, Statistical Applications in Finance, Exploratory Data Analysis, Modelling using Financial Statements Data, Modelling stock price behaviour, Modelling Credit Default using classification algorithms, Introduction to Machine Learning algorithms for price forecasting and Portfolio Modelling, Introduction to Montecarlo Bootstrapping, simulation and cross validation, Sentiment Analysis in Finance

PDFT* ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

PDFT* ZG527 Entrepreneurship in FinTech 4

FinTech Themes, Changing landscape in raising capital, FinTech Hubs, Early stage funding, Integrated FinTech Ecosystems, Emerging Markets and Social Impact, Valuation of FinTech Firms, FinTech Solutions - Case Studies, Legal, Regulatory, Data privacy and Ethical aspects of FinTech startups, Capital and Investment for new businesses, Enterprise Innovation

PDFT* ZG529 Machine Learning for Finance 4

Univariate and Multivariate Financial Time series and their characteristics, Applications of Support Vector Machines, Neural Networks and Gradient-Based Optimization, Applications of Tree based ensemble methods (Random Forests, Boosting), Dimension reductions using PCA and Auto Encoders, Feature Engineering, Cross validations, Credit Scoring, Predicting Bankruptcy, Fraud Identification models, Applications of Clustering Algorithms, Introduction to sequential Learning

PDFT* ZG530 InsurTech 4

Digital Transformation in Insurance, Insurance of Things, From Insurance Premium to Discrete Event, Telematics, Collaborative Approach, Insur Tech Value Chain, Business Models, Practical Robotics in Insurance, Claims Handing, Applications of Technology in Underwriting, New Business Generation and Policy Processing.

PDFT* ZG532 Deep Learning Applications in Finance4

Review of Machine Learning, Foundations of Neural networks and deep learning, Fundamentals of deep networks, Multilayer Perceptron, Convolutional neural networks (CNN), Recurrent neural networks (RNN) frameworks – LSTM, GRU. Hands on building Deep learning networks, Auto-encoders, Parameter tuning, Generative Adversarial Networks (GAN), Semantic Segmentation, Unsupervised Learning, Applications of Deep Learning in FinTech.

PDFT* ZG533 Technology Disruptions in FinTech 4

Big Data in the Financial Services Industry, Internet of Things, Impact of IoT on Businesses, IoT in Financial Services, Cyber Security, Cybersecurity Categories and Players, Data Privacy and Governance, Cloud Computing, Networks, Mobile Applications and Smart Phones

PDFT* ZG553 Block Chain and Applications 4

Introduction, Evolution of Block chain, Building blocks of block chain, Smart contracts, Block chain Principles, Asset Monetization in Block Chain, Building a block chain network, Use cases of Block chain in different sectors across the world (Manufacturing and Industrial, Government and Public Sector, Consumer Goods and Retail Industry, Food Industry, Cryptocurrencies in detail), Limitations of existing block chains, Regulatory Aspects, Strategy to implement across the enterprise, Best Practices in implementing Block chain, Different types of Block chain architectures – Hyper Ledger, Ethereum, Future challenges.

PDFT* ZG554 Digital Banking and Beyond 4

Traditional Banking landscape, First principles of Banking, Effect of Digital Technology, New Operating Models for Banking, Regulation vs. Innovation, Reframing identity through Technology, Embedded Banking, Banking Chatbots, From products and channels to experiences, Designing Digital banks without branches, Building Relationships through digital banking, Technologies enabling digital banking, Security, New economics of digital bank, Beyond digital banking, Role of AI and Big Data in Banking.

PDFT* ZG555 Algorithmic and High Frequency Trading 4

Introduction to Algorithmic trading, Users of Algorithmic Trading, Currently Popular trading Algorithms, Algo trades for individual investors, Optimization, Stock personality clusters, Selecting a Cohort of Trading Stocks, Stock Profiling, Volatility, Alpha Algo strategies, Benchmarks and Performance Measures, Technical Analysis (TA), Heuristics, AI, Artificial Neural Networks and Other Avenues, From the Efficient Market Hypothesis to Prospect Theory, Mean Reversion strategies, Momentum strategies, risk management.

PDFT* ZG557 FinTech in Wealth Management 4

Introduction, Traditional wealth management industry, Digitization in wealth management, Digitizing client advisory, Robo advisors, Gamification, Digitizing wealth management operations, Digital platforms, products and eco systems, Block chain applications in asset and wealth management, Algorithms of Automated Portfolio Rebalancing, Digital Financial Advisor, Future of Digital Advice, Personalize the Investment Experience, Future of wealth tech.

PDFT* ZG560 Global Financial Markets & Products4

Capital markets; stock markets, bond markets, derivative markets; operations of these markets from a global perspective; Overview and features of key financial products, equities, fixed income securities and derivatives; bond features, indenture, coupon, maturity, YTM, zero coupon, valuation, duration, convexity; Equities, product features, basic valuation concepts; derivatives, forwards, futures, options, swaps, commodity derivatives, cost of carry, concepts, basic features, payoff, put call parity, basic option strategies; relevant case studies, simulations, modeling.

PDMM* ZG511 Managing People & Organizations 4

Concepts and principles of management as applied to a variety of organizations; study of managerial roles, styles, activities and decision making; relationship with organizational effectiveness; planning activities, leadership & control; manpower development; organizational behavior and theory.

PDMM* ZG522 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; qualityfunction deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability.

PDMM* ZG526 Operations Management 4

Operations strategy; process view vs. functional view in operations; factors in product and process design and selection; facility configuration; demand planning and forecasting; capacity planning; aggregate planning; planning service operations; productivity of operations; inventory

planning and independent demand systems; materials requirements planning; quality management; uncertainty and variability; project management; current developments in operations management.

PDMM* ZG537 Lean Manufacturing 5

Birth of Toyota production system, house of Toyota production system, stability, standardization, just-in-time, jidoka, involvement, hoshin planning, Toyota culture, Toyota way, Case Studies.

PDMM* ZC411 Marketing 4

Definition and scope, consumer behavior, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

PDMM* ZC415 Financial and Management Accounting 4

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

PDMM* ZC416 Managerial Economics 4

Fundamental concepts, supply, demand, market mechanism; theory of demand (consumer behaviour); production, costs (theory of the firm); market structures (perfect competition, monopoly, monopolistic competition, oligopoly); circular flow of income, national income accounting, national income determination; money and banking, employment, interest, inflation, economics of information, problem of adverse selection, moral hazard problem, market failure, externalities, public goods.

PDMM* ZC417 Quantitative Methods 4

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, time series and forecasting, index numbers, decision theory, linear programming, transportation and assignment problems, queuing theory, network problems, simulation; application of statistical software (SYSTAT, SPSS, SIMULA8, etc.) and spreadsheets.

PDSM ZG515 Connected Manufacturing 4

Connected Factories: Why Connected Factories?, Digitization in Manufacturing, Business Challenges addressed by Connected factories (Case Studies), Implementation of Connected factories using sensors and IoT, Robots and Cobots, Review of General Motors, Siemens and Tesla Connected Factories, Use of immersive technologies and mobile applications in connected factories, Network Security & Privacy in Connected Factories, Data analytics and business intelligence in connected factories.

Connected Workforce: Remote Work, Digital Collaboration, Mobile Workforce, Role of IoT, Wearable Technology (smartwatches, fitness trackers, and augmented reality (AR) glasses), Artificial Intelligence, Data Security and Privacy, Workforce Analytics, Employee Experience, Skills Development and Training.

PDSM ZG516 Microfabrication Technologies 4

Introduction to Microfabrication; IC fabrication techniques – Si, GaAN; MEMS fabrication; Additive manufacturing; Assembly and Packaging; Automation in Microfabrication; Yield Analysis; Process Simulation using Conventor or similar software; Real time process optimization using statistical process control (SPC), model-based control, and feedback control systems; Case study on digital twin technology of the microfabrication process and equipment.

PDSM ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

PDSM ZG622 Industrial Internet of Things 4

Workplace safety, industrial revolution 4.0, connected factories, smart industrial devices and products, cyber physical system in manufacturing, connecting industrial devices and equipment with each other and with internet, data acquiring and collection, communication technologies, RFID, QR codes and cellular technologies, protocols, hardware in IoT, software (IDE), cloud platform, connectivity and networking in IIoT, smart eyes on shop floor, integrating smart into existing equipment, programming using IoT, case study and implementation.

PDSM ZG532 Big Data Analytics in Manufacturing 4

Big Data and its applications in manufacturing. Five V's of big data, analysis of structured and unstructured data in various forms, uncovering hidden patterns and unknown correlations for better operational decisions. Key technologies used in storing, manipulating, and analyzing big data. Tools for statistical analysis and data visualization. Open source frameworks for data analysis.

PDSM ZG535 Cyber Security in Manufacturing 4

Overview of cyber security for industry 4.0 landscapes with an emphasis on design and manufacturing application. Technological foundation of cyber security within manufacturing domain, existing threats faced by industry 4.0 sectors along with the existing solutions. Implementation of risk mitigation measures in industry.

PDSM ZG561 Mechanisms and Robotics 5

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

PDSM ZG565 Machine Learning 4

Introduction to Machine Learning, Various kinds of learning, Supervised Learning, Unsupervised Learning, Model Selection; Bayesian Learning, MAP Hypothesis, MDL Principle, Bias Variance Decomposition, Bayes Optimal Classifier, Naive Bayes Classifier; Linear Models for Regression, Linear Models for Classification; Non-Linear models, Decision trees; Instance Based Learning, KNN Algorithm, CBR Learning; Support Vector Machines, VC Dimension; Neural Networks, Perceptron Learning, Back Propagation Algorithm; Introduction to Genetic Algorithms.

PDSM ZG527 Cloud Computing 5

Introduction to Cloud Computing, Virtualization Techniques and Types, Infrastructure as a Service, Container Technology, PaaS and SaaS, Capacity management and Scheduling in cloud computing, Issues and Challenges: Availability, Multi-Tenancy, Security and SLA, Overview of Cloud data storage, Programming models / architectural styles, Deployment and operations.

PDSM ZG569 Blockchain Technologies & Systems 4

Highly successful decentralized blockchain-based systems, such as Bitcoin, have immense potential to revolutionize financial, information, and other infrastructures. This course aims to provide a broad overview of the essential concepts involved in blockchain technology in order to lay down the foundation necessary for developing applications. This course also covers the technical aspects of consistency and consensus in distributed algorithms, public distributed ledgers, public-key cryptography and cryptographic properties, cryptocurrencies, and smart contracts. The course aims to

develop expertise among students to build these systems, interact with them, and to design and build secure distributed applications.

PDSMO ZC411 Introduction to Autotronics and Control 4

Fundamentals of automotive electronic micro controller, control concepts and control design. Sensors,sensor types, signal conditioning, system modelling, dynamic response of systems, feedback/closed loop controllers. Analog and digital controllers, controller development; Vehicle control - wheel slip, ABS/TCS systems, driving dynamics and stability; introduction to motor control.

PDSMO ZC412 Automotive Networks & Communications 4

Automotive networking - overview of TCP/IP systems, distributed and network-embedded systems, internal vehicle communication infrastructure including serial wired bus (UART, SPI, I2C) and protocols like LIN, Ethernet and Deterministic Ethernet, CAN, MOST, FlexRay and BroadR Reach; v2x communication like Vehicle to network (V2N), Vehicle to infrastructure (V2I), Vehicle to vehicle (V2V), Vehicle to cloud (V2C), Vehicle to pedestrian (V2P), Vehicle to device (V2D), Vehicle to grid (V2G); IOT in automotive domain, DSRC standards, aerial networks, automotive middleware: AUTOSAR (AUTomotive Open System Architecture) classic and AUTOSAR adaptive; Protocol coexistence, adaptation, control, and heterogeneity.

PDSMO ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

PDSMO ZC442 Advanced Driver Assistance Systems 4

Automotive safety systems, assist and autonomous systems, automotive sensors and actuators for ADAS (stereo and mono cameras ultrasonic sensors, LIDAR, RADAR), fundamentals of machine vision, data fusion for ADAS, mechatronics for ADAS, human – machine interface for ADAS, telematics and infotainment, ADAS system, legal and ethical aspects of ADAS, real time systems and development, advanced driver assistance systems, advanced computer systems, automated driving applications and systems.

PDSMO ZG519 Automotive Security 4

Security concepts, security attacks and risks, architectures, policy management, mechanisms, understanding the risks and advantages of vehicle to internet (V2I), vehicle to vehicle (V2V), vehicle to IoT (V2IoT) connectivity, issues concerning the security of intelligent transport systems that communicate with the vehicle, telematics, cryptography, security standards, security system interoperation and case studies of the automotive security systems and connectivity technologies, automotive cyber security and autonomous vehicles, connected vehicle driver responsibility, issues around liabilities related to automotive cyber security incidents.

PDSMO ZG621 Safety Critical Advanced Automotive Systems 4

Functional safety, safety in electrical engineering, architecture / design practices for safety critical systems, ISO 26262: Road vehicles – functional safety, IEC 1508 standards; Methodology of certification and qualification for IEC 1508, modelling real time systems (UML-RT, and the tools), reliable, common system bus – VME, ASCB, safeBus, multiBus II etc. Real time and safety standard and certifications, FPGA and ASIC based design, low-power techniques in RT embedded systems on-chip networking; Hardware software partitioning and scheduling, co-simulation, synthesis and verifications, architecture mapping, HW-SW interfaces.

PDSMO ZG524 Vehicle Dynamics 4

Fundamentals of vehicle dynamics, steering, single and two degree-of-freedom systems, vibration isolation, absorbers, anti- vibration mounts, exhaust mount, tire properties, influence on vehicle dynamics, tire forces/moments & kinematics, modified SAE tire axes & terminology, introduction to tire modeling ,suspension and steering effects , basic tire modeling consideration, brush tire model, steady state lateral/longitudinal slip force generation, interaction between lateral slip and longitudinal slip, transient tire forces, steady state cornering stability analysis, handling diagram, quasi steady state cornering, straight line braking stability analysis, transient cornering dynamic cornering, principles of anti-lock braking system (ABS), steady state cornering of single unit heavy trucks, effect of tandem axles and dual tires, equivalent wheelbase handling diagram of complex vehicles, vehicle parameters and states estimation, road and basic driver models principles, basic powertrain, modeling, brake system modeling, electronic stability control (ESC), vibration mounts, construction and heavy engineering equipment.

PDSMO ZG513 Model Based System Development 4

Develop a computer model of the plant from the physics of the system, validate the model in open loop (for existing systems), perform initial control design, design a feedback controller based on the model, simulate the closed loop performance of the controller to meet specifications, perform Model In the Loop (MIL) and Software In the Loop (SIL) simulations, deploy the control algorithm on target and develop a Hardware In the Loop (HIL) simulator. Case studies involving automotive fuel lines, powertrain, suspensions, motors, battery management systems etc.

PDSMO ZG512 Machine Intelligence in Autonomous Vehicles 4

Overview of AI systems, clustering, intro to machine learning, regression and classification, training of neural networks - steepest descent gradient algorithm, Object classification and localization using Convolutional Neural Networks, Recurrent neural networks, reinforcement learning and generative adversarial networks (GAN).

PDSMO ZG514 Vehicle Diagnostics and Reliability 4

Designing and building analogue interfaces, regulation and control of power electronic converters; converter models for feedback: basic converter dynamics, fast switching, piece-wise linear models, discrete-time models, OBD II; Voltage mode and current mode controls for DC-DC converters, comparator based control for rectifier systems, P and PI control applications; Control design based on linearization: transfer functions, compensation and filtering, compensated feedback control systems; Hysteresis control basics, and application to DC-DC converters and inverters; Automotive diagnostics, electronic interfaces, sensors and interfacing, introduction to microsystems packaging, microcomputer control systems, reliability, diagnostics, and testing of vehicles.

PE*ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, singlephase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

PE* ZC113 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

PE* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

PE* ZC211 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

PE* ZC213 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

PE*ZC214 Pharmaceutical Analysis 3

Basic techniques of pharmaceutical analysis, data handling and analysis, sources of error in analysis. The analytical methods would comprise of various titrimetric methods, such as acid-base, complexometric, non-aqueous, oxidation-reduction, precipitation, conductometric; physical and instrumental analysis such as gravimetric, polarography, nephelometry, amperometry, turbidometry, potentiometry; chromatographic separations such as TLC, coloumn, ion-exchange, extraction methods such as gel-filtration, fractionation processes, analysis of metallic and non-metallic elements; water content, as well as evaluation of drug constituents in various pharmaceutical preparation.

PE* ZC221 Disinfection & Sterilization Processes 3

Common sources of microbes, contamination methods; processes involved in disinfection of materials; enclosed space, sanitation; sterilization methods – dry heat, moist heat, air, filtration; aseptic processing, sterility testing, indicators and sampling methods; skin disinfection.

PE* ZC231Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

PE* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

PE* ZC234 Manufacturing Processes 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

PE* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

PE* ZC241 Mechanical Technology 3

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

PE* ZC242 Thermodynamics& Kinetics 3

Importance and Fundamental concepts of Thermodynamics, concept of states, systems, equilibrium, extensive and intensive properties, homogeneous and heterogeneous systems, First Law of Thermodynamics, Internal energy, heat capacity, isothermal, and adiabatic processes, Second law of Thermodynamics, criteria of equilibrium, Maxwell's relations, Gibbs-Helmholtz equation, Entropy, Kinetic Theory, Auxiliary Functions, Heat Capacity, Enthalpy, Phase Equilibrium in one component system, Concept of Third law, relation between Cp and Cv, Fugacity, equilibrium constant, use of Y S - functions, Ellingham-Richardson diagrams, phase stability diagrams, Behaviour of Solutions, Thermodynamics of non-reacting mixtures, reaction rate theory, Introduction to metallurgical kinetics, heterogeneous reaction kinetics-gas-solid, solid-liquid, liquid-liquid and solid-solid systems, concept of Johnson- Mehl equation, effect of temperature on reaction rates, energy of activation, Solutions, partial molal quantities, ideal and non-ideal solutions, Henry's law, Gibbs - Duhem equation, regular solution, Change of standard state, Phase relations and phase rule, Free energy composition diagrams for binary alloy systems, determination of liquidus, solidus and solvus lines, Effect of pressure on phase transformation and phase equilibria.

PE* ZC252 Mineral Beneficiations and Agglomeration 3

Early development in Metal Extraction, General methods of extraction, The necessity and methods of beneficiation, mineralogical assessment, Minerals and ores, refining, importance of mineral dressing, principles of flotation, Refractories, different comminution methods-fracture, Crushing and Grinding machines, liberation, size-criteria, energy-size relationships, crushing grinding and attrition, screening and classification, cyclones, concentration processes-density, electrical, magnetic separators and other physical methods, Interfacial phenomenon, surfactants, Floatation principles and froth floatation, liquid-solid separation-floculation, thickening, classification, free and hindered settling, Dry and wet sizing, Jigging, surface chemistry of minerals, dewatering, Pollution in beneficiation plants, Agglomeration: Basic processes-Nodulization, briquetting, Pelletization, sintering, Material Balances in process flows: Component and total mass balances of reactive and non-reactive systems including recycling, Batch and steady state flows, Unit Processes in pyrometallurgy: calcination, roasting, sintering, smelting , converting, distillation, Metallothermic reduction and hydrogen reduction, refining processes with examples for metals like copper, nickel, lead, zinc, etc. Unit processes in hydrometallurgy: leaching, purification of leach liquor, solvent extraction and ion exchange process, metal recovery from aqueous phase. Unit processes in electrometallurgy: Faraday's laws of electrolysis, concept of overvoltage, limiting current density, overall cell voltage, series and parallel electrical circuits in refining, Electrowinning and electrorefining with reference to Cu, Zu, Al, Mg.

PE* ZC262 Iron Making 3

World production of Iron and steel, occurrence and distribution of iron ore, coal and limestone in India and world, General

layout of integrated steel plant, Raw materials in ferrous production metallurgy, coke production, agglomeration of iron ores. Technology of blast furnace iron making - operational details, Study of blast furnace processes and blast furnace slag, Blast furnace reactions, Raceway, Cohesive zone, Thermodynamics of slag-metal reactions, high top pressure, oxygen enrichment, injection of auxiliary fuels. Blast furnace design, Furnace productivity, the coke rate, hot metal quality. Alternate routes of iron making, Temperature profile, Aerodynamics, different factors, Irregularities etc., Heat exchange zones in blast furnace.

PE* ZC272 Furnace Technology 3

Conventional, non-conventional and newer sources of energy, energy management problems in metallurgical Industries, role of high temperature systems and materials, deposits, manufacturing, properties and testing of solid, liquid and gaseous fuels; Principles of fuel combustion and burner design. Classification of refractory, manufacturing and properties of common refractories such as silica, fire clay, high alumina, dolomite, magnesite and chrome refractories. Furnaces, Types, Design of high temperature furnaces, waste heat utilization, heat recuperators and refrigerators, stack design, gas cleaning, heat balance diagrams; furnace dynamics: fluid flow calculations, fuel fired furnaces, electric arc furnaces, vacuum, electron beam, plasma, laser furnaces.

PE* ZC311 Chemical Engineering Thermodynamics 4

Concept of heat and work, Ideal and real gas systems, Thermodynamic Laws, P-V-T behaviour of real gases, Concept of entropy, Heat effects, First and Second law analysis of processes including power plants and refrigeration systems, Thermodynamic Property relations, Vapour liquid equilibrium, Solutions thermodynamics: Theory and applications, Chemical Reaction equilibria, Special topics in Phase equilibrium, Role of thermodynamics in process simulation, Case studies.

PE* ZC312 Steel Making & Casting 3

Fundamentals of Steel making, Historical development of steel making processes. Open hearth, basic oxygen, electric arc and induction furnace steel making, processes, Thermodynamics, kinetics and transport phenomena in steel making, Introduction to ladle metallurgy. Refining of Steel. Continuous Casting, near net shape making, clean steel practices, stainless steel making and emerging trends in steel making and continuous casting. Introduction to casting, Molding Equipment Processes, Molding Sand, Cores, Core Materials, Solidification of Metals.

PE* ZC313 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio-visual aids; editing.

PE* ZC314 Power Plant Engineering 3

Classification of power plants. Components and layout of; thermal, nuclear, hydroelectric power plants. Site selection for various power plants. Combined cycle power plants. Magneto Hydro Dynamics (MHD) systems. Economics of power generation, economic loading of power stations. Load curve analysis; load factor, diversity factor. Power plant instrumentation and controls.

PE* ZC316 Transport Phenomena- I 4

Diffusional transport of fluid heat and mass (a comparison), Fluid statics, Laminar and turbulent flows, Boundary layer concept (hydrodynamic, thermal and concentration), Continuity equation, Bernoulli's equation, Introduction to equations of motion, Laminar and turbulent flow in pipes, concept of drag, packed beds and fluidization, steady state heat conduction, concept of heat transfer coefficient, convective heat transfer (forced and natural convection correlations), introduction to radiative heat transfer, interphase mass transfer and mass transfer coefficients, analogy between fluid flow, heat and mass transfer.

PE* ZC317 Transport Phenomena – II 4

Transportation and metering of fluids (pumps, fittings, valves and compressors), flow measurement, Condensation and boiling, heat exchange equipment, absorption, concept of equilibrium stage operations, distillation, extraction selected operations like crushing, grinding, drying, filtration, evaporation, etc.

PE* ZC318 Fundamentals of Transport Processes 4

Concept of momentum transfer, Newton's law of viscosity, Continuity and Bernoulli's equation, Concept of pressure drop and drag, Introduction to conduction, convection (free and forced) and radiation including Fourier's law of heat conduction, Newton's law of cooling, Stefan Boltzmann and Kirchhoff's laws, concept of resistance and lumped capacitance; Boundary layer theory (momentum, thermal and mass), Heat transfer correlations; Phase change heat transfer, Diffusion fundamentals including Fick's law, Interphase mass transfer, Concept of mass transfer coefficient, Momentum, heat and mass transfer analogies, Introduction to transport equations.

PE* ZC319 Unit Operations - 1 4

Pumps and compressors, Flow measurement devices, piping networks, Agitation and mixing, Packed and fluidized beds, Heat exchangers including boilers and condensers, LMTD, epsilon-NTU method, Co-current counter-current and cross flows, NTU – epsilon method for exchanger evaluation, Distillation, Absorption, Leaching, Humidification and drying, Cooling towers.

PE* ZC320 Unit Operations - II 4

Sedimentation, Evaporation, Liquid – Liquid extraction, adsorption, Mechanical separations like filtration, centrifugation, froth floatation etc., Solid separations based on size reduction including sieving operations and related equipment like crushers, mills, pulverizers etc., special separation processes like ion-exchange, membranes, chromatography etc.

PE* ZC321 Chemical Process Calculations 3

Properties of gases, liquids and solids; material and energy balances; elementary process analysis involving phase equilibria and chemical reactions; recycling and unsteady state processes; combustion calculations and typical industrial applications.

PE* ZC322 Process Design Principles 4

Process invention using heuristics and analysis (The Design process, Process creation and heuristics for process synthesis), Sequencing of separation trains, concept of pinch technology and heat exchanger network analysis, Cost estimation and profitability analysis, Role of simulators in process engineering, Case studies.

PE* ZC323 Corrosion Engineering 3

Corrosion principles: electrochemical aspects, environmental effects, metallurgical & other aspects; various forms of corrosion. Materials: metals and alloys, non-metallics (polymers and ceramics). Corrosion prevention: Materials selection, alteration of environment, design, cathodic and anodic protection, Coatings, Case Studies.

PE* ZC324Chemical Reaction Engineering 3

Ideal reactor concepts, design equations for batch and continuous reactors (constant and variable volume), Kinetics and interpretation of batch reactor data, Catalytic reactors including external diffusion and intra-particle diffusion effects, Non-ideal reactor concepts, Industrial reactor systems.

PE* ZC331 Quality Control Assurance & Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling

distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

PE* ZC342 Materials Management 3

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; appraisal and control; just in time (JIT); automation in materials management.

PE* ZC343 Industrial Pharmacy 3

Pharmaceutical processes and equipment commonly used in pharmaceutical industries; drug extraction and clarification; mixing and granulation; pharmaceutical preparations such as aromatic waters, spirits, syrups, elixirs, lotions, liniments, official solutions etc.; galenical products like infusions, decoctions, tinctures, extracts, etc, glandular preparations and blood plasma substitutes.

PE* ZC344 Thermodynamics & Reaction Engineering 4

Development and applications of the combined first and second laws; relations between state properties; chemical equilibria in reacting and non-reacting systems; Kinetics of homogeneous, heterogeneous reactions; ideal reactors; selectivity; analysis and design of chemical reactors.

PE* ZC345 Pharmaceutical Quality Control & Regulatory Affairs 3

Course description to be developed.

PE* ZC352 Energy Management 4

World and Indian Energy scenario including production, consumption and pricing, Energy conservation and its importance, Energy conservation act and its features, Energy Management and Audit including energy audit instruments, Energy action planning, Energy monitoring and targeting, Energy economics, Energy efficiency in thermal utilities, Energy efficiency in electrical utilities, Energy performance assessment for equipment and utilities, Application through case studies.

PE* ZC353 Industrial Engineering 3

Industrial systems and organization; engineering economy; work measurement techniques; motivation and time studies; factory planning and materials handling; industrial standardization; critical path methods; quality control; reliability; maintenance and management planning; scheduling; job analysis (evaluation); value engineering.

PE* ZC361 Environmental Pollution Control 3

Air and water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies.

PE* ZC362 Steel Processing 3

Introduction to metal casting, Moulding, materials and processes, patterns, sand and binders. directional solidification, rapid solidification. Solidification of short & long freezing range alloy castings, Gating and Risering of castings, Cupola, rotary furnace, induction furnace, crucible furnace melting, Introduction to cast alloys, classification, microstructures and properties of cast irons, plain carbon and Hadfield Manganese steels, Heat treatment of cast alloys, Casting defects and remedy, Special casting processes, Introduction to metal joining processes, welding, Fundamentals of metal working, Temperature, strain rate, friction & lubrication, Rolling, Classification & processes Forging, Extrusion, Drawing, cold working and warm working, Bulk and sheet metal forming, Mechanical and Hydraulic Presses, Stretching, drawing and bending of sheet metal, Metallurgical changes during metal working; thermo-mechanical processes. Slab analysis of plane strain and axisymmetric upsetting.

PE* ZC382 Cement Technology 3

Indian & Global Cement Industries; Geological classification of rock; Geo-chemistry of lime stone; Crushing, Grinding and Raw material handling process; different type of milling systems and applications - Raw mill, Coal mill, Cement mill; Kiln system and process, Fuel and firing system, Clinker cooling, storage, grinding and packing; merging trends in cement manufacture.

PE* ZC385 Fertilizer Technology 3

Introduction, fertilizer industry in India during last few decades; technology / production of fertilizer products such as intermediates, nitrogenous fertilizers, phosphatic fertilizers, potassic fertilizers, complex fertilizers; guidelines for mixing fertilizers.

PE* ZC383 Extractive Metallurgy 3

Introduction, Methods of extraction and refining of metals, principles of pyrometallurgy, heat transfer and fluid flow, rates of metallurgical reactions, analysis of unit processes, principles of electro and hydrometallurgy.

PE* ZC411 Production Planning & Control 3

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

PE*ZC412 Process Equipment Design 4

Process design of major fluid, heat and separation equipment including pumps and heat exchangers, Mechanical Design considerations and material of construction, Pressure vessel design, Storage vessel design, Design of flange and vessel heads, Mechanical design of specific equipment like heat exchangers, distillation columns etc., Case studies.

PE* ZC423 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

PE* ZC423T Project Work 10

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project. At the beginning of the semester, the student should select an area of work that is considered vital to the sponsoring organization, and prepare a detailed project outline, in consultation with his/her Mentor. The student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, and taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and a final seminar and viva-voce.

PE* ZC434 Quality Control, Assurance & Reliability 4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

PE* ZC442 Advances in Materials Science 3

Deformation of materials, deformation at high temperatures and creep, recovery, recrystallization and grain growth, fracture of materials and fatigue failure, deterioration of materials, corrosion and oxidation, surface properties, surface energy and tribology, polymers and fibre reinforced polymeric composites, mechanical testing, nondestructive testing techniques.

PE* ZC452 Process Plant Safety and Environment4

Role of safety in society; engineering aspects of process plant safety; chemical hazards and worker safety; hazardous properties of chemicals; safety aspects in site selection and plant layout; design and inspection of pressure vessels; storage, handling and transportation of hazardous chemicals; risk assessment methods; toxic release, fire and explosions; boiling liquid expanding vapor explosions; safety audit; emergency planning and disaster management; Introduction to air pollutants, water pollutants and solid wastes; sampling & analysis techniques; impact of these on environment; national and international regulations, case studies.

PE* ZC453 Process Control & Instrumentation 4

Importance of Process Control; Process dynamics, modeling and transient response; Control actions and feedback control; Hydraulic-, pneumatic- and electronic controllers; Controller design, tuning and stability; Measuring instruments and their working principles; Instrument characteristics and transmission; Transducers, sensor and actuators; Control valves; Piping and Instrumentation diagrams; Signal conditioning and processing; Display and recording; Signal-flow graph and Mason's gain formula; Feed forward, cascade and ratio control; Direct digital control; Programmable logic controllers; DCS and SCADA systems; PC based instrumentation; Introduction to multivariable control system.

POM* ZC441 Human Resource Management 4

Introduction, manpower planning, career and succession planning, procurement of personnel, performance appraisal, job satisfaction and morale, job rotation, employee communication, audit and control, management training and development, wage and salary administration, welfare administration, trade unions and collective bargaining, industrial dispute and worker participation in management.

POM* ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

POM* ZG511 Disinfection and Sterilisation 4

Theories and kinetics of the disinfection reaction, study of the principles involved in vivo and in vitro evaluation of disinfectants and antiseptics, structure activity relationships of the representative groups of disinfectants, sterilization, heat, ionizing and ultraviolet radiations, ultrasonic waves, filtration, gaseous sterilization and cellular dessication methods, controls used and special problems involved.

POM* ZG512 Dosage Form Design 5

A study of physical and chemical, pharmacological and biopharmaceutic factors involved in the design and stability of dosage forms; transport of drugs across biological membranes; absorption, distribution and elimination of drugs; formulation additives, closures and containers and sustained release dosage forms; micro-encapsulation; radio pharmaceuticals.

POM* ZG513 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

POM* ZG515 Pharmaceutical Administration and Management 5

Technology innovation and creativity, new drugs and products planning, strategic considerations, project implementation, product development, production management and scale up, preparation of product literature and marketing strategy, IPR processes, human resource development, industrial relations, documentation, R & D management, ethical aspects.

POM* ZG521 Statistical Process Control 5

What is SPC, history & development of SPC, averages & measures of dispersion, process variation, variable & attribute data, simple statistical problem solving tools: check sheets, histograms, Pareto diagrams, stratification graph, scatter plots, cause & effect diagram; Various types of control charts, control chart for attributes, cumulative sum charts, X bar R charts; construction & interpretation of control charts process capability; Lot try lot acceptance sampling for attributes, acceptance sampling variables, other acceptance sampling procedures.

POM* ZG522 Quality Assurance & Regulatory Affairs 5

Quality control, quality assurance, quality management, various parameters for achieving quality pharmaceutical products, application of statistics in quality assurance, reliability, current good manufacturing practice (cGMP) for pharmaceutical manufacturing, pharmaceutical process validation, drug regulatory affairs, clinical research protocols, new drug applications, drug product labeling.

POM* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

POM* ZG525 Pharmaceutical Process Development & Scale-up 4

Optimization techniques in pharmaceutical processing; development of test systems to evaluate performance of dosage forms and unit operations; Scale-up of unit operations related to various pharmaceutical formulations; process analytical technology (PAT) and its applications in solving problems of scale-up.

POM* ZG531 Manufacturing Organization and Management 5

Manufacturing environment; Engineering considerations; Design and planning of manufacturing systems; Manufacturing cost control; Material flow control; Quality; Human resources; Financial management; Marketing management.

POM* ZG532 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

POM* ZG534 Advanced Pharmaceutical Technology 5

Overview of pharmaceutical processes used in pharmaceutical manufacturing; advanced manufacturing equipments for various pharmaceutical dosage forms; current

manufacturing techniques for large scale production of tablets, hard and soft gelatin capsules, aerosols, semi-solid preparations including ophthalmic formulations, small and large volume parenterals, and multiparticulate systems; approaches of in-process quality assurance and documentation in automated manufacture; advanced packaging technology for various pharmaceutical dosage forms.

POM* ZG541 Modern Analytical Techniques 4

Fundamentals and applications of sophisticated analytical instruments like NMR, Mass spectrometer; X-ray crystallography; GC, HPLC, UV, IR, Atomic absorption spectrophotometer, High voltage electrophoresis, gel electrophoresis, ultracentrifuge, spectrofluorimeter, DTA, DSC polarimeter in pharmaceutical industry including spectral data analysis and molecular characterization

POM* ZG542 Production and Operations Management 4

Production & operations management functions; capacity requirement planning; inventory control; layout, handling & location decisions; resource procurement & operation control; project scheduling & resource allocation; the production & operating function; methods of forecasting demand; financial analysis of operating plans; determination of economic order quantity; development of efficient work methods, quality control, management of R&D, technological forecasting, equipment replacement and interfaces with other functional areas.

POM* ZG545Intellectual Property Rights and Pharmaceuticals 3

Key aspects of intellectual property law and their impact on Pharmaceutical industry; concept of property with respect to intellectual creativity; emerging debates, policy issues and law reforms related to IPR with respect to pharmaceuticals; Issues of Intellectual Property such as Patents, Copyright, Trademarks, and Design; rules and regulations of marketing and competition; Patent processing, infringement of patents, ethics and economic issues related to IPR.

POM* ZG551Advanced Physical Pharmaceutics 5

Preliminary evaluations and molecular optimization, Drug substance considerations including protein, peptide and biological products, Bulk characterization, Solubility analysis, Rheology and dispersed systems, Micromeritics and shape factor analysis, Compression and compaction, Principles of dissolution, Dissolution test design and release kinetics evaluation, Compatibility testing, Stability analysis and test design according to international standard, Studies of broad category of polymers used in drug delivery, Rationale basis of formulation recommendation.

POM* ZG611 Strategic Management & Business Policy5

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

POM* ZG628T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

POM* ZG631 TQM Tools and Techniques 5

Benchmarking; introduction, why benchmark; Planning: what to benchmark, benchmarking partners, data collection methods; Analysis: determining the current competitive gap, projecting future performance levels; Integration: developing action plan, implementing specific actions & monitoring progress, re-calibration; Maturity: beyond benchmarking; Quality function deployment, QFD concept, overview & QFD process, the voice of customer developing a QFD matrix, reviewing the matrix for priority items, organizing teams & planning QFD projects; Process RE-engineering, BPR philosophy, possibilities & pitfalls, BPF framework, opportunity assessment, planning & BPR project, risk & impact assessment, planning & implementing the transition; Failure mode & effect analysis; FMEA: concepts & applications in TQM; Quality cost, concepts, quality cost definitions, quality cost program implementation use of quality cost, reducing quality cost.

POW*ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, singlephase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

POW* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

POW* ZC231 Thermodynamics 3

Concepts and laws of thermodynamics; macroscopic thermodynamic properties; application to closed and open system; microscopic approach to entropy; equations of state; thermodynamics of non-reacting mixtures.

POW* ZC232 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

POW* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

POW* ZC234 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

POW* ZC242 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

POW* ZC313 Power Generation 4

Indian power scenario, sources of energy, working of thermal, nuclear, IC engine, gas turbine, hydro and renewable energy based power plants, power plant building and layout, economics of power generation, environmental impact assessment of power generation.

POW* ZC314 Prime Movers & Fluid Machines 4

Theoretical analysis of energy and momentum transfer between fluid and rotor; principles of axial, mixed and radial flow compressors, turbines and pumps; design considerations; cascade aerodynamics and performance limitations; applications to power plant systems, laboratory exercises in testing reciprocating machines.

POW* ZC315 Transport Phenomena 4

Fundamental concepts of fluid flow, concept of momentum transfer, Newton's law of viscosity, Continuity and Bernoulli's equation, concept of pressure drop and drag; Heat transfer: steady state and unsteady state heat conduction; analytical and empirical relations for forced and free convection heat transfer; heat exchanger analysis and design, heat transfer by radiation; Elements of mass transfer; one dimensional compressible flow; associated laboratory on condenser, boiler, economizer, super heater etc.

POW* ZC316 Power Electronics 4

PNPN devices, power transistor characteristics, rating and specifications; triggering mechanism and commutation circuits; controlled power rectifiers, Inverters (DC to AC converters), choppers (DC to DC Converters); speed control of DC motors, speed control of AC motors; other industrial applications of thyristors and power transistors; voltage regulation and starting of electrical drives; logic modules for static converters; introduction to application of microprocessors for electrical drives.

POW* ZC321 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio-visual aids; editing.

POW* ZC332 Energy Management 3

System's view of energy in society involving societal goals, energy resources, the sub-systems for the generation. T&D, and utilization of energy carriers, energy economics and analysis, energy strategies, policies, policy instruments, policy agents and policy implementation. The "development-oriented end-use approach" to energy analysis, strategy design and policy formulation involving the disaggregation and scrutiny of demand beyond sectors into end-uses and basic needs. Energy management at the national, state, firm, city and village levels.

POW* ZC342 Power Systems Engineering I 3

Parameters of transmission lines, electrical and mechanical characteristics of transmission line, synchronous phase modifiers - overhead insulators - underground cables - distribution lines - substation practice -relevant portions of Indian Electricity Act.

POW* ZC343 Microprocessors & Microcontollers 3

Introduction to microprocessors and microcontrollers. Architecture of 8086 microprocessors; Assembly directives, Assembly language programs with algorithms, Memory interfacing and timing diagrams; Architecture of 8-bit microcontrollers; Assembly language programming for microcontrollers; Interfacing I/O devices; System design examples.

POW* ZC344Instrumentation & Control 4

Generalized measurement system and performance characteristics, Transducers - principles and applications, Signal conditioning circuits – bridges, amplifiers, data converters, filters; Process control – control schemes, controllers, multi-loop control configuration, Control valves; Programmable Logic Controllers, DCS and SCADA, Simulation, Case Studies.

POW* ZC411Environmental Pollution Control 3

Environmental pollution: Solid, liquid and gaseous pollutants; removal of soluble and particulate pollutants from atmosphere, natural water systems and process systems; use of current literature for pollution control problems.

POW* ZC413 Process Control 3

Dynamic modeling and simulation of momentum, energy and mass transfer and reacting systems; analysis of the dynamic behaviour of lumped and distributed parameter systems; analysis and design of simple feedback and advanced control systems; design of control systems with multiple input and multiple output; introduction to computer control.

POW* ZC421 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

POW* ZC431 Maintenance & Safety 3

Basic maintenance systems and practice; maintenance planning; estimating and budgeting; scheduling maintenance jobs; importance of safety; factors affecting safety; safety aspects of site and plant; hazards of commercial chemical reaction and operation; instrumentation for safe operation; safety education and training; personnel safety; disaster planning and measuring safety effectiveness; future trends in industrial safety; maintenance of components and equipment's; new dimensions in maintenance covering plant engineering, tribology, materials technology, terotechnology (life cycle costing) etc.; extensive case studies.

POW* ZC434 Quality Control, Assurance & Reliability 4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

POW* ZC441 Power Systems Engineering II 3

Elementary principles of power system economics - Powers systems stability, equal area criterion and step by step method - protection, relays and relaying, protection of transmission lines, transformer and generators - High Voltage Protection - Symmetrical components, symmetrical and unsymmetrical faults.

POW* ZC412 Power System Operation & Control 3

POW* ZC422 Power System Drawing and Design 3

Course description for the above courses to be developed.

POW* ZC452 Renewable Energy 3

Introduction of renewable energy, advantages, potential, status of development, broad details of different renewable energy systems such as solar, wind, biomass, microhydel,

geothermal etc.; Renewable energy development policy, Renewable energy industries, international co-operation, HRD and career growth opportunities, consultancy areas and future thrust areas in renewable energy development.

POW* ZC471 Power Electronics & Drives 3

Course description for the above course to be developed.

POW* ZC481 Plant Layout & Design 4

Factors affecting plant layout, Types of layout, procedure for plant layout, techniques and tools for planning layout, quantitative layout analysis, material handling equipment, improving and revising existing layout, evaluation of layout, plant location, evaluation of location, design of layout, computer applications in layout design.

PS* ZC111 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal ES* ZGand student's t-distribution; test of hypothesis; correlation and linear regression.

PS* ZC112 Human Anatomy and Physiology 3

Structure and functions of the various systems of the human body; Homeostatic mechanisms; Progression of disease; Principles of drug action.

PS* ZC113 General Mathematics - I 3

Review of coordinate geometry, Theory of equations, Progression and series, permutations and combinations, Binomial theorem, Functions: Trigonometric (with identities), Transcendental. One Dimensional Calculus: Limit and continuity, Differentiation, Integration. Applications of derivatives and definite integration.

PS* ZC114 General Mathematics – II 3

Polar coordinates, Function of several variables, Multiple integrals, Vector valued functions. Complex functions and their analyticity. First order and second order ordinary differential equations, Laplace transformations and its applications to ordinary differential equations.

PS* ZC212 Basic Statistical Process Control 3

Course description to be developed.

PS* ZC213 Scale –Up of Pharmaceutical Operations 3

Pilot plant design including process and product layout; Scale-up consideration in solid dosage forms including powder mixing, granulation, compaction, and coating; Scale-up considerations in non-sterile liquids and semi-solids including principles of similarity, dimensionless numbers method, inter-relationship between surface area and volume upon scale-up; Sterile drug product scale-up; Synthetic scale-up; Chromatographic scale-up; Scale-up of biotechnology derived products.

PS* ZC214 Utilities in Pharmaceutical Operations 3

Course description to be developed.

PS* ZC221 Business Communication 3

Managerial communication – national and international contexts, Interpersonal Communication, persuasive communication, communication technology, effective listening group communication, professional presentation.

PS* ZC222 Pharmaceutical Quality & GMP 4

Regulatory perspective for drug product filing and approval, NDA, ANDA, sNDA and drug user fee act; Quality systems including concepts of TQM, ICH guidelines like Q1, Q3, Q6, Q7 and Q9; Quality control and validation including process validation, prospective and retrospective validation, analytical method validation; Good manufacturing practices in pharmaceutical industry; SUPAC guidelines; Quality audits.

PS* ZC223 Fundamentals of Biochemistry and Microbiology 4

Prokaryotic and eukaryotic cells; Chemistry of biomolecules like carbohydrates, proteins & peptides, lipids, vitamins and nucleic acids; Enzymes – classification, mechanism of action, kinetics and regulation of activities; Growth of microorganisms including media requirements, growth curve, preserving and obtaining bacterial culture; Viruses; Sterilization techniques including principles, instruments and methods; Antiseptics, disinfectants and preservatives; Sterility testing, pyrogen testing, evaluation of antimicrobial drugs, Biosafety.

PS* ZC224 Novel Drug Delivery Systems 3

Course description to be developed.

PS* ZC225 Environmental Studies 3

Environment, human population, and industrialization; natural resources and the impact of man-made activities on them; structure and function of ecosystem, population ecology, biodiversity and its conservation, overview of natural resources, environmental pollution, social issues and the environment, and environmental impact assessment.

PS* ZC231 Physical & Inorganic Chemistry 3

Atomic structure and chemical bonding including the concepts of hydrogenic atoms and VB theory; Thermodynamics and chemical kinetics; Electrochemistry including Nernst equation and its application, electrochemical series; Concepts in inorganic chemistry including electronegativity, measure of acid-base strength, Systematics of acid base interactions, Hard soft acid base(HSAB) concept- relevance to diverse metal-ligand interactions, symbiosis; Main group elements (Periodicity); Introduction to co-ordination compounds including double salts, chelates and isomers, VB and CF theories, organometallic chemistry, bio-inorganic chemistry.

PS* ZC232 Chemistry of Synthetic Drugs 3

Synthesis of Five-membered heterocyclic drugs; Six-membered heterocyclic drugs; Five-membered heterocyclic fused with benzene ring; Six-membered heterocyclic fused with benzene ring; Seven-membered heterocyclic fused with benzene ring; Heterocycles fused to two benzene rings; Heterocycles fused to other heterocyclic rings.

PS* ZC233 Pharmaceutical Packaging 3

Course description to be developed.

PS* ZC234 Techniques in Pharmaceutical Analysis4

Principles of titrimetric analysis including acid-base, redox and complexometric titrations; Modern analytical techniques used in drug product analysis – concepts, instrumentation, method of analysis and interpretation; UV-Visible spectroscopy, Spectro-fluorimetry, Infrared spectroscopy, NMR spectrometry, Mass spectroscopy, Chromatography including Paper, TLC, GC, HPLC and electrophoresis.

PS* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

PS* ZC241 Pharmaceutical Chemistry 3

This course deals with study of important classes of organic compounds such as alcohols, ethers, esters, aldehydes etc and their reactions. The mechanisms for various reactions will also be dealt with to comprehensively cover the basics of chemical reactions. Some important five and six member heterocycles with their reactions will also be part of the course. This course also emphasizes the use of inorganic compounds in pharmacy.

PS* ZC244 Physical Pharmacy 3

This course is designed to make the students conversant with the applications of physico-chemical principles to the study of the drug stability behaviour of drug powers and of other pharmaceutical systems; it includes the discussion of drug degradation, micromeritics, rheology and interactions of drugs.

PS* ZC311 Pharmaceutical Unit Operations – I 3

Various pharmaceutical unit operations like Extraction, Distillation, Evaporation, Re-crystallization, Filtration and Drying; Equipment used; Factors affecting the process and the properties of the product obtained; Identification of the critical factors; Relevance to manufacturing of various pharmaceutical products.

PS* ZC312 Pharmaceutical Unit Operations – II 3

Various pharmaceutical unit operations like Size reduction & Size Separation, Mixing, Granulation, Compression & Consolidation, Humidification & De-humidification and Materials of Construction; Equipment used; Factors affecting the process and the properties of the product obtained; Identification of the critical factors; Relevance to manufacturing of various pharmaceutical products.

PS* ZC313 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio-visual aids; editing.

PS* ZC314 Pharmaceutical Jurisprudence in India 3

Growth of modern pharmacy & pharmaceutical industry, brief overview of pharmacy act; Central Drugs Standard Control Organization (CDSCO): about the CDSCO, importance, functioning, and regulation; Drugs and Cosmetics Act; Various provisions of Schedule M; Branded and Generic medicines; Ministry of chemical and fertilizers: importance, functioning, and regulations; Indian Pharmacopoeia Commission: importance, functioning, and regulations; Provisions of Drug Price Control Order and National Pharmaceutical Pricing Authority; Narcotic and Psychotropic Substances Act; Medicinal and Toilet Preparations Act; Bonded and non-bonded laboratories; Drugs and Magic Remedies Act (Objectionable advertisements); The prevention of cruelty to animals act; Provision of Insecticide Act; Consumer protection Act.

PS* ZC318 Fundamentals of Transport Processes4

Concept of momentum transfer, Newton's law of viscosity, Continuity and Bernoulli's equation, Concept of pressure drop and drag, Introduction to conduction, convection (free and forced) and radiation including Fourier's law of heat conduction, Newton's law of cooling, Stefan Boltzmann and Kirchhoff's laws, concept of resistance and lumped capacitance; Boundary layer theory (momentum, thermal and mass), Heat transfer correlations; Phase change heat transfer, Diffusion fundamentals including Fick's law, Interphase mass transfer, Concept of mass transfer coefficient, Momentum, heat and mass transfer analogies, Introduction to transport equations.

PS* ZC321 Chemical Process Calculations 3

Properties of gases, liquids and solids; material and energy balances; elementary process analysis involving phase equilibria and chemical reactions; recycling and unsteady state processes; combustion calculations and typical industrial applications.

PS* ZC322 Pharmaceutical Quality by Design 3

Course description to be developed.

PS* ZC323 Sterile Pharmaceutical Products 3

Sterile products characteristics; Sterile dispersed systems; Sterile manufacturing process; Freeze drying of sterile products; QA & QC of sterile drug products; Process validation & equipment qualification in sterile product manufacturing; Packaging of sterile drug products.

PS* ZC324 Name Reactions in Chemical Synthesis 3

Stereochemistry in drug action; Rearrangement reactions and their applications to drug synthesis; Name reactions and examples in drug synthesis.

PS* ZC331 Pharmaceutical Formulations- I 3

Various liquid dosage forms and semi-solid dosage of drugs manufactured in pharmaceutical industries; Excipients used and their role in liquid dosage forms and semi-solid dosage forms; Manufacturing methods and equipment used in manufacturing liquid and semi-sloid dosage forms; Various quality control tests performed; Selection of suitable liquid and semi-sloid dosage form for a given drug.

PS* ZC332 Pharmaceutical Formulations – II 4

Various solid dosage forms and aerosols manufactured in pharmaceutical industries; Excipients used and their role in solid dosage forms and aerosols; Manufacturing methods and equipment used in manufacturing solid dosage forms and aerosols; Various quality control tests performed; Selection of suitable solid dosage form for a given drug.

PS* ZC341 Drug Discovery and Action 4

Drugs discovery process; Different regulatory requirements in the process of drug discovery; Effect of drugs on living organisms and application to therapeutics; Mechanism of action; physiological and biochemical effects (pharmacodynamics); Absorption, distribution, metabolism and excretion (pharmacokinetics); Adverse effects and interactions.

PS* ZC342 Medicinal Chemistry 3

This course deals with the study of important classes of drugs. Various aspects like structure, properties, therapeutic and pharmaceutical importance and the uses of drug molecules both of natural and synthetic origin will be covered. Study of physico-chemical properties, mechanism of action, S.A.R. and metabolism of drugs dealt will also be emphasized. Special emphasis will be given on Important topics such as Anti hypertensive drugs, Drugs affecting sugar metabolism, Antimalarial drugs, Anticancer agents, Antiviral agents etc.

PS* ZC343 Professional Ethics 3

Ethics, nature and purpose; ethical theories; ethics in business and management; ethics in engineering, global ethical issues.

PS* ZC344 Natural Drugs 3

The course imparts a knowledge of the crude drugs of natural origin used in pharmaceutical and medical practice. Study will include the different systems of classifications of crude drugs; cell contents; general principles of cultivation, collection, drying, storage and commerce of natural products of current medical and pharmaceutical importance; their morphologial and microscopical study: use and knowledge of common substitutes and adulterants.

PS* ZC361 Environmental Pollution Control 3

Air and water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies.

PS* ZC414 Biopharmaceutics 3

Biopharmaceutics and Biopoharmaceutical aspects of drug delivery covering absorptions, distribution, metabolism and elimination (ADME) characters of drugs. Compartment model, pharmacokinetics of drugs and their applications, bioavailability, bioequivalence and their studies, drug-drug interactions and other related matters.

PS* ZC229T Project 5

Apply the knowledge of chemical technology operations in the manufacture of API or formulation technology operations in the

manufacture of pharmaceutical drug product and assess the quality of the same; the student's actual day-to-day task involvement would constitute the central thread of the learning process. The evaluation will recognize this aspect by demanding day-to-day engagement and productivity of the student.

PS* ZC499T Capstone Project 15

Real-life problems related to the manufacture and quality control of active pharmaceutical ingredients and pharmaceutical drug products, as per applicable regulatory guidelines; Jointly mentored by the industry experts and faculty; Presentation of the progress and results in appropriate forms; Periodic review of the progress of the project.

QM ZC441 Human Resource Management 4

Introduction, manpower planning, career and succession planning, procurement of personnel, performance appraisal, job satisfaction and morale, job rotation, employee communication, audit and control, management training and development, wage and salary administration, welfare administration, trade unions and collective bargaining, industrial dispute and worker participation in management.

QM ZC472 Precision Engineering 3

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and microfinishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerancing.

QM ZG514 Leadership & Managing Change 4

Individuals as leaders, team leadership and organizational leadership. Introduction to managing change, management of change: organizational structure, culture, recruitment, performance management, human resource development, reward management, employee relations and involvement, downsizing, and evaluating and promoting.

QM ZG515 Quantitative Methods 4

Basic concepts in Operations Research; Analytical & Mathematical Modeling Techniques; Model Building; Inventory Control, queuing theory; Linear Programming; Transportation and assignment problems, simulation, index numbers, decision theory, etc.

QM ZG524 Quality Management Systems 5

Quality system & quality management, evolution of quality post world war II era i.e. Quality control, quality assurance, total quality control & total quality management; ISO 9000 series of standards, formation of ISO (1947), background & development of ISO 9000. ISO 9000 family of standards, selection & use of appropriate model of ISO 9000. Requirements of ISO 9001; System demonstration & documentation, how to organize formal quality assurance system, pyramid of quality system documentation structure, two tier, three tier & four tier documentation, preparation of quality manual & quality procedures, quality records; Implementing documented quality system, how to proceed, how to implement change, obtaining top management commitment, assessing current company position, developing the implementation plan, initiating people (employees) to own the system, system development; System audit & review, objective of system audit, types of quality audit, product Vs system audit, internal quality audit, management review; System certification, benefits of third party certification, choice of certification body, route to certification, surveillance & renewal; Other quality system standards, relating ISO 9000 with QS 9000 and ISO 14000.

QM ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

QM ZG526 Operations Management 5

Operations strategy; process view vs. functional view in operations; factors in product and process design and selection; facility configuration; demand planning and forecasting; capacity planning; aggregate planning; planning service operations; productivity of operations; inventory planning and independent demand systems; materials requirements planning; quality management; uncertainty and variability; project management; current developments in operations management.

QM ZG528 Reliability Engineering 5

Basic Reliability Models, Reliability of Systems, Design for Reliability and Maintainability, Maintainability, availability and reliability; Data Collection and Empirical Methods, Reliability Testing, Identifying Failure and Repair Distributions, Reliability Estimation and Application.

QM ZG531 Statistical Quality Control 5

Sources of Variation: Common and Assignable Causes, Descriptive Statistics, Statistical Process Control Methods, Control Charts for Variables, Control Charts for Attributes, C-Charts, Process Capability, Acceptance Sampling, Operating characteristic curve, Statistical Quality Control in Services.

QM ZG532 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability

QM ZG533 Manufacturing Planning & Control 5

Planning and control of manufacturing operations; material flow planning; product and process planning; demand forecasting and forecasting models; facility location; plant layout planning and design; machine cells; capacity planning; designing work methods; material handling; line balancing; aggregate planning; inventory models and systems for independent demand; materials requirements planning; elements of monitoring and production control; current developments in operations management.

QM ZG535 Decision Analysis 4

Introduction to quantitative techniques and statistics, Decision making, intelligence design and choice phases, basic theory of decision making under uncertainty; decision trees, qualification of judgments and preferences, Bayes theorem, the structuring of complex decisions, and multi-attribute utility theory. Statistical estimation and forecasting.

QM ZG536 Design of Experiments 4

Course description to be developed.

QM ZG539 Six Sigma 4

History of Six Sigma, Implementing Six Sigma, Becoming a Customer and Market-Driven Enterprise, Customer Expectations and Needs, Linking Six Sigma Projects to Strategies, Attributes of Good Metrics, Using resources wisely, Project Management Using the DMAIC and DMADV Models, The Define Phase, The Measure Phase, Measurement System Analysis, Analyzing Data: Value Streams and Dealing with Variations, Designing Experiments, The Improve Phase, The Control Phase.

QM ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer

Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

QM ZG611 Strategic Management & Business Policy 4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

QM ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

QM ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

QM ZG663 Concurrent Engineering 5

Introduction of concurrent engineering and need, concurrent engineering tools, advances in design and manufacturing engineering, design for manufacture, design for assembly, rapid prototyping, simulation, concurrent approaches to design, manufacturing and other aspects of engineering.

QM ZG628T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SE* ZC111 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal ES* ZGand student's t-distribution; test of hypothesis; correlation and linear regression.

SE* ZC163 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

SE* ZC222 Discrete Structures for Computer Science3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

SE* ZC234 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

SE* ZC241 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

SE* ZC263 Digital Electronics and Microprocessors 4

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

SE* ZC312 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio-visual aids; editing.

SE* ZC313 Object Oriented Programming & Design4

Object oriented concepts and design, abstraction, architecture and design patterns, GUI programming and frameworks, design of object oriented solutions using UML, design for concurrency, implementation of solutions using object oriented languages like C++ or Java; Language level mapping and realization of object oriented constructs, realization and performance issues versus abstraction and usability.

SE* ZC333 Systems Programming 4

Batch processing; Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces with focus on contemporary open source operating system-specific programming; laboratory experiments or programming assignments involving Unix/Linux System-specific

Programming including shell-scripting via online laboratory facility.

SE* ZC337 Database Systems & Applications 4

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS, database programming experiments involving use of SQL, database creation etc. via online laboratory facility.

SE* ZC344 Software Engineering 4

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

SE* ZC353 Computer Organization & Architecture 4

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; Virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies; This course covers the fundamentals of computer organization and architecture from a programmer's perspective.

SE* ZC363 Data Structures & Algorithms 4

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; Analysis of algorithms; Linear data structures – stacks, arrays, lists, queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees; Implementation techniques for different data structures including trees, graphs and search structures; Performance evaluation of data structures and algorithms; Implementation issues in large data structures.

SE* ZC364 Operating Systems 4

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, inter process communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules, select laboratory experiments related to creating different elements of operating system and/or implementation of select scheduling, memory management and I/O related algorithms/schemes, using system calls for creating file system specific command, creating simple file system etc. via online laboratory facility.

SE* ZC373 Compiler Design 4

Introduction to Programming Languages and Compilers, Programming Language Features, Front End of a Compiler, Back End of a Compiler, Special aspects of compilers and runtime.

SE* ZC410 Marketing 4

Definition and scope, consumer behavior, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

SE* ZC420 Data Visualization 3

Information overload and issues in decision making. Design of visual encoding schemes to improve comprehension of data and their use in decision making; presentation and visualization of data for effective communication. elementary graphics programming, charts, graphs, animations, user interactivity, hierarchical layouts, and techniques for visualization of high dimensional data & discovered patterns.

SE* ZC425 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

SE* ZC444 Artificial Intelligence 3

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving. The course also aims at understanding its implementation using LISP and PROLOG languages.

SE ZC447 Data Storage Technologies and Networks 4

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Storage arrays, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids, Storage QoS – Performance, Reliability, and Security issues, Object storage, Storage as a Service, Software defined storage

SE* ZC465 Machine Learning 4

Introduction to Machine Learning, Various kinds of learning, Supervised Learning, Unsupervised Learning, Model Selection; Bayesian Learning, MAP Hypothesis, MDL Principle, Bias Variance Decomposition, Bayes Optimal Classifier, Naive Bayes Classifier; Linear Models for Regression, Linear Models for Classification; Non-Linear models, Decision trees; Instance Based Learning, KNN Algorithm, CBR Learning; Support Vector Machines, VC Dimension; Neural Networks, Perceptron Learning, Back Propagation Algorithm; Introduction to Genetic Algorithms.

SE* ZC467 Computer Networks 4

Introduction: components of a modern computer network, packet switched network and its metrics, layered architecture of protocols and historical perspective; Application Layer: principles, examples: Web and HTTP, Email, DNS, Peer-to-Peer applications, socket programming; Transport Layer: Services, the concept of connection less, connection oriented and reliable transport, TCP congestion control; Network Layer: addressing mechanism in networks, router architecture, intra and inter-AS routing protocols, multicast and broadcast; Link Layer: error detection and correction, medium access, MAC addressing, Ethernet, switches, Point to point protocol and link virtualization; Physical Layer: signals, medium, and transmission methods, QoS: forward error correction, scheduling and policing mechanism in the networks.

SE* ZC472 Computer Graphics 3

Generation of dots, lines, arcs and polygons; color graphics, shades and levels; image transformation, windowing and clipping; 2-D and 3-D graphics; data structures, algorithms and

optimization methods; case studies using GKS, CORE, etc; graphic languages and compilers.

SE* ZG501 Software Quality Assurance and Testing 4

Quality assurance, management and testing; SQA process and activities; Quality planning, metrics and QMS; Team structure & organization of SQA; Quality control tools, Six-Sigma methodology; Types of quality; Software testing as a tool for improving quality; Planning, management & control of testing; Testing in different domains; Test Automation – Strategy, Process and Architecture.

SE* ZG502 Advanced Topics in Software Engineering 4

Recent and emerging topics in software engineering will be discussed in detail with the help of latest publications, software product information and industry practice.

SE* ZG503 Full-Stack Application Development 4

Evolution in web app architectures: Client Server - 2 tier, 3/n tiered, Layered; Distributed - SOA, Web Services, Microservices, Cloud (IaaS/PaaS/FaaS); Modern application landscape; Web applications: Typical structure of end-to-end application; Application components-Frontend / Backend / API / Database / Services; Web Browsers - Client WebAPIs - Browsers APIs for storage, audio, video; Web Assembly; Responsive web; Web Servers; Load balancers; Application servers; API gateways; ORM; DNS; HTTP/S: HTTP headers, HTTP messages, HTTP request methods; Caching; Modern application architectures and Tech-Stacks: Microservices, Serverless; Application development Stacks-Conventional; Modern JavaScript stacks; (Full-Stack) Application Development: Languages (client/server side), Frameworks; Platforms, Deployment (on-prem/cloud); Databases(RDBMS/NoSQL); Interactions(method calls, APIs/REST, messaging); MEAN/MERN as exemplar frameworks.

SE* ZG504 API-based Products 4

API-based Products: Case for digital business/transformation, API-based Product mindset; API users; API types, API paradigms; API ecosystem; API life cycle; Principles and elements of API design; Collaborative API design process; API Design-First approach; API standards and documentation; API architectural styles and implementation: REST, gRPC, GraphQL etc., API design and implementation; Async APIs; API design practices: Design patterns and anti-patterns; Scaling, API security, change management/versioning, API publish / release; maintenance/deprecation; API testing strategies: Acceptance testing, Automations, Contract testing; Tools; Developer Experience: DevRel and DX; Developer ecosystem strategy; Developer resources; API product management: API strategy, API economy, API revenue models; Metrics for API-based Products; API management platforms; API lifecycle management; API analytics.

SE* ZG505 User Experience Design 4

UX principles; UX roles and responsibilities; UX design Frameworks; UX strategy; UX design process; UX research: Generative research, Evaluative research, Qualitative and Quantitative research; Usability studies; Observation techniques and feedback methodologies; Synthesis of results- Deriving actionable strategy from the observations; Empathizing with users and user perspective; Interaction design: User stories; User journey maps; Information architecture; UX writing; Visual design: Wireframes; Prototypes, Storyboards; Design systems; Design for accessibility; Internationalization and Localization; UX evaluation- Testing and Validation; Design for Conversational UI- Chatbots, Personal/Voice Assistants; Proximity-based UI.

SE* ZG506 API-driven Cloud Native Solutions 5

Analyze, Design, Develop and Deploy cloud native applications in innovative areas such as Artificial Intelligence/Machine Learning (AI/ML), IoT, Data Analytics etc.; Build an end to end complex application; Extensive usage of well-known PaaS/APIs; Demonstration of compliance with relevant, industry adapted best practices; Deployment using modern strategies; Presentation of the milestones and outcomes in appropriate forms; Periodic review of progress of the project by faculty.

SE* ZG507 Product Discovery and Requirements Engineering 4

Finding and defining product opportunities; Market research vs Product discovery; Product discovery techniques - framing, assessing opportunities, planning, ideation, prototyping, testing transformation; Product discovery approaches, frameworks and tools; User Research and experiments; Creation of discovery hypothesis, measurement for product-market fit, MVP specification; OKRs, KPIs definition; Requirements specification and validation; Agile requirements: User personas, Stories, Epics, Themes; Acceptance tests, Product Backlog, Story Maps, Wireframes, Storyboards, Prototypes; Requirements estimation and prioritization techniques; Managing use case evolution.

SE* ZG508 Product Strategy and Planning 4

Market scanning and analysis, Strategy Formulation, Strategy Implementation and Control, Strategic Issues in Managing Technology & Innovation, Creating and validating Opportunity Hypothesis; Product vision and product strategy, Principles of Product Vision and Strategy Product objectives; Product Roadmap: Planning, prioritization, development and communication of Roadmap, Roadmap changes; Product Lines and Portfolios. Portfolio Roadmaps; Evaluating product portfolio, OKRs, KPIs; New Products: Proposal, Development, and Launch; Outsourcing, Licensing models, Economics of Software: Development Cost (Buying/Licensing, Outsourcing/Building), Deployment Cost (Packaging and Distribution, Hosting, Scaling, and Usage), Maintenance Cost; Costing vs. pricing (B2B vs. B2C, Services, Usage models); Product release planning: Product evangelism; GTM and Sales strategy; Product positioning and branding.

SE* ZG509 Communication, Estimation, and Negotiation 4

Product Manger's Roles and Responsibilities: Understand organizational culture, product stakeholders and their perspectives, Effective product descriptions and presentations, Product news and crisis communication; The cross-functional nature of product manager's work: Strategic and tactical communication, Working with engineering teams, Working with design teams, Working with customer-facing stakeholders, Working with customers; Networking skills; Product-to-Project Translation – Resource (human resources, tools / technologies, and time) estimation and prioritization. Negotiation: Strategic negotiation with leadership; Tactical negotiation with internal (i.e. design/engineering) teams and customer-facing stakeholders.

SE* ZG510 Product Analytics 5

Concepts, approaches and process for data Analytics; Product Analytics scope; Qualitative and Quantitative Analysis techniques; Product vs Marketing analytics; Analytics in product lifecycle; Product analytics design; Product phases, goals and metrics; Analytical frameworks; Direct/Indirect, Exploratory, Descriptive/Statistical, Predictive product analytics; Product Analytics tools and platforms; Web and Mobile analytics; Other relevant analysis techniques.

SE* ZG512 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SE* ZG514 Introduction to DevOps 4

Continual Service - continuous integration and continuous delivery; Scaling: automating infrastructure and infrastructure-as-code; DevOps and Cloud: platform-as-a service and DevOps, use of virtual machines and containers for deployment, Micro-services; application lifecycle management: deployment pipeline and application deployment, continuous deployment pipeline; stack management - life cycle of stack and events, resource and event monitoring, auto healing; Security: security of deployment pipeline, policy-as-code.

SE* ZG515 Data Warehousing 5

Need and evolution of data warehousing; Goals, benefit, and challenges of data warehousing; Architecture; Approaches-Data Marts/ODS/DataLakes/DataLakeHouse; Data warehouse design; ETL, ELT, EtLT and Data Quality; OLAP & Multidimensional Analysis, Business Intelligence; Query performance enhancement techniques; Metadata management; Infrastructure and Physical design process; Data lake design: ingestion, storage (conventional / multi-modal / data-dumps), processing (batch / incremental / streaming, in-memory); Deployment: on-premise, cloud, hybrid; Cloud Data Warehousing: Topologies, Provider Selection, Configuration, Management; Migration from on-prem to cloud DW; Real Time data warehousing.

SE* ZG516 Embedded Systems Design 4

Design issues involved in embedded systems and system-on-chip technologies, Programming languages and processor architectures used for embedded systems, Standard Embedded System Development tools and hands-on experience involving these tools, understanding design constraints such as – power, memory, size constraints in system design and tradeoffs. Introduction to other specialized embedded design techniques – such as hardware, software co-design, design of accelerated and distributed embedded systems, fault tolerant design etc.

SE* ZG518 Database Design & Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SE* ZG519 Data Structures & Algorithms Design 5

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues) – Implementation using Arrays and Linked Lists; Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, QuickSort and Randomization). Unordered Collections: Hashtables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Algorithm Design: Greedy Algorithms and Dynamic Programming. Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees). Introduction to Complexity Classes (P and NP) and NP-completeness. NP-Hard problems. Designing Algorithms for Hard Problems – Back tracking, Branch-and-Bound, and Approximation Algorithms.

SE* ZG522 Big Data Systems 5

What is big data - are existing systems sufficient?; Data Warehouse v/s Data Lakes; Hadoop – Components; Storage - Relational DBs/ NoSQL dbs / HDFS / HBase / Object Data stores - S3; Serialization; Interfaces - Hive/ Pig; Stream Processing; Spark; Mahout.

SE* ZG527 Cloud Computing 5

Introduction to Cloud Computing, Virtualization Techniques and Types, Infrastructure as a Service, Container Technology, PaaS and SaaS, Capacity management and Scheduling in cloud computing, Issues and Challenges: Availability, Multi-Tenancy, Security and SLA, Overview of Cloud data storage, Programming models / architectural styles, Deployment and operations.

SE* ZG528 Cyber Physical Systems 4

This course provides an overview of Cyber-Physical Systems, with respect to its components and characteristics. As an example of a Cyber-Physical System, this course explains the various aspects of IoT systems, and helps students understand the IoT system components, its protocol stack and design methodologies. The course also enables students to get familiar with the Raspberry Pi platform, via simple examples/applications. At the end of this course, students will be able to explain the various facets of Cyber-Physical Systems, with focus on IoT and demonstrate simple IoT applications.

SE* ZG530 Design of Conversational Experiences 4

Cognitive virtual assistant (CVA): Use-cases; Classification of conversational AI platforms; Architecture of Conversational Platform; Deployment and Pricing models; Platform landscape; Designing Bots: Bot Architecture; Bot Anatomy; Design process overview; Branding, Personality, and Human Involvement; Conversation; Rich interactions; Engagement methods; Use case definition and exploration; Conversation scripting; Context and Memory; User testing; Designing Voice User Interfaces(VUI): Conversational Voice User Interface(VUI); VUI Designer; VUI design principles; Designing effective process and dialogue; Personas, Avatars, Actors; Speech recognition technology; Advanced VUI Design; User testing; Development: Building and deploying conversational AI assistants (voice assistants & chatbots) using cloud native / open source platforms such as Google Dialogflow, RASA or MS Bot framework; Bot Discovery and installation; Monetization; Analytics and Continuous improvement; Trends: SuperBot Platforms; Multiplatform Bots; Identity consolidation; Voice-enabled Devices – Smart Homes and Smart Cars as example environments.

SE* ZG533 Service Oriented Computing 4

Introduction to Web Services: Distributed computing using software component technologies like DCOM and EJBs-overview about Service Oriented Architecture- RPC and Document centric SOAP enabled web Services-Describing information using XML -SAX and DOM based XML parsers-XSLT-XPath. SOAP Protocol for web services- Describing Web Services using WSDL-Publishing and Finding web services using UDDI Registry-UDDI SOAP APIs-Inquiry APIs-Publisher APIs. Web Services security –Need for secured web service-confidentiality of web service invocation using XML encryption and its advantages over SSL security -Integrity of soap message using xml digital signing-Maintaining confidentiality and integration together for soap messages - Authentication mechanisms for Web service client – Security Assertion Markup Language- Incorporating saml assertions for web service client authentication- IP layer security for web service- Need for work flow of web services-Usage of Business Process Execution Language for describing workflow of web services-Rest web service, its protocol and usage-Usage of Ajax in invoking Rest web service-Role played by web services in cloud computing.

SE* ZG544 Agile Software Processes 4

Introduction to Agile; Basics of Agile Software Development approaches; Principles of Agile; Agile Methodologies; Release Planning; Roles and Artifacts in Agile; Agile Requirements;

Iteration Planning and Ceremonies; Executing a Sprint; Agile Metrics; Agile Testing and Maintenance; Agile Pitfalls; Ensuring Agile Success.

SE* ZG547 Usability Engineering 5

Usability-driven approach to Information Design; software usability bridge& its critical components; Iterative & evaluation of a two-level approach of UCID (User-Centered Information Design); five key principles of UCID; getting UCID into organization ; Benefits of implementing UCID; key features of UCID;UCID process & analysis; traditional processes for information development & their limitations; Managing UCID; role of usability engineers; preparing the usability plan; implementing a metrics program in typical UCID projects; key contributors; goal setting for software usability & information quality; critical design goals; designing the information architecture ;designing the specifications & prototypes; evaluating prototypes; two-level design activities; designing software labels; designing effective messages; designing online support elements & printed support elements; achieving information design goals; online search & navigation; evaluating information; two-level evaluation; approach achieving information design goals for improved software usability; testing information & validating; quality indicators; retrievability; implementation techniques & issues; Application of Usability Engineering in typical live projects to validate improved software usability .

SE* ZG548 Advanced Data Mining 4

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

SE* ZG552 Software Testing Methodologies 4

Software testing techniques and tools; software testing life cycle and its management; specification-based testing; code-based testing; model-based testing; integration testing; system testing; object oriented testing; regression testing; user acceptance testing; Automated testing at different levels (unit, integration, and system) – scripting and testing tools; test case minimization, prioritization & optimization.

SE* ZG555 Data Visualization and Interpretation 5

Visualization as a Discovery tool, Visualization skills for the masses, The Visualization methodology, Visualization design objectives, Exploratory vs. explanatory analysis, Understanding the context for data presentations, 3 minute story, Effective Visuals, Gestalt principles of visual perception, Visual Ordering, Decluttering, Story Telling, Visualization Design; Taxonomy of Data Visualization Methods: Exploring Tableau, Dashboard and Stories, Bullet graphs, Pareto charts, Custom background images; Dashboard : Dashboard categorization and typical data, Characteristics of a Well-Designed Dashboard, Key Goals in the Visual Design Process; Power of Visual Perception: Visually Encoding Data for Rapid Perception, Applying the Principles of Visual Perception to Dashboard Design.

SE* ZG557 Artificial and Computational Intelligence 5

Agents and environments, Task Environments, Working of agents; Uninformed Search Algorithms: Informed Search. Local Search Algorithms & Optimization Problems: Genetic Algorithm; Searching with Non-Deterministic Actions, Partial Information and Online search agents, Game Playing, Constraint Satisfaction Problem, Knowledge Representation using Logics: TT-Entail for inference from truth table, Proof by resolution, Forward Chaining and Backward Chaining, Inference in FOL, Unification & Lifting, Forward chaining, Backward Chaining, Resolution; Probabilistic Representation and Reasoning : Inference using full joint distribution, Representation of Conditional Independence using BN, Reinforcement Learning; Difference between crisp and fuzzy logic, shapes of membership function, Fuzzification and defuzzification, fuzzy logic reasoning; Decision making with fuzzy information, Fuzzy Classification; Connectionist Models: Introduction to Neural Networks, Hopfield Networks, Perceptron Learning, Back propagation & Competitive Learning, Applications of Neural Net: Speech, Vision, Traveling Salesman; Genetic Algorithms - Chromosomes, fitness functions, and selection mechanisms, Genetic algorithms: crossover and mutation, Genetic programming.

SE* ZG566 Secure Software Engineering 5

Best practices for designing secure systems, software engineering principles for designing secure systems, criteria for designing secure systems; analysis of system properties and verification of program correctness; use of formal methods and verification for security; tools for verification of security properties; techniques for software protection (such as code obfuscation, tamper-proofing and watermarking) and their limitations; analysis of software based attacks (and defenses), timing attacks and leakage of information, and type safety.

SE* ZG568 Applied Machine Learning 4

Need for machine learning. Prediction and classification methods. Use cases in application domains. Interpretation of results. Limitations of various techniques. End to end Machine learning - data collection, data preparation, model selection.

SE* ZG569 Blockchain Technologies & Systems 4

Highly successful decentralized blockchain-based systems, such as Bitcoin, have immense potential to revolutionize financial, information, and other infrastructures. This course aims to provide a broad overview of the essential concepts involved in blockchain technology in order to lay down the foundation necessary for developing applications. This course also covers the technical aspects of consistency and consensus in distributed algorithms, public distributed ledgers, public-key cryptography and cryptographic properties, cryptocurrencies, and smart contracts. The course aims to develop expertise among students to build these systems, interact with them, and to design and build secure distributed applications.

SE* ZG583 Scalable Services 5

Software principles related to scalability. Architectures for Scaling. Microservices - design, service discovery, load balancing, API management. Deployment - container configurations and orchestrations, automated deployments of microservices, integration with CI/CD pipelines. Performance: Scaling and load balancing with containers and microservices, Ensuring QoS and SLAs.

SE* ZG585 Cross Platform Application Development 4

Cross-platform applications development involves creation of software applications that are compatible with multiple platforms or software environments. This can be achieved through various development frameworks like Ionic, React Native, Adobe PhoneGap, Xamarin etc. This course aims to equip students with the expertise to design and develop web and mobile based applications that can operate in varied environments and platforms. Additionally, it also aims to develop the understanding of the role and importance of API management in such applications. The course involves hands-on exposure to full stack development of cross-platform applications using some of the existing development frameworks.

SE* ZG586 Edge Computing 5

Introduction, What Is Edge Computing, Edge, Fog and Cloud, edge to edge and edge to cloud communication, Sensor networks and related protocols, Key Techniques that Enable Edge Computing, Definition, Benefits, Edge Computing Systems, Multi Access Edge Computing, To Edge or Not to Edge, The Cloud Part of MEC, The Edge Part of MEC, The Access Part of MEC, Challenges and Opportunities in Edge Computing, Service Management, Privacy and Security,

Application Distribution, Edge Computing Tools, Virtualization, Resource Management, Edge Analytics, Conceptual Framework for Security and Privacy in Edge Computing, Overview of Security, Privacy, and Threats in Edge Computing, Framework for Security and Privacy in Edge Computing, case study and use cases, Edge computing and the Hybrid and Distributed Cloud.

SE* ZG587 Open Source Software Engineering 4

Understanding Open Source Software: The Cathedral and the Bazaar, Teams and Hierarchies, Processes, Licensing, and Business Models; Code walking and analysis of Open Source Products: Analyze the code of a few select products – extract data flow and control flow from an input-output perspective or a high level events perspective; Tools and Technologies in the Open Source Community: Understand and use select open source tools for development, code analysis and transformation, and deployment; Modify a module in an Open Source Product: Identify a functional and/or a critical missing feature / or a potential improvement to an Open Source product and make the required changes and test; Peer Review – Internal / External; Get Peer Reviews done for the changes and the impact / implications: internal review across teams; external reviews via discussion forums.

SE* ZG589 Middleware Technologies 4

Evolution of Middleware Technologies: Transaction Processing, Remote Procedure Calls, Message-Oriented-Middleware, Object Request Brokers, Web services and REST; Forms of Middleware: Enterprise Middleware, Web Middleware, and Cloud / Services Middleware; Middleware Elements: communication protocols, middleware protocols, data representation, server process control, naming and directory services, security, system management; Select case studies such as MS .NET, J2EE. Service Oriented Architecture: Loosely Coupled Systems, Business processes, Tiers, Architectural Choices; Resiliency in Middleware: resiliency techniques, hardware failures, communication failures, software failures; Performance and scalability in Middleware; Security in Middleware; Implementation Aspects: business process implementation, enterprise integration, web and database middleware (e.g. NoSQL middleware) change management. Case studies of Enterprise application architecture (EAI) - Eg. Tibco, Websphere.

SE* ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SE* ZG626 Hardware Software Co-Design 5

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

SE* ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SE* ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

SE* ZG681 Cyber Security 4

Cyber Security principles; Security architectures; Security threats, attacks and vulnerabilities; CIA Triad, Cyber Security Policies, Models and Mechanisms; Types of Cyber Attacks; Security Risk Management; Malware; Ransomware; Implementing Cyber Security Solutions

SE* ZG685 Software Product Management 5

Identifying customer needs. Defining value proposition. Specifying and validating MVP. Building products through agile and scrum. Metrics, measurement and improvements. Software product lifecycle management; analytical evaluation techniques; quality systems.

SS* ZC111 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal ES* ZGand student's t-distribution; test of hypothesis; correlation and linear regression.

SS* ZC163 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

SS* ZC222 Discrete Structures for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

SS* ZC234 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

SS* ZC241 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial,

personnel, legal and marketing functions; accounting and budgeting, balance sheets.

SS* ZC263 Digital Electronics and Microprocessors 4

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

SS* ZC312 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio-visual aids; editing.

SS* ZC313 Object Oriented Programming & Design 4

Object oriented concepts and design, abstraction, architecture and design patterns, GUI programming and frameworks, design of object oriented solutions using UML, design for concurrency, implementation of solutions using object oriented languages like C++ or Java; Language level mapping and realization of object oriented constructs, realization and performance issues versus abstraction and usability.

SS* ZC327 Systems Programming 4

Batch processing; Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces with focus on contemporary open source operating system-specific programming; laboratory experiments or programming assignments involving Unix/Linux System-specific Programming including shell-scripting via online laboratory facility.

SS* ZC328 Software Testing 3

Brief description of importance of software, Life cycle model and process, Basic software testing, all definitions, Types of testing and techniques (CFG, CDG etc.), Black Box & white box Testing Methodologies, Finite State Machine Model, State based Testing, Static Testing and analysis, Test cases, Test Data Generation ,Test selection ,Minimizations and Prioritization, Test adequacy criteria, Software Testing on Web Engineering, Object based Software Testing, Architecture of Testing tool, Software Test Effort Estimation, Testing behavior and process model, Qualitative analysis, Quality factors in software testing, Selection of testing tools.

SS* ZC337 Database Systems & Applications 4

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS, database programming experiments involving use of SQL, database creation etc. via online laboratory facility.

SS* ZC343 Software Engineering 4

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

SS* ZC353 Computer Organization & Architecture4

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; Virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies; This course covers the fundamentals of computer organization and architecture from a programmer's perspective.

SS* ZC363 Data Structures & Algorithms 4

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; Analysis of algorithms; Linear data structures – stacks, arrays, lists, queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees; Implementation techniques for different data structures including trees, graphs and search structures; Performance evaluation of data structures and algorithms; Implementation issues in large data structures.

SS* ZC364 Operating Systems 4

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, inter process communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules, select laboratory experiments related to creating different elements of operating system and/or implementation of select scheduling, memory management and I/O related algorithms/schemes, using system calls for creating file system specific command, creating simple file system etc. via online laboratory facility.

SS* ZC373 Compiler Design 4

Introduction to Programming Languages and Compilers, Programming Language Features, Front End of a Compiler, Back End of a Compiler, Special aspects of compilers and runtime.

SS* ZC416 Mathematical Foundations for Data Science 4

Vector and matrix algebra, systems of linear algebraic equations and their solutions; Eigenvalues, eigenvectors and diagonalization of matrices, multivariate calculus, vector calculus, Jacobian and Hessian, multivariate Taylor series, gradient descent, unconstrained optimization, constrained optimization, nonlinear optimization, stochastic gradient descent, dimensionality reduction and PCA, optimization for support vector machines.

SS* ZC425 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

SS* ZC427 Software for Embedded Systems 4

Design methodologies for embedded software, Real time operating systems fundamentals, Embedded Linux and other commercially available real time systems, fundamental of device drivers development, Introduction to Android

SS* ZC444 Artificial Intelligence 3

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving. The course also aims at understanding its implementation using LISP and PROLOG languages.

SS ZC447 Data Storage Technologies and Networks 4

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Storage arrays, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids, Storage QoS – Performance, Reliability, and Security issues, Object storage, Storage as a Service, Software defined storage

SS* ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

SS* ZC463 Cryptography 3

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

SS* ZC467Computer Networks 4

Introduction: components of a modern computer network, packet switched network and its metrics, layered architecture of protocols and historical perspective; Application Layer: principles, examples: Web and HTTP, Email, DNS, Peer-to-Peer applications, socket programming; Transport Layer: Services, the concept of connection less, connection oriented and reliable transport, TCP congestion control; Network Layer: addressing mechanism in networks, router architecture, intra and inter-AS routing protocols, multicast and broadcast; Link Layer: error detection and correction, medium access, MAC addressing, Ethernet, switches, Point to point protocol and link virtualization; Physical Layer: signals, medium, and transmission methods, QoS: forward error correction, scheduling and policing mechanism in the networks.

SS* ZG512 Embedded Systems Design 4

Design issues involved in embedded systems and system-on-chip technologies, Programming languages and processor architectures used for embedded systems, Standard Embedded System Development tools and hands-on experience involving these tools, understanding design constraints such as – power, memory, size constraints in system design and tradeoffs. Introduction to other specialized embedded design techniques – such as hardware, software co-design, design of accelerated and distributed embedded systems, fault tolerant design etc.

SS* ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SS* ZG514 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SS* ZG515 Data Warehousing 5

Need and evolution of data warehousing; Goals, benefit, and challenges of data warehousing; Architecture; Approaches-Data Marts/ODS/DataLakes/DataLakeHouse; Data warehouse design; ETL, ELT, EtLT and Data Quality; OLAP & Multidimensional Analysis, Business Intelligence; Query performance enhancement techniques; Metadata management; Infrastructure and Physical design process; Data lake design: ingestion, storage (conventional / multi-modal / data-dumps), processing (batch / incremental / streaming, in-memory); Deployment: on-premise, cloud, hybrid; Cloud Data Warehousing: Topologies, Provider Selection, Configuration, Management; Migration from on-prem to cloud DW; Real Time data warehousing.

SS* ZG516 Computer Organization and Software Systems 5

Programmer model of CPU; Basic concept of buses and interrupts; Memory subsystem organization; I/O organization; Concept of assembler, linker & loader; Types of operating systems; Concept of process; OS functions: Process scheduling, Memory management, I/O management and related issues.

SS* ZG518 Database Design & Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SS* ZG519 Data Structures & Algorithms Design 5

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues) – Implementation using Arrays and Linked Lists; Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, QuickSort and Randomization). Unordered Collections: Hashtables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Algorithm Design: Greedy Algorithms and Dynamic Programming. Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees). Introduction to Complexity Classes (P and NP) and NP-completeness. NP-Hard problems. Designing Algorithms for Hard Problems – Back tracking, Branch-and-Bound, and Approximation Algorithms.

SS* ZG520 Wireless and Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum systems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

SS* ZG522 Design and Operation of Data Centres5

Data Center Design: Principles (Scalability, Reliability, and Elasticity), Components - Computing Infrastructure (Processing, Storage, and Networking) and Physical Infrastructure (Power, Cooling, and Physical Security); Servers – Server Hardening, Server Optimization, Server Deployment and Consolidation, Converged and Hyper-Converged Infrastructure. Application monitoring and maintenance. Networking for data centers – device hardening,

bandwidth aggregation, traffic management, redundancy, network isolation, deployment of internal security and peripheral security; Contingency Planning & Disaster Recovery: Backup, recovery, and redundancy/replication technologies and approaches. Data Center Architecture: Private, Public, and Hybrid models; Distributed Data Centers; Introduction to Software Defined Data Centers. Costing and Pricing– Costing and Cost Optimization, Pricing and Economics of Data Center Operation.

SS* ZG525 Advanced Computer Networks 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

SS* ZG526 Distributed Computing 5

The course focuses on the fundamental principles and models underlying all aspects of distributed computing. It addresses the principles underlying the theory, algorithms and system aspects of distributed computing. The course covers topics such as Logical and Vector clocks, Global state and Snapshot recording algorithms, Basic distributed algorithms, Message Ordering and termination detection, Distributed Mutual Exclusion & Deadlock detection, Consensus and Agreement Algorithms, Peer-to-Peer computing and Overlay graphs, Cluster Computing, consistency models, Paxos algorithm, example distributed databases.

SS* ZG527 Cloud Computing 5

Introduction to Cloud Computing, Virtualization Techniques and Types, Infrastructure as a Service, Container Technology, PaaS and SaaS, Capacity management and Scheduling in cloud computing, Issues and Challenges: Availability, Multi-Tenancy, Security and SLA, Overview of Cloud data storage, Programming models / architectural styles, Deployment and operations.

SS* ZG528 Cyber Physical Systems 4

This course provides an overview of Cyber-Physical Systems, with respect to its components and characteristics. As an example of a Cyber-Physical System, this course explains the various aspects of IoT systems, and helps students understand the IoT system components, its protocol stack and design methodologies. The course also enables students to get familiar with the Raspberry Pi platform, via simple examples/applications. At the end of this course, students will be able to explain the various facets of Cyber-Physical Systems, with focus on IoT and demonstrate simple IoT applications.

SS* ZG529 Deep Learning 4

Common Architectural Principles of Deep Networks; Building Blocks of Deep Networks; Convolutional Neural Networks (CNNs); Recurrent Neural Networks; Recursive Neural Networks; Building Deep Networks with ND4J; Applications to Sequence Data, Anomaly Detection; Tuning Deep Networks; Vectorization.

SS* ZG536 Advanced Statistical Techniques for Analytics 4

This course will cover the statistical techniques which are very important in Data analytics. It covers the models related to descriptive statistics, inferential statistics, predictive analytics and applied multivariate analytics. And also this course introduces the important tools used in Data Analytics in Particular R language.

SS* ZG537 Information Retrieval 4

Organization, representation, and access to information; categorization, indexing, and content analysis; data structures for unstructured data; design and maintenance of such data structures, indexing and indexes, retrieval and classification schemes; use of codes, formats, and standards; analysis, construction and evaluation of search and navigation techniques; search engines and how they relate to the above. Multimedia data and their representation and search.

SS* ZG547 Usability Engineering 5

Usability-driven approach to Information Design; software usability bridge& its critical components; Iterative & evaluation of a two-level approach of UCID (User-Centered Information Design); five key principles of UCID; getting UCID into organization ; Benefits of implementing UCID; key features of UCID;UCID process & analysis; traditional processes for information development & their limitations; Managing UCID; role of usability engineers; preparing the usability plan; implementing a metrics program in typical UCID projects; key contributors; goal setting for software usability & information quality; critical design goals; designing the information architecture ;designing the specifications & prototypes; evaluating prototypes; two-level design activities; designing software labels; designing effective messages; designing online support elements & printed support elements; achieving information design goals; online search & navigation; evaluating information; two-level evaluation; approach achieving information design goals for improved software usability; testing information & validating; quality indicators; retrievability; implementation techniques & issues; Application of Usability Engineering in typical live projects to validate improved software usability .

SS* ZG548 Advanced Data Mining 4

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

SS* ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi-processing and distributed systems.

SS* ZG554 Distributed Data Systems 5

Distributed File Systems - File System Models; Replication and Synchronization - Caching; Failure & Recovery; File System Security. Distributed Databases - Distributed Data Sources and Updates; Database Connectivity; Concurrency Control and Distribution mechanism; Distributed indexing schemes. Database security. Data on the Web - Web as a distributed data repository. Data Collection and Use Crawlers, Search Engines, and Indexing Schemes. Information Retrieval Techniques. Data Exchange - Hierarchical Data Models, XML, and query languages. Semi-structured / Unstructured data - querying and synchronization. Pervasive Data - Data distribution and access for non-computing devices, small computing devices, embedded computing devices and sensory devices.

SS* ZG556 Stream Processing and Analytics 5

Real Time , Streaming Data & Sources, Real time streaming system architecture , Characteristics of a Real Time Architecture and Processing ; Configuration and Coordination Systems: Distributed State and Issues, Coordination and Configuration using Apache ZooKeeper; Data Flow Management : Distributed Data Flows , Various Data Delivery and Processing Requirements, N+1 Problem, Apache Kafka (High-Throughput Distributed Messaging); Processing Stream Data with Storm; Overview of Data Storage – Requirements: Need for long-term storage for a real time processing framework, In-memory Storage, No-Sql Storage Systems,

Choosing a right storage solution; Visualizing Data :Requirements, Principles and tools; Bounds of Random variables, Poisson Processors, Maintaining Simple Statistics from Data Streams, Sliding Windows and computing statistics over sliding windows, Data Synopsis (Sampling, Histograms, Wavelets, DFT), Exact Aggregation, Timed Counting and Summation, Multi Resolution Time Series Aggregation, Stochastic Optimization; Statistical Approximation to Streaming Data: Probabilities and Distributions, Sampling Procedures for Streaming Data, Approximating Streaming Data with Sketching, Registers and Hash Functions, Working with Sets, The Bloom Filter, Distinct Value Sketches, The Count-Min Sketch; Clustering techniques for Streaming Data; Classification methods : Decision Tree (VFDT); Evaluating stream processing algorithms; Case Studies in Designing solutions to streaming data

SS* ZG562 Software Engineering and Management5

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SS* ZG566 Secure Software Engineering 5

Best practices for designing secure systems, software engineering principles for designing secure systems, criteria for designing secure systems; analysis of system properties and verification of program correctness; use of formal methods and verification for security; tools for verification of security properties; techniques for software protection (such as code obfuscation, tamper-proofing and watermarking) and their limitations; analysis of software based attacks (and defenses), timing attacks and leakage of information, and type safety.

SS* ZG567 AI and ML Techniques in Cyber Security 5

Introduction to Cyber-Security; Supervised Learning for Misuse/Signature Detection; Machine Learning for Anomaly Detection; Malware detection and classification; Network Intrusion detection and classification; Detection and categorization of domain names; Profiling Network Traffic; Adversarial Machine Learning for Malware detection

SS* ZG568 Applied Machine Learning 4

Need for machine learning. Prediction and classification methods. Use cases in application domains. Interpretation of results. Limitations of various techniques. End to end Machine learning - data collection, data preparation, model selection.

SS* ZG569 Blockchain Technologies & Systems 4

Highly successful decentralized blockchain-based systems, such as Bitcoin, have immense potential to revolutionize financial, information, and other infrastructures. This course aims to provide a broad overview of the essential concepts involved in blockchain technology in order to lay down the foundation necessary for developing applications. This course also covers the technical aspects of consistency and consensus in distributed algorithms, public distributed ledgers, public-key cryptography and cryptographic properties, cryptocurrencies, and smart contracts. The course aims to develop expertise among students to build these systems, interact with them, and to design and build secure distributed applications.

SS* ZG570 Cloud, IoT and Enterprise Security 5

Enterprise Security Overview, Security Architectures, Security as a Process, Securing the Network, Systems, Enterprise Data, Internet of Things, Security Requirements in IoT and Current Vulnerabilities, Security Architecture in the Internet of Things , Device Security and Node Authentication, Data Security Schemes for IoT and Social IoT Concerns, Cloud Computing Fundamentals, Cloud Computing Software Security Fundamentals, Cloud Computing Risk Issues, Cloud Computing Security Challenges, Cloud Computing Security Architecture

SS* ZG574 Embedded Network Security 4

Introduction to networked embedded systems, network security fundamentals, internet communication and security protocols, techniques for embedded network security, wireless communication in embedded network security, wireless and cellular network security, WSN and adhoc network security, embedded device attestation techniques, handling attacks from compromised systems, security issues in IoT devices and networks.

SS* ZG575 Ethical Hacking 3

Techniques and tools for ethical hacking and countermeasures; exploit approaches – social engineering, scanning, footprinting, enumeration, sniffers, buffer overflows, web-hacking including cross scripting, SQL injection, privilege escalation, root kits, search engine highjack, covert channel, binary auditing, services specific hacking like DNS, Email, Web servers, Proxy; techniques of bypassing security mechanisms and hardening systems and networks for countermeasures of security analysis, monitoring and analysis tools including network traffic and system logs.

SS* ZG576 Identity and Access Management Technologies 4

Course description to be developed.

SS* ZG577 Metaheuristics for Optimization 4

Metaheuristics refers to class of approximation algorithms which can solve hard optimization problems within an acceptable time limit. This course covers principles behind such algorithms and application to real world problems. The algorithms covered in the courses include simulated annealing, evolutionary algorithms, ant colony method, and particle swarms.

SS* ZG578 Mobile Networks 4

This course covers networking topics, including in-depth study of networking protocols and system designs, with specific focus on mobile and wireless scenarios and applications. The main objective of this course is to introduce a wide range of current and next-generation wireless networking protocols and technologies. The course focuses on the most widely used mobile and wireless network standards including cellular (LTE), Wi-Fi, Bluetooth, etc. During the course, students will learn the specific mechanisms of different network architectures and tools used to analyze network performance. Given wireless and mobile networking is a very dynamic and constantly changing area, the course will cover emerging research advances in the areas of 5G, Internet-of-Things, LTE-direct, and other work from recent conferences in the field.

SS* ZG579 Real Time Scheduling 4

Real time scheduling algorithms, Resource constraints and allocation, Real time scheduling for multi-processing and distributed systems, Real time operating systems

SS* ZG580 Software Defined Networks 5

The course covers genesis of Software Defined Networks (SDN), characteristics and operation of SDN, SDN Devices and controller, Protocols such as overflow, Controller and application models, Middleboxes and network function virtualization in SDNs, SDN in the data center, Applications of SDN.

SS* ZG584 Data Management for IoT 5

Data in IoT, IoT analytics, data acquisition and preparation for IoT, data exploration for IoT, Big data management for IoT, applied predictive analytics, IoT analytics over the cloud, IoT data analytics case studies.

SS* ZG585 Cross Platform Application Development 4

Cross-platform applications development involves creation of software applications that are compatible with multiple platforms or software environments. This can be achieved through various development frameworks like Ionic, React Native, Adobe PhoneGap, Xamarin etc. This course aims to

equip students with the expertise to design and develop web and mobile based applications that can operate in varied environments and platforms. Additionally, it also aims to develop the understanding of the role and importance of API management in such applications. The course involves hands-on exposure to full stack development of cross-platform applications using some of the existing development frameworks.

SS* ZG586 Edge Computing 5

Introduction, What Is Edge Computing, Edge, Fog and Cloud, edge to edge and edge to cloud communication, Sensor networks and related protocols, Key Techniques that Enable Edge Computing, Definition, Benefits, Edge Computing Systems, Multi Access Edge Computing, To Edge or Not to Edge, The Cloud Part of MEC, The Edge Part of MEC, The Access Part of MEC, Challenges and Opportunities in Edge Computing, Service Management, Privacy and Security, Application Distribution, Edge Computing Tools, Virtualization, Resource Management, Edge Analytics, Conceptual Framework for Security and Privacy in Edge Computing, Overview of Security, Privacy, and Threats in Edge Computing, Framework for Security and Privacy in Edge Computing, case study and use cases, Edge computing and the Hybrid and Distributed Cloud.

SS* ZG588 Cyber Crimes, Forensics and Incident Handling 4

Introduction to Computer Forensics: collection, preservation, analysis, preparation and presentation of computer based evidence for the purposes of criminal law enforcement or civil litigation. Structure of Storage Media: Study of different file systems (FAT12, FAT16, FAT32, NTFS, EXT2/EXT3, etc.). Study of digital forensic techniques: Disk forensics, Network forensics and Device forensics. Understanding Computer Crime, Data Acquisition, Forensic Analysis (Internet History files, Email files and major operating system files for different OS's). Study of Steganography: information hiding and retrieval. Live versus Dead forensics. Use of Forensic Tools for file system analysis, registry analysis, network analysis, etc., Introduction to computer crimes in India and abroad, Overview of cloud forensics.

SS* ZG589 Middleware Technologies 4

Evolution of Middleware Technologies: Transaction Processing, Remote Procedure Calls, Message-Oriented-Middleware, Object Request Brokers, Web services and REST; Forms of Middleware: Enterprise Middleware, Web Middleware, and Cloud / Services Middleware; Middleware Elements: communication protocols, middleware protocols, data representation, server process control, naming and directory services, security, system management; Select case studies such as MS .NET, J2EE. Service Oriented Architecture: Loosely Coupled Systems, Business processes, Tiers, Architectural Choices; Resiliency in Middleware: resiliency techniques, hardware failures, communication failures, software failures; Performance and scalability in Middleware; Security in Middleware; Implementation Aspects: business process implementation, enterprise integration, web and database middleware (e.g. NoSQL middleware) change management. Case studies of Enterprise application architecture (EAI) - Eg. Tibco, Websphere.

SS* ZG599 Natural Language Processing 4

Natural Language Understanding and Generation, N-gram and Neural Language Models, Word to Vectors / Word Embedding (Skip gram/CBOW, Glove, BERT/ XLM, MURIL), Part of Speech Tagging, Hidden Markov Models, Parsing - Syntactic, Statistical, Dependency, Word Sense Disambiguation, Semantic Web Ontology.

SS* ZG626 Hardware Software Co-Design 5

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

SS* ZG653 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SS* ZG656 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

SS* ZG681 Cyber Security 4

Cyber Security principles; Security architectures; Security threats, attacks and vulnerabilities; CIA Triad, Cyber Security Policies, Models and Mechanisms; Types of Cyber Attacks; Security Risk Management; Malware; Ransomware; Implementing Cyber Security Solutions

SS* ZG682 Embedded Middleware Design 5

System Middleware, hardware abstraction Middleware, distributed computing middleware, with a focus on architectural principles, overview of required functions of emerging middleware and how middleware is designed to support these function, middleware for mobile computing, middleware for embedded systems, and middleware for sensor networks.

SS* ZG683 Fault Tolerant Embedded System 4

Design techniques for reliable, fault-tolerant, fail-safe and fail-soft systems, Fault diagnosis and fault avoidance methods, Fault Tolerant Networks, Experimental and Commercial fault-tolerant embedded systems

SS* ZG684 Parallel Embedded Architectures 4

Instruction level parallelism, Typical RISC Pipeline Design, Superscalar Architectures, Data Parallel Architecture, Thread & Process Level Parallel Architectures, Multi-Threaded Architectures.

SSTM* ZG511 Sanitation Technology 5

This course aims to give the participants a review of the fundamentals as well as the latest technological developments applied in the field of sanitation. Urban Drainage and Sewerage, Carbon, nitrogen and phosphorus removal & recovery; sludge treatment, Site evaluation; toilets; onsite sanitation systems; emptying and transport; established and transferring technologies for dewatering, stabilization, pathogen inactivation and nutrient management, urban low cost drainage, Innovation processes, Intro & Exercise technology selection tool / decision support system; discuss outcomes

SSTM* ZG512 Sanitation and Public Health 5

This course will have four modules – Introduction to Sanitation, Sanitation system and services, Public Health and Analysis of sanitation flow. Background on urban sanitation, Material flow analysis, Monitoring frameworks, Shit Flow Diagrams, Human Health Hazards and Waste, Review and Assessment of Transmission Routes, Review and Assessment of

Transmission Routes, Disease Cycles – Lifecycles & Vectors, Control Measures, Risk Evaluation Tools, Urban development trends, demography, Urban sanitation planning & programming

SSTM* ZG513 Sanitation Governance, Behavioral Change and Advocacy 5

This particular course will have two modules – Sanitation Governance and Behaviour change & Advocacy. Water & sanitation governance: definitions, debates, controversies, Power relations among actors in the local and global levels: Gender, class & race relations and power asymmetries, Practices of coordination & decision, making around contested water distribution, Case studies on regulatory frameworks around the world – how is sanitation managed: where, how and why, Everyday sanitation from different perspectives. Behaviour with reference to Societal and cultural aspects, Types: Knowledge, motivations and reactions, Reinforcements: Norms and behaviour Settings

SSTM* ZG514 Sanitation Financing & Project Management 5

This course will have two modules – Sanitation Financing and Project Management. Introduction to financial viability, CAPEX, OPEX, business models and PPP of sanitation project, Calculating CAPEX and OPEX of a sanitation project and developing a business model, Local authority/municipal budgeting and public/government financing, Key aspects of project management including stakeholders' relationship, people management, risk management, budget management, reporting, Objective Oriented Project Planning.

SSTM* ZG515 Emergency Sanitation & Leadership 5

This course will have two modules – Emergency Sanitation and Leadership. The evolution of humanitarian aid: historical events and the humanitarian system as it stands today. Overview of the international legal framework (Refugee law, International Humanitarian Law-IHL, International Disaster Relief Law-IDRL), code of conduct and guiding principles of humanitarian action. Standards applied by relief agencies and global cluster, Sphere, WASH cluster. Disaster cycle, risk reduction/ response/ recovery/ development, emergency response phases. Overview of relief organizations, their mandates, their commitments and priorities in emergencies.

SSTM* ZG516 Environmental Sampling and Analytical Methods 5

Principles of sample collection and data analysis / interpretation, Gravimetric methods, titrimetric methods, electrochemical methods, Spectrometric methods of analysis, Chromatographic methods of analysis, Sampling techniques for air and water pollution, Biological methods of analysis, Interpretation of data in environmental monitoring

SSTM* ZG521 Environmental Chemistry 5

Fundamentals of Physical Chemistry, Water Chemistry, Water pollution, Green Chemistry, Fundamentals of Analytical Chemistry, Atmospheric Chemistry and air pollution, Energy and climate change, Toxic compounds, Metals, soils, sediments and waste disposal, Case studies

SSTM* ZG522 Environmental Biotechnology 5

Principles, concepts and applications of Biotechnology to the management of environmental problems, Microbial technologies for waste management, Bioremediation of toxicants, Microbial systems for detoxification, Microbial technologies for waste management, Biochemical kinetics and engineering, Concept of rDNA technology, Regulation and ethics

SSTM* ZG523 Biological Treatment Principles and Design of Waste Water Systems 4

Fundamentals of biological treatment, Biochemistry and kinetics of biochemical processes like oxidation, nitrification & denitirification, Dephosphatization, Acedogensis and methogenasis, Aerobic and anaerobic treatment processes, Basic description of equipment and design methodologies, Design of reactors and configurations; Case studies for industrial and wastewater treatment.

SSTM* ZG524 Environmental Statistics 4

Introduction to probability and Statistics, Probability concepts and probability distributions, Fundamentals of data analysis, Uncertainty in Measurement, Precision and accuracy, Reproducibility/repeatability, Types of errors, Error propagation, Confidence intervals, Hypothesis testing for equality of mean and standard deviation: t-test, chi-square test and F-test, Errors in hypothesis testing, Experiment design and analysis of variances, Autocorrelation, cross-correlation and sensitivity analysis in data sets, Linear least-squares regression. Precision of parameter estimates, Coefficient of determination; Interpreting statistical results, documentation and recommendations, Theory of attributes, Time series analysis, Case studies

SSTM* ZG525 Environmental Systems Modelling 4

Introduction to air quality models, Atmospheric stability and turbulence, Gaussian dispersion models, single source and multisource models, Transport and fate of pollutant in aquatic systems, Introduction to modeling of river, lake and estuarine hydrodynamics, Stratification and eutrophication of water bodies, Dissolved oxygen model for water streams, Computational methods in environmental modeling and simulation, Transport and fate of pollutants in soils and ground water, Applications of public domain models and software; Case studies.

SSTM* ZG526 Solid Waste Management 4

Introduction to solid waste management: Sources and classification, Composition and Properties of Solid Waste and emerging e-waste, Onsite handling, storage and processing including segregation, Collection of solid waste, Transfer and transport, Recycling, Incineration pyrolysis and composting, Processing technique and equipment, Recovery of resources, conversion products, and energy, Biomedical and hazardous waste, Electronic waste, Regulatory framework, categorization, generation, collection, transport, treatment and disposal, Leacheate collection and treatment, Bioleaching and bioremediation; Case studies.

SSTM* ZG527 Environmental Management Systems 5

Introduction to air & water pollutants & solid wastes; sampling & analysis techniques; impact of these on environment; national & international regulations; ISO series; conventional & non-conventional energy resources; life cycle analysis; environmental audit; sustainable developments; case studies.

SSTM* ZG528 Environmental Risk and Impact Assessment 4

Introduction to Environmental Impact Assessment (EIA), Environmental assessment framework, Impact assessment methodologies; Air and water quality Impact analysis (AQIA / WQIA), Energy and noise impact analysis (EnIA / NIA), Vegetation, wild life and socio-impact analysis, Environment risk assessment, Environmental Impact statement.

SSTM* ZG628T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

ST* ZG511 Matrix Methods in Civil Engineering 5

Matrix techniques; basic equations of solid mechanics; variational methods; finite difference and finite element methods; applications to structural mechanics, soil and rock mechanics, fluid mechanics, and hydraulic structures.

ST* ZG513 Advanced Computational Techniques 4

Interpolation, Polynomial Interpolation, Lagrange, Newton's Interpolation, Numerical integration, Wilson θ Method, Newmark's Method, Gauss and Hermitian Quadrature, Quadrature rules for multiple integrals, Large system of linear simultaneous equations, Direct and iterative algorithms based on Gauss elimination, Gauss Seidel method and symmetric banded equations, storage schemes – skyline, band solver, frontal solver, Cholesky decomposition, Non-linear system of equations, Eigen value problems, Forward iteration, Inverse iteration, Jacobi, Given's method, Transformation of generalized Eigen value problem to standard form, Vector iteration method, Initial and boundary value problems, Solution of first and second order differential equations using Euler, modified Euler, and Runge-Kutta methods, Finite difference operators.

ST* ZG514 Structural Optimization 4

Introduction, Engineering Optimization Problems, Optimal problem formulation, Single-variable optimization algorithms, Bracketing methods, Region Elimination methods, Gradient-based methods, Multivariable optimization algorithms, Evolutionary optimization methods, Simplex Search method, Hooke-Jeeves pattern search method, Powell's conjugate direction method, Cauchy's method, Newton's method, Conjugate Gradient method, Constrained Optimization algorithms, Kuhun-Tucker conditions, Transformation methods, Direct search for constrained minimization, Feasible Direction Method, Specialized algorithms, Integer Programming, Geometric Programming, Nontraditional optimization Algorithms, Genetic algorithms, Simulated Annealing, Structural Optimization, Methods of optimal design of structural elements, minimum weight design of truss members, optimum reinforced design of R.C. C. Slabs and beams, Optimization to the design of structures such as multi-storey buildings, water tank, shell roofs, folded plates.

ST* ZG521 Topics in Structural Engineering 5

Introduction to structural optimization, application to simple structures such as trusses, and simple frames; Theory of plates and its applications in Civil Engineering; folded plate design; theory and design of shell structures specifically with application in structures covering large area.

ST* ZG522 Structural Health Assessment and Rehabilitation 4

Introduction, Overview of present repair, retrofitting, and strengthening practices, Distress identification, Repair management, Causes of deterioration and durability aspects, Holistic models of Deterioration of RCC, Durability Aspects, Intrinsic and Extrinsic causes an stages of Distress, Condition Survey and Non-destructive Evaluation, Classes of Damages and Repair Classification, Structural Analysis and Design, Reserve Strength, Evaluation of Building Configuration, Repair materials and their selection, Rehabilitation and Retrofitting Methods, Analysis and Design of Externally FRP and ECC Strengthened Structures, Retrofitting using External Unbonded Post-tensioning and Near Surface Mounted FRP Rebars, Durability Based Design of FRP Reinforced/Strengthened Bridge Girders, Case Study Problems.

ST* ZG523 Advanced Concrete Technology 4

Components of Concrete, chemical properties of cement & cementitious paste, properties of aggregates; chemistry of admixtures: mineral, chemical; effect of concrete composition on properties of fresh concrete and hardened concrete; Durability of concrete and its relation with concrete composition; Techniques for non-destructive evaluations (NDE) of concrete; Concrete mix design; Special concrete, Concrete with alkali activated binder.

ST* ZG524 Advanced Concrete Structural Design 5

Design of indeterminate beams and frames; Design of beam-column joints, Design of flat slabs, Analysis of slab using yield-line theory; Design of circular slabs; Design of beams curved in plan, Design of Folded plates and cylindrical shells, Design of Water Tanks.

ST* ZG532 Advanced Soil Mechanics 4

Modern concept of soil structure and its application in explaining its behaviour; effects of seepage on equilibrium of ideal soil; mechanics of drainage; theories of elastic subgrade reaction; theories of semi-infinite elastic soils; vibration problems.

ST* ZG533 Advanced Composite Materials for Structures 4

Introduction and History of FRP, Overview of Composite materials, Physical and Mechanical Properties and Test methods, Design of RC Structures reinforced with FRP Bars, Flexural Strengthening of RC Beams, Shear Strengthening of Beams, Flexural Strengthening of Slabs, Strengthening of Axially and Eccentrically Loaded Columns, Seismic Retrofit of Columns.

ST* ZG551 Dynamics of structures 4

Free and forced Vibration Analysis of SDOF system, Response to general dynamic loadings, Numerical evaluation of dynamic response, Effect of damping; Free and forced vibration of undamped and damped multi degree of freedom systems; Modeling for multi degree of freedom systems; Equation of motions, Evaluation of natural frequencies and mode shapes, orthogonality conditions, Modal analysis and modal combination rules, Numerical evaluation of dynamic response for multi degree of freedom, time history analysis; support excited vibration, analysis of non-linear systems, Free and forced vibration analysis of continuous systems, Random vibrations, Stochastic response; Vibration isolation, vibration absorber and tuned mass damper; Evaluation of wind, blast, wave loading and other dynamic forces on structure; Modeling and dynamic analysis of buildings, bridges, water tank, liquid storage tanks, stack like structure, machine foundations etc.

ST* ZG552 Advanced Structural Mechanics and Stability 4

Analysis of stress and strain in three-dimension domain, deviatoric stress and strain; stress and strain invariants, compatibility conditions, equilibrium equations; stress-strain relations for anisotropic, orthotropic and isotropic elastic materials; yield criterion; plastic potential and flow rules. Problems on plane stress and plain strain conditions, Airy stress function; Axi-symmetric problems; torsion of prismatic bars, circular and non-circular sections; thin-walled sections, membrane and sand-heap analogies, concept of stability of structures and examples of instability. Stability of structures with one and two degree of freedom, buckling of columns; beam-columns and simple frames, lateral torsion buckling of beams; and introduction to postbuckling of plates.

ST* ZG553 Theory of Plates and Shells 4

Analysis procedure and the basic theory of plates and shells; Different kinds of plates such as rectangular, circular, and elliptical; Different kinds of shell structures such as shell of revolution: spherical shells, cylindrical shells and special shell structures; Principles and applications of bending of plates, membrane theory, bending of shells, and stability of plates and shells; Kirchoff theory, Reissner-Mindlin-Naghadi type theories, rectangular plates-solution by double Fourier series,membrane theory of shells, and case study on plates and shells using numerical tools.

ST* ZG554 Advanced Structural Design 4

Practical design problems on analysis and design of multistoried and industrial buildings, chimney, retaining wall,

water tank, towers, etc using both the steel and concrete materials. Modeling of structures subjected to various load (DL, LL, WL, EQ etc.) combinations, structural analysis, design, and detailing of specific advanced concrete and steel structures.

ST* ZG610 Computer Aided Analysis and Design in Civil Engineering 5

Computer languages; CAD, graphics; database management system; knowledge base expert system; development of preprocessor and post processor with graphic interface; analysis and design, optimization techniques, genetic algorithms, software development for analysis and design, interfacing.

ST* ZG612 Advanced Steel Structures 4

Steel properties; high strength steels, structural behaviour, analysis and design; loads and environmental effects; load and resistant factor design (LRFD); column and beams; connections; member under combined loads; bracing requirements; composite members; plastic analysis and design; tall steel buildings, detailing in steel structures.

ST* ZG613 Advanced Concrete Structures 4

Materials; high strength concrete, flexure analysis and design; shear and diagonal tension; bond and anchorage; serviceability; torsion; columns; joints; indeterminate beams and frames; yield line analysis; strip method for slabs; composite construction; footing and foundations; concrete building system; concrete tall buildings, detailing in concrete structures.

ST* ZG614 Prestressed Concrete Structures 4

Effect of prestressing; source of prestress, prestressing steel; concrete for construction; elastic flexure analysis, flexural strength; partial prestressing; flexural design based on concrete stress limits; tension profile; flexural design based on load balancing; losses due to prestress; shear diagonal tension and web reinforcement; bond stress, transfer and development length, anchorage zone design, deflections.

ST* ZG615 Earthquake Engineering 4

Single and multi-degree freedom system; seismic risk, causes and effects of earthquakes; seismicity, determination of site characteristics; design earthquakes; earthquake resistant design philosophy; seismic response; earthquake resistant design of structures; detailing for earthquake resistance in concrete and steel structures.

ST* ZG616 Bridge Engineering 4

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

ST* ZG617 Advanced Structural Analysis 4

Flexibility Method; stiffness method; beam curved in plan; two dimensional and three dimensional analysis of structures; shear deformations, shear wall analysis; interactive software development for analysis of structures.

ST* ZG618 Design of Multi-Storey Structures 4

Loads and stresses; building frames; framing systems, bracing of multistorey building frames; diaphragms; shear walls and cover; tube structure, approximate analysis and preliminary design; frame analysis; design loading, wind effects and response, earthquake response of structures.

ST* ZG619 Finite element analysis 5

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

ST* ZG620 Advanced Foundation Engineering 4

Types of foundations, capacity and settlement of foundations, soil properties, design considerations, discrete method for analysis, design of shallow and deep foundations, failure in foundations, remedial measures, case studies of foundations.

ST* ZG621 Fluid Dynamics 5

Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory;flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

ST* ZG622 Soil-Structure-Interaction 4

Importance of soil-structure interaction, basic theories, types of interaction problems, numerical modelling, experimental and field investigations, prediction of failure mechanism, economic considerations.

ST* ZG623 Ground Improvement Techniques 4

Requirements for ground improvement, various techniques of improvement, water table lowering, ground freezing, electro-osmosis, compaction, tamping, use of explosives, vibratory probes, thermal treatment, addition of lime, cement and bitumen, gravel and sand columns, preloading techniques, reinforced earth, soil replacement techniques.

ST* ZG631 Selected Topics in Soil Mechanics and Geotechnical Engineering 4

Formation of soil & soil deposits, subsurface exploration, collapsible soils identification treatment & design consideration, review of casting expansion models in soil, treatment of weak soil, numerical modelling, fracture propagation & fracture energy, fluid infiltered materials, modern trends.

ST* ZG641 Theory of Elasticity and Plasticity 5

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.

TA ZC163 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

TA ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting(Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations),Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

TA ZC142 Computer Programming 3

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development;

structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

TA ZC233 Engineering Measurements 4

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

TA ZC312 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio-visual aids; editing.

TE* ZG511 Soil Mechanics for Highway Engineering4

Origin and classification of soils; physicochemical properties, index properties of soil, IS classification of soils and their applications in roads, airfields and embankments, Stresses within a soil, effective stress principle, Soil - water systems - capillarity, flow, Darcy's law, permeability, and tests for its determination, Stresses due to applied load, Stress analysis for embankments and pavements, Compressibility and consolidation characteristics, over consolidation ratio, determination of coefficients of consolidation and secondary compression (creep), consolidation under construction loading, Shear Strength and Mohr Coulomb strength criterion, direct and triaxial shear tests, drained, consolidated undrained and undrained tests, strength of loose and dense sands, NC and OC soils, dilation, pore pressures, Skempton's coefficients. Compaction characteristics, water content – dry unit weight relationships, OMC, maximum dry unit weight, field compaction, quality control, etc. Analysis and design of highway embankment, Characterization of ground, site investigations, methods of drilling, sampling, in situ test - SPT, CPT, plate load and dynamic tests, in-situ permeability and groundwater level, etc., Earth Pressure Theories, Selection and design of earth retaining structures.

TE* ZG512 Soil Exploration and Field Techniques 4

Necessity and Importance of soil exploration, Method of sub surface exploration Test pits, Trenches, Wash boring, Percussion drilling, Rotary drilling, Factors affecting the selection of a suitable method of boring. Extent of boring, Factors controlling spacing and depth of bore holes, Spacing and depth of various Civil engineering structures. Indirect method of exploration, Seismic method, Electrical resistivity, Resistivity sounding and profiling, Different method of stabilization of the bore holes, their relative merits and demerits. Different method of ground water observation: Time lag in observation, sampling of ground water. Source of disturbance and their influence. Type of sampler, Principle of design of sampler, Representative and undisturbed sampling in various types of soils. Surface sampling, Amount of sampling, Boring and sampling record, Preservation and shipment of sample, preparation of bore log. Penetration tests, Standard penetration tests, Dynamic cone penetration tests with and without bentonite slurry, Static cone penetration tests, Pressure meter, Dilatometer, factors affecting the penetration tests. Various corrections in the test results. Interpretation of test result for design and determination of modulus of deformation. Small size penetrometers, Plate load test, Field CBR, Dynamic cone penetrometer for CBR evaluation. Various corrections, empirical correlations and interpretation of test result for design in transportation engineering.

TE* ZG513 Reinforced Soil Structures for Transportation Engineering 4

Introduction and need for geosynthetics, Types, functions, properties and testing of geosynthetics, Strength analysis of reinforced soil, different types of soil retaining structure, Design codes for reinforced soil retaining walls, External and internal stability of reinforced soil retaining walls, Bearing capacity of footings resting on reinforced soil, Geo-synthetics in flexible pavements, geosynthetics application and design for Separation, Filtration, drainage, erosion control, barrier in highway engineering, Reinforced slope, Design and Construction of Geosynthetic Reinforced Embankments on Soft Subsoils, Other methods of reinforcement like soil nailing, rock bolting, stone columns etc., Practical case studies of reinforced soil structures, Applications of Geocell, PVD, Jute Geotextile and Coir Geotextile in transportation engineering, case studies.

TE* ZG514 Advanced Concrete Technology in Transportation Engineering 4

Cements including blended cements, chemical and physical processes of hydration; concrete admixtures: pulverized fuel ash, ground granulated blast furnace slag, silica fume; effects on properties of concretes, mortars and grouts; methods of test; applications; mixer blends and blended cement; admixtures: Review of types and classification; chemical composition; origin and manufacture; actions and interactions; usage; effects on properties of concretes, mortars and grouts; methods of test; applications; Aggregates: Review of types; elementary mineralogy and petrology; aggregate prospecting; quarrying and gravel-winning practice; production of artificial aggregates; sampling and testing; effects on properties of concretes, mortars and grouts; Fresh concrete: Rheology of concentrated suspensions, pastes, mortars and concretes; workability, segregation and bleeding. Theory and principles governing the correct placing and compaction of concrete; Setting and hardening concrete: Plastic settlement and plastic shrinkage; exothermic characteristics; early age thermal movements; strength development; maturity, accelerated curing; assessment of safe stripping times; hot and cold weather concreting; Properties of hardened concrete: Strength; deformation under load; elasticity; creep; drying shrinkage and other volume changes. Thermal properties; Durability of concrete and concrete construction: Durability concept; pore structure and transport processes; reinforcement corrosion; fire resistance; frost damage; sulphate attack; alkali silica reaction; delayed ettringite formation; methods of providing durable concrete; short-term tests to assess long-term behaviour; Mix design: Review of methods and philosophies; mix design for special purposes; Special concretes: Lightweight concrete: autoclaved aerated concrete, no-fines concrete, lightweight aggregate concrete and foamed concrete. High strength concrete; refractory concrete; high density and radiation-shielding concrete; polymer concrete; fibre-reinforced concrete; mortars; renders; recycled concrete; Special processes and technology for particular types of structure: Sprayed concrete; underwater concrete; grouts, grouting and grouted concrete; mass concrete; slipform construction; pumped concrete; concrete for liquid retaining structures; vacuum process; concrete coatings and surface treatments; Ready-mixed concrete; Precast concrete; Concrete for roads and industrial floors

TE* ZG515 GIS Applications in Transportation Engineering 4

Remote sensing: Physics of remote sensing, Ideal remote sensing system, Remote sensing satellites and their data products, Sensors and orbital characteristics, Spectral reflectance curves, resolution and multi concept, FCC, Interpretation of remote sensing images. Digital image processing: Satellite image – characteristics and formats, Image histogram, Introduction to image rectification, Image enhancement, Land use and land cover classification system. Geographic information system (GIS): Basic concept of geographic data, GIS and its components, Data acquisition, Raster and vector formats, Topography and data models, Spatial modelling, Data output, GIS applications. Global positioning system (GPS): Introduction, Satellite navigation system, GPS- space segment, Control segment, User segment, GPS satellite signals, Receivers; Static, Kinematic and Differential GPS. Applications in Transportation

Engineering: Intelligent Transport System, Urban Transport Planning, Accident Studies, Transport System Management, Road Network Planning, Collecting Road Inventory

TE* ZG516 CAD Laboratory in Transportation Engineering 4

Basic AUTOCAD commands, exercises on earth work computations, cross sections of highways, exercises on packages like MX Roads to compute earth work, geometric design of highways, Exercises on HDM 4 package

TE* ZG517 Road Safety and Audit 4

Characteristics of accidents, accidents vs. crash, land use and road environment for safety, Multidisciplinary approach to planning for traffic safety and injury control; pre-crash and post-crash models; role of vehicle, roadway traffic, driver, and environment on road safety, crash and injuries.; accident analysis, conflict points at intersections, pedestrian safety, road safety improvement strategies; Road safety audit and analysis: Stages, aim and objectives, principles, process, roles and responsibility, Specific parameters, design standards, various stages of road safety audit, Road safety audit for rural roads, Checklists, Structuring of report. Steps in treatment of crash locations, diagnosing crash problem and solutions, accident report form, storing of data, using and interpreting crash data, identifying and prioritizing hazardous locations, condition and collision diagrams; Vulnerable road users: crashes related to pedestrian and bicyclists, their safety, provision for disabled; Crash reconstruction: understanding basic physics, calculation of speed for various skid, friction, drag, and acceleration scenarios; Engineering Measures: Speed humps and bumps, speed tables and cushions; Community awareness and education; Enforcement- Non-physical measures- physical measures; Road Safety Audit Case study.

TE* ZG518 Pavement Analysis and Design 4

Types of pavements, flexible, rigid and semi-rigid; components of pavement structure; stresses and strains in flexible and rigid pavements: layered systems, visco-elastic solutions; stresses and deflections in rigid pavements; computer programmes for analysis of stresses and deflections in rigid pavements; traffic loadings, load equivalency factors, traffic projections and analysis; material characterization as input to pavement design; flexible pavement design using IRC, AASHTO, MEPDG methods; Rigid pavement design using IRC, AASHTO, MEPDG, ACI and PCA methods; design of overlays; Considerations in pavement drainage design.

TE* ZG519 Pavement Evaluation Field Project 4

Structural condition, Functional Condition and Safety evaluation of pavements, Flexible and Rigid Pavement Rating and establishment of Pavement Condition Index, Case study, involving a failed pavement structure, to investigate the condition and suggest remedial measures, Use of HDM 4 software for establishing the best alternative remedy for the chosen case study.

TE* ZG520 Infrastructure Planning and Management 4

The goals and perspectives of planning; forecasting and design of alternatives; plan testing: economic, financial and environmental evaluation; the challenges of managing infrastructure; Information management and decision support system; Concepts of total quality management; Economics: life-cycle analysis and maintenance, Rehabilitation and Reconstruction (M.R & R) programming; Infrastructure management system (IMS) development and implementation; Rural Infrastructure Planning.

TE* ZG521 Environmental Impact Assessment 4

Environment and global problems; Framing Environmental issues; effects of infrastructure development on environment; prediction and assessment of environmental impacts of infrastructure projects: technical and procedural aspects, guidelines and legal aspects of environmental protection, impacts on air, water, soil and noise environment, valuation, strategic assessment, mathematical modeling for environmental processes; social impact assessment (SIA), dislocation/disruption impact of Infrastructure projects; Life Cycle Assessments (LCA) and risk analysis methodologies; mitigation of environmental impacts; case studies; environmental management plan (EMP), national and international certification and guidelines including ISO.

TE* ZG523 Transportation Systems Planning and Management 4

System and environment; sequential transportation systems planning: trip generation, trip distribution, modal split and traffic assignment. Transportation Systems Management (TSM) actions: traffic management techniques for improving vehicular flow, preferential treatment for high occupancy modes, demand management technique for reduced traffic demand, staggered hours, vehicle restrictions; planning for pedestrians, parking planning; Methods of accident data collection and analysis.

TE* ZG524 Urban Mass Transit Planning, Operations and Management 4

Modes of public transportation and application pf each to urban travel needs; Comparison of transit modes and selection of technology and transit service; Estimating demand in transit planning studies and functional design of transit routes; Terminal design; Management and operation of transit systems, Model for operational management; Fleet and crew management; Terminal management; Fiscal management.

TE* ZG528 Selection of Construction Equipment and Modeling 4

Selection and application of construction and earth moving equipment; Productivity analysis of equipment operations; mathematical models for construction operations; Quality issues in construction process modeling.

TE* ZG534 Pavement Material Characterization5

Soil properties for highway engineers: Origin, properties of soils, tests on soils, Aggregates: origin, classification, requirements, properties, importance of aggregate gradation; bituminous materials: origin, preparation, properties and tests, criterion for selection of different viscosity grades of bitumen, modified binders and bituminous emulsions, Bituminous mixture design: Marshall method of mixture design, SUPERPAVE procedure of mixture design; mechanical properties of bituminous mixtures: resilient modulus, dynamic modulus, visco-elastic and fatigue characteristics. Warm mix asphalt, micro-surfacing, slurry seal, dense bituminous Macadam and bituminous concrete Cement concrete pavement materials: requirements and design of concrete mixture for rigid pavement, IRC and IS specifications and tests, joints, filler and sealant materials.

TE* ZG535 Highway Geometric Design 4

Highway functional classification; route layout and selection, design controls and criteria: turning paths, driver performance, traffic characteristics; highway capacity; access control; safety; environment; Elements of design: sight distance, horizontal alignment, transition curves, super elevation and side friction; vertical alignment: - grades, crest and sag curves; highway cross-sectional elements and their design; at-grade Inter-sections – sight distance consideration and principles of design, channelization, mini roundabouts, layout of roundabouts, inter-changes: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design; parking layout and design; terminal layout and design, geometric design for express ways.

TE* ZG536 Traffic Engineering and Safety 4

Road users and their characteristics; traffic studies- volume, speed, origin-destination (O-D) and delay studies; analysis and interpretations of traffic studies; traffic forecasting; capacity and level of service analysis; traffic characteristics at un-signalized and signalized intersections; design of

signalized intersections, capacity and LOS of signalized intersections, actuated signal control, signal coordination; traffic controls: signs, markings, street furniture; traffic regulations; parking studies; nature of traffic problems and their solutions; traffic safety: accidents- data collection and analysis; causes and prevention.

TE* ZG537 Transportation Economics and Finance4

Need for economic evaluation; concept of total transport cost; fixed and variable costs, elasticity of demand, marginal costs; value of travel time, accident costs; methods of economic evaluation; taxation in road transport, user charges: fees and tolls; highway legislation; investment policies and pricing, issues in financing and subsidy policy, public private partnership (PPP) options in transport sector: BOT, BOOT, BOLT; feasibility studies, identification and sharing of risks in PPP projects, operation and management agreements.

TE* ZG539 Introduction to Discrete Choice Theory4

Introduction, element of choice process, individual preferences, behavioral choice rule, utility based choice theory; data collection techniques, stated preference (SP) survey, revealed preference (RP) survey, paradigms of choice data; discrete choice models, property of discrete choice models, Multinomial logit model; overview and structure, Nested logit model formulation; discriminant analysis, Naive Bayes classification, classification trees, classification using nearest neighbors; application of fuzzy logic and artificial neural network in discrete choice modeling.

TE* ZG543 Traffic Flow Theory 4

Traffic flow elements: speed, volume and density and their relationships; time-space diagrams, controlled access concept, freeway concept, system performances, measures of effectiveness; mathematical modeling; probabilistic & stochastic models of traffic flow process, discrete and continuous modeling: headways, gaps and gap acceptance; macroscopic models; car-following model; queuing models; fundamentals & development of queuing processes; traffic simulation; intelligent transportation systems (ITS).

TE* ZG545 Airport Planning and Design 4

Air Transport-structure and organization; forecasting air travel demand: trend forecasts and analytical methods; air freight demand; airport system; characteristics of the aircraft; airport planning: site selection, layout plan, orientation and length of runway; airport capacity and configuration; geometric design of runway, taxiway and aprons; passenger terminal function, passenger and baggage flow, design concepts, analysis of flow through terminals, parking configurations and apron facilities; air cargo facilities-flow through cargo terminals, airport lighting; airport drainage; pavement design; airport access problem; environmental impact of airports.

TE* ZG546 Highway Construction Practices 4

Road planning and reconnaissance; right of way selection; fixing of alignment; road construction techniques: construction staking, clearing and grubbing of the road construction area; subgrade construction: excavation and filling, compaction, preparation of sub grade, quality control tests as per MORTH specifications; granular subbase and base course construction: gravel courses, WBM, WMM, stabilized soil subbases, use of geo-textiles and geo-grids; construction of bituminous layers; concrete pavement construction; field quality control ; road making machinery.

TE* ZG547 Pavement Failures, Evaluation and Rehabilitation4

Pavement deterioration, distress and different types of failures, pavement surface condition deterioration such as slipperiness, unevenness, rutting, cracking; pot holes, etc., causes, effects, methods of measurement and treatment, use of modern equipment for pavement surface condition measurements, Analysis of data, interpretation. Structural deterioration of pavements: causes, effects, methods of treatment. Structural evaluation of flexible pavements by rebound deflection method, analysis of data, design of overlay, use of FWD and other methods for evaluation of flexible and rigid pavements and their application. Evaluation of new pavement materials, model studies, pavement testing under controlled conditions, accelerated testing and evaluation methods, Test track studies. Instrumentation for pavement testing.

TE* ZG548 Pavement Management Systems 4

Components of pavement management systems, pavement maintenance measures; pavement performance evaluation: general concepts, serviceability, pavement distress survey systems, performance evaluation and data collection using different equipment; evaluation of pavement distress modeling and safety; pavement performance prediction: concepts, modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM-IV models, comparison of different deterioration models, functional and structural condition deterioration models; ranking and optimization methodologies: Recent developments, economic optimization of pavement maintenance and rehabilitation.

TE* ZG549 Rural Road Technology 4

Network planning, accessibility and mobility; road alignment and survey; geometric design: cross-sectional elements, sight distance, horizontal and vertical alignments; road materials and use of marginal materials; pavement design, drainage, culverts and small bridges; construction and specifications; quality control in construction; pavement failures; maintenance; preparation of detailed project report (DPR); community participation in planning, design, construction and management.

TE* ZG616 Bridge Engineering 4

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

TE* ZG619 Finite element analysis 5

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

TE* ZG623 Ground Improvement Techniques 4

Requirements for ground improvement, various techniques of improvement, lowering the water table, ground freezing, electro-osmosis, compaction, tamping, use of explosives, vibratory probes, thermal treatment, addition of lime, cement and bitumen, gravel and sand columns, preloading techniques, reinforced earth, soil replacement techniques, Modern methods of ground improvement with rubber tires, construction wastes, bio-cementation.

PART VIII

ADMINISTRATIVE STRUCTURE

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
ADMINISTRATIVE STRUCTURE

VICE-CHANCELLOR

Director, Pilani Campus	Director, K K Birla Goa Campus	Director, Hyderabad Campus	Director, Dubai Campus	Director, Off-Campus Programmes and Industry Engagement	Registrar

Divisions										Departments	
Dean	**Dean**	**Dean**	**Dean/Associate Dean**	**Dean**	**Dean**	**Dean**	**Dean**	**Dean**	**Dean**	**Head of the Department (HoD)**	
Administration	**Academic – Graduate Studies and Research**	**Academic – Under Graduate Studies**	**Student Welfare**	**Alumni Relations**	**Sponsored Research and Consultancy**	**Faculty Affairs**	**Practice School**	**Work Integrated Learning Programmes**	**International Programmes and Collaboration**		
	Associate Deans Faculty In-charge Nucleus members	**Associate Deans Faculty In-charge Nucleus members**	**Chief Warden Nucleus members**	**Associate Deans**	**Associate Deans Nucleus members**	**Associate Deans Nucleus member**	**Associate Deans Nucleus members**	**Associate Deans Nucleus members**	**Associate Deans**		
Administration and Finance	Admissions Operation of Flexibilities (Transfer, etc.) Registration Planning & Operation Academic Records of Students Eligibility Transcripts, Provisional Certificates Counselling Timetable Teaching Allocation & Implementation Feedback & Monitoring Academic Programs & Growth Curriculum Design & Implementation Pedagogic Practices Ph.D. Programmes	Admissions Operation of Flexibilities (Transfer, Dual Degree etc.) Registration Planning & Operation Academic Records of Students Eligibility Transcripts, Provisional Certificates Counselling Timetable Teaching Allocation & Implementation Feedback & Monitoring Academic Programs & Growth Curriculum Design & Implementation Pedagogic Practices	Hostels, NSS, Games & Athletics Student Activities Railway Concessions Scholarships & Aids Students Personal Files & Testimonials Student Discipline Recreational Activity Forum	Connect with global alumni and conceptualize, develop and organize various alumni led initiatives related to campus development, student life, and academic processes Alumni Records	Sponsored Research and Consultancy, interface with external funding agencies and Industry, Innovation and IP management, Technology Transfer & Commercialization	Faculty Recruitment, Performance Appraisal, Faculty Training & Development, Extension & Reappointment of Faculty	Establishment of Stations Faculty Allocation Feedback & Monitoring Student Needs at PS Location Station Operation Student Assignment & Evaluation	Off-Campus Work Integrated Learning Programmes Operation of Centres Preparation and delivering of Courses Academic Monitoring Board Admissions, Registration & Students Records	Promotes relations with renowned Institutions abroad for student and faculty exchanges and collaborative research with peers at foreign Universities	Chemical Engineering Civil Engineering Computer Science & Information Systems Electrical & Electronics Engineering Mechanical Engineering	Biological Sciences Chemistry Economics and Finance Management Mathematics Pharmacy Physics Humanities and Social Sciences

Registrar	*Section Head*	*Section Head*	*Unit Chief*	*Unit Chief*	*Professor –in-Charge*	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge & Estate Manager	Faculty-in-Charge	Faculty-in-Charge
General Administration	**HR Section**	**Accounts and Finance Section**	**Centralized Purchases**	**Placement**	**Anuradha and Prashanth Palakurthi Centre for Artificial Intelligene Research (APPCAIR)**	**Center for Innovation, Incubation & Entrepreneurship**	**Educational Technology Support**	**Estate Management**	**Infant Care Center & Institution Functions**	**Workshop**
Meetings, Institute Records, Award of Degrees/ Diplomas & Medals Scrutiny of Grades/ Reports Legal Affairs, Statutory Compliances	Recruitment, Personal Records of all employees, Compensation & Benefits, Employee Welfare (PF, ESI, Gratuity, Pension), PMS, Training, Budget preparation, Medical, LTC, Loans (Housing, Computer & Vehicle loan), Statutory Compliances, etc.	Accounts, Finance Planning, Budget preparation, Auditing, Statutory Compliance, GST, PF, Fixed Assets Management, Direct-Indirect taxes, Depositions & Accounting, Payroll-returns, Handling Govt. Grants, Treasury Management & Banking, MIS, etc.	Central Purchase Central Inventory of equipment	Campus Interviews, Placements	Research, Collaboration and Linkage with Industry	Entrepreneurship Development CEL and Network Activities TBI, PIED Technology Innovation Centre	Education & Research	Electricity & Water Supply Campus Planning, Buildings' Construction, Maintenance	Extension Activities Infant Care Centre Inter National Relational	Student Training Fabrication Servicing & Maintenance

Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge
Institutional Knowledge Analysis Cell (IKA)	**Information Processing Centre**	**Instrumentation, Reprography**	**Public Relations**	**Publications & Media Relations**	**Societal Development**	**Software Development & Educational Technology**	**Teaching Learning Centre**	**Transport Services Section, VFAST & Cafeteria**
Benchmarking, Rankings & Accreditation	Centralized Computer Facilities	Service & Maintenance of instruments EPABX Projection facilities Stage Light and Public Address System Printing	Public Relations	All publications of the Institute Publicity through audio-visual and print media publications Media Relations Printing & Reprography	NSS NIRMAN	Software Research & Development Software Consultancy Identification and deployment of Educational Technologies e-Learning technologies, course management etc. Video-conferencing	Faculty Orientation & Teaching Learning	Transportation services, VFAST & Cafeteria

Librarian/Dy. Liabrarians	CMO/Dy.CMO	Section Head
Library	**Medical Centre**	**Security Section**
Information Centre: Electronic resources- Databases, Journals and E-books, Publications	Healthcare services	Security services

ADMINISTRATIVE STRUCTURE

The Institute has a functional administrative structure (pages VIII-1 and VIII-2). Vice-Chancellor is the executive head of the Institute, including all its campuses. The Registrar is the ex-offcio Secretary of all the authorities of the Institute. Further, each Campus has a Director who takes care of the day-to-day academic and administrative operations of the Campus.

Various activities and requirements arising out of innovative educational programmes have been grouped into functions and each functional Division is headed by a Dean and each Unit by a Chief. Similarly the departments are headed by the Head of the Department. There are also faculty members designated as Incharge of various activities such as Instruction, Registration, Practice School, etc.

For each Division and Unit, there are cohesive teams of faculty known as the nucleus to support the activities of the Division/Unit. The administrative officers are:

Dean: Head of a Division

Chief: Head of a Unit

Head: Head of a Department

Some faculty members of the Institute are administratively attached to a Department / Division / Unit or to offices like Vice-Chancellor's Office and Director's Office, etc.

OFFICERS OF ACADEMIC ADMINISTRATION

Vice-Chancellor

Prof. V Ramgopal Rao

Directors

Prof. Sudhirkumar Barai**,** Pilani Campus

Prof. Srinivasan Madapusi, Dubai Campus

Prof. Suman Kundu, K K Birla Goa Campus

Prof. G. Sundar**,** Hyderabad Campus & Off-Campus Programmes and Industry Engagement

Registrar

Col Soumyabrata Chakraborty (Retd)

Chief Financial Officer

Mr. Arun Khetan

Head, HR

Mr. Mahesh Gopalan

Chief Placement Officer

Mr. G. Balasubramanian

Programme Head, ERP

Mr. Puram Ramachandra

ADMINISTRATION

Dean, Administration (Campuswide)

Prof. S.K. Verma, Pilani Campus

Prof. Meenal Kowshik, K K Birla Goa Campus

Prof. P. Yogeeswari, Hyderabad Campus

Associate Dean (Campuswide)

Prof. B.G. Prakash Kumar, Dubai Campus

ACADEMIC - GRADUATE STUDIES AND RESEARCH (AGSR)

Dean, AGSR (Institute Wide)

Prof. M B Srinivas

Associate Deans, AGSR

Prof Shamik Chakraborty, Pilani campus

Prof. Bharat Madhusudan Deshpande, K K Birla Goa campus

Prof. Venkata Vamsi Krishna Venuganti, Hyderabad campus

Prof. Ramanujam Karthikeyan, Dubai campus

Faculty incharge, Academic Research

Prof. Manoj Kumar Pandey, K K Birla Goa Campus

Nucleus, AGSR

K K Birla Goa Campus: Prof. Chandradew Sharma, Dr. Sudeep Baudha

ACADEMIC - UNDER GRADUATE STUDIES (AUGS)

Dean, AUGS (Institute Wide)

Prof. Ajit Pratap Singh

Associate Deans, AUGS

Prof. Sachin U Belgamwar, Pilani Campus

Prof. Biju K. Raveendran Nair, K K Birla Goa campus

Prof. Sridhar Raju, Hyderabad Campus

Prof. K. Kumar, Dubai campus

Nucleus, AUGS

K K Birla Goa Campus: Prof. Judith Maria Branganca, Prof. Prasanna Kumar Nekkare, Prof. Shibu Clement, Prof. Ramesha C K, Prof. Ram Shanker Patel, Dr. Vadiraj Anant Hemadri, Dr. Mayank Goel, Prof. Rajorshi Sen Gupta, Prof. Ashish Chittora, Dr. Sayantani Sarkar, Dr. Manjuri Kumar, Dr. Jayadevan Kampurath Poduvattil, Dr. Amol Anilrao Deshpande, Dr. Subhasis Roy

ADMISSIONS

Professor incharge (BITSAT)

Prof. Chittaranjan Hota, Hyderabad Campus

Faculty Incharge

Prof. Vishal Gupta, First Degree Admissions Tests, Pilani Campus

Prof. Atish T. Paul, Higher Degree and Ph.D. Admission Tests, Pilani Campus

Prof. Pravin Sakharam Mane, K K Birla Goa Campus

Prof. Amit Nag, Hyderabad Campus

Nucleus (Admissions)

Prof. Sandhya Mehrotra**,** K K Birla Goa Campus

Faculty In Charge, Registration

Prof. Jitendra Singh Rathore, Registration & Counseling, Pilani Campus

Faculty In Charge, Registration Academic Counseling And Monitoring

Prof. Teny Theresa John, K K Birla Goa Campus

Faculty In Charge, Time Table

Prof. Tincy Lis Thomas, K K Birla Goa Campus

FACULTY AFFAIRS DIVISION (FAD)

Dean, FAD (Institute wide)

Prof. Souri Banerjee

Associate Deans, FAD

Prof. Anshuman Dalvi, Pilani campus

Prof. Prasanta Kumar Das, K K Birla Goa campus

Prof. Vidya Rajesh, Hyderabad Campus

Prof. K. K Singh, Dubai Campus

PRACTICE SCHOOL DIVISION (PSD)

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Prof. Srinivasa Prakash Regalla

Associate Deans, PSD

Prof. G Muthukumar, Pilani campus

Prof. Annapoorna Gopal, PS (Off-campus), Bangalore

Prof. Waigaonkar Sachin Damodharrao, K K Birla Goa Campus

Prof. Sandip S. Deshmukh, Hyderabad Campus

Prof. A. Somasundaram, Dubai Campus

Nucleus, PSD

Prof. S. Murugesan, Pilani Campus

University Wide Operation Manager

Mr. Varun Singh Dewal

SPONSORED RESEARCH AND CONSULTANCY DIVISION (SRCD)

Dean, SRCD (Institute wide)

Prof. Sanket Goel

Associate Deans, SRCD

Prof. Raj Kumar Gupta, Pilani campus

Prof. Shibu Clement, K K Birla Goa Campus

Prof. Anupam Bhattacharya, Hyderabad Campus

WORK INTEGRATED LEARNING PROGRAMMES DIVISION (WILPD)

Dean, WILPD

Prof. S. Gurunarayanan

CEO, WILPD

Mr. Rajiv Tandon

Associate Deans, WILPD

Prof. Srinivasan Periaswamy, Pilani Campus

Prof. Punna Rao Ravi, Hyderabad Campus

Prof. P.B. Venkataraman , Hyderabad Campus

Prof. Anupama Karuppiah, K K Birla Goa Campus

Profl Raghunathan Rajasekaran, Hyderabad Campus

Profl. Anita Ramachandran, Bangalore centre

Prof. Krishnamurthy Bindumadhavan, Hyderabad Campus

INTERNATIONAL PROGRAMMES AND COLLABORATION DIVISION (IPCD)

Dean, IPCD

Prof. Srikanth Mutnuri, K K Birla Goa campus

Associate Deans, IPCD

Prof. Sailaja Nandigama, Pilani campus

Prof. Rejesh Mehrotra , K K Birla Goa campus

Prof. Bivudutta Mishra, Hyderabad campus

Faculty--in-Charge

Dr. Vincent Shantha Kumar, Dubai campus

ALUMNI RELATIONS DIVISION

Dean (Institute wide)

Prof. Arya Kumar

Head, Alumni Relations & Fundraising

Sachin Arya

Associate Dean

Prof. Rajeev Sakhuja, Pilani Campus

Prof. Nitin Sharma, K K Birla Goa Campus

Prof. Aruna Malapati, Hyderabad Campus

Prof. Trupti Swarup Gokhale, Dubai Campus

Student Alumni Relations Cell (SARC)

Pilani Campus - Yash Thakker, Vidushi Sahay

Aditya Mishra, Ronak Vishnoi, Soham Bhowmick, Rhea Verma

K K Birla Goa Campus - Aarohi Verma, Bhavya Ladha, Krupali Jadhav, Shreerang Gupte, Shreya Aiyar

Hyderabad Campus - Sidhant Bhat, Dhruv Choudhary, Arjun Tyagi, Prachee Sharma, Ishita Mohile, Aastha Khare, Vaka Ashrita Naidu, Arun Mitra, Aryan Asrani.

Dubai Campus - Durwa Thakur, Rishin Mashoom Shah, Avani Kottalgi, Maryam Naseer Khan, Ved Vijay Uplenchwar, Jayantra Thulasidas Andal, Hitansh Tuli, Akash Rajasekar, Rishabh Somani.

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Physical Education

Dr. Pintu Modak (In-charge, Physical Education)

Mr. Ajaykumar Rajpati Kewat, Physical Education Instructor, K K Birla Goa Campus

Mr. Gnana Prasad Reddy M, Physical Education Instructor, Hyderabad Campus

National Service Scheme

Dr. Ashish Tiwari, Societal Development, Faculty incharge (NSS and Nirmaan)

Prof. N. Kishore Kumar (Programme Co-ordinator), Hyderabad Campus

Communications Division, Dubai Campus

Unit Chief, Dubai Campus
Dr B G Prakash Kumar (Associate Dean, Administration)

Manager - Marketing, Dubai Campus

Ms Anuradha Srinivasan

Executive Marketing
Ms Shivali Gaikwad

Customer Service Associate

Ms. Michelle Barrete Villadar

Unit Chief, Centralised Purchases Unit (CPU)

Prof. N.V. Muralidhar Rao

Faculty-incharge CPU

Prof. A. Ramesh Babu, Hyderabad Campus

Unit Chief, Placement Unit (PU)

Prof. Hari Om Bansal

Faculty Incharge, Placement

Dr. Devendra Gokul Patil., K K Birla Goa Campus

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Mr. Tabir Mishra, Pilani Campus

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Mr. Abdul Razzak Sohail, Dubai Campus

Unit Chief, Workshop

Prof. Kuldip Singh Sangwan, Pilani campus

In-charge, Workshop

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Estate Manager

Mr. Amit Goel, Pilani Campus

Mr. B. Muthukrishnan, Hyderabad Campus

Mr. Anand Kallanna Patil, Senior Manager**,** K K Birla Goa Campus

Anuradha and Prashanth Palakurthi Centre for Artificial Intelligence Research (APPCAIR)

Professor In charge

Prof. Ashwin Srinivasan, K K Birla Goa Campus

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Joint Registrar, Mr. Sailesh Narayan Mohanty, K K Birla Goa Campus

Deputy Registrar

Dr. Ashish Gupta, Pilani Campus

Mr. Venkata Narayana Rao A, Hyderabad Campus

Mr. Akshay Chutani, Dubai Campus

Assistant Registrar

Mr. O.P. Redu, Pilani Campus

Mr. Ankit Singh Tanwar, Pilani Campus

Ms. Anjali Dixit, K K Birla Goa Campus

Mr. Durga Shankar Chand, Hyderabad Campus

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Faculty Incharge

Prof. Gajendra Singh Chauhan, Pilani Campus

Mr. Arjun Candrakant Halarnkar, K K Birla Goa Campus

Prof. Lavanya Suresh, Hyderabad Campus

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Head, Accounts & Finance

Mr. Satyen Sharma, Pilani Campus

Ms. Sunitha Suresh, Hyderabad Campus

Mr. Mohammad Akram, Dubai Campus

Manager, Finance

Mr. V.N. Sharma, Pilani Campus

Mr. Irfan Sherif Yaqoob, Dubai Campus

Senior Manager, Finance

Mr. Ian Francis Sardinha, K K Birla Goa Campus

Manager, MIS

Mr. Rahul Rastogi, Pilani Campus

Accounts Officers

Mr. Krishna Kumar Kedia, Pilani Campus

Chief Accountant

Mr. Mukesh Kumar Jangir, Pilani Campus

Mr. Gonegondla Krishna Babu, Hyderabad Campus

HUMAN RESOURCE SECTION

Pilani Campus, Head HR Section, Ms. Rupali Wadhwa

K K Birla Goa Campus, Senior Manager HR, Ms. Sonia Gaurav Nagarsekar,

Hyderabad Campus, Manager HR, Ms. Vasundhari Alluri

Dubai Campus, Sr. Executive Administration, Ms. Sathya Raja

SECURITY SECTION - (Security Officers)

Mr. Kishore Singh, Pilani Campus

Mr. Pradip Kr. Yadav, K K Birla Goa Campus

Mr. Durga Shankar Chand, Hyderabad Campus

INSTITUTIONAL KNOWLEDGE ANALYSIS CELL

Professor In-charge (IKA Cell)

Prof. Vishal Saxena, Pilani Campus

FACULTY INCHARGE

Pilani Campus

Prof. Yashvardhan Sharma, Information Processing Centre

Prof. Pawan K Ajmera, Instrumentation Unit, Reprography

Prof. Virendra Singh Nirban, Public Relations

Prof. Pankaj Kumar Sharma VFAST, Transport & Cafeteria

Prof. Virendra Singh Shekhawat, Software Development & Educational Technology

Prof. Shilpi Garg, Infant Care Centre and Institute Functions

Prof. Hari Babu Katakula, Timetable

K K Birla Goa Campus

Prof. Sanjay Kumar Sahay, Computer Centre

Prof. Rashmi Chauhan, Community Welfare

Hyderabad Campus

Prof. Anasua Guharay, Community Welfare

Prof. R Gururaj, Computer Centre

Prof. Runa Kumari, Time Table & Exams

Dubai Campus

Dr. S. Ramachandran S, Outreach

Centre for Innovation, Incubation & Entrepreneurship (CIIE)

Faculty-InCharge:

Prof. Satyendra Kumar Sharma, Pilani Campus

Dr. Gulshan Kumar, Dubai Campus

Prof. Saroj Sundar Baral, K K Birla Goa Campus

Dr. Harish Vijay Dixit, Hyderabad Campus

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Prof. Rajdeep Chowdhury, Biological Sciences

Prof. Pratik N Sheth, Chemical Engineering

Prof. Indresh Kumar, Chemistry

Prof. Anupam Singhal, Civil Engineering

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Prof. Krishna M, Economics and Finance

Prof. Navneet Gupta, Electrical & Electronics Engineering and Instrumentation

Prof. Devika, Humanities and Social Sciences

Prof. Udayan Chandra, Management

Prof. Devendra Kumar, Mathematics

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K K Birla Goa Campus

Prof. Srinivas Krishnaswamy, Head, Department of Chemical Engineering.

Prof. Abhijit Jayant Pethe, Head, Department of Electrical & Electronics Engineering

Prof. Karthikeyan Ganesarethinam, Head, Department of Mechanical Engineering.

Prof. Santonu Sarkar, Head, Department of Computer Science and Information Systems

Prof. Dibakar Chakrabarty, Head, Department of Biological Sciences

Prof. Halan Prakash, Head, Department of Chemistry

Prof. V.V.S.N.V Prasad Chundru, Head, Department of Economics & Finance

Prof. Alamelu Geetha Krishnamurthy, Head, Department of Humanities and Social Sciences

Prof. Jajati Keshari Sahoo, Head, Department of Mathematics

Prof. Radhika Vatsan, Head, Department of Physics

Hyderabad Campus

Prof. I Sreedhar, Dept. of Chemical Engineering

Prof. Murari Raja Raja Varma, Dept. of Civil Engineering

Prof. Subhendu Kumar Sahoo, Dept. of EEE

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Prof. Nishith Gupta, Dept. of Biological Sciences

Prof. Sounak Roy, Dept. of Chemistry

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Dr. Vivek Balachandra Kartha, Civil Engineering.

Dr. Kalaichelvi Venkatesan, Electrical & Electronics Engg.

Dr. Priyank Upadhyaya, Mechanical Engineering.

Prof. Vijayakumar Balakrishnan, Computer Science

Prof. Neeru Sood, Head, Biotechnology

Prof. Ramadoss Roop Kumar, General Sciences

Dr. Sartaj Rasool Rather, Humanities and Social Sciences

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Students Aid Fund (SAF), Pilani Campus - Prof. Navin Singh (Convener), Prof. Rajesh Prasad Mishra, Prof. Sachin U Belgamwar, Prof. Jitendra Singh Rathore, Prof. Vishal Gupta, Mr. Yatik Gupta, Mr. Nishchay Shopurkar, Mr. Sparsh Wairya, Ms. Anushka Singh, Mr. Chinmay Agarwal, Mr. Deepak Jain.

Recreational Activity Forum (RAF), Pilani Campus - Prof. Navin Singh (Incharge), Prof. Rahul Singhal, Prof Shilpi Garg, Mr. Atul Runthala, Dr. Ashish Gupta, Mr. Vishav, Mr. Vishal Kumar Jha, Mr. Akhilesh Parwal, Mr. Adya Pathak, Mr. U Aswathy, Mr. Raghav Kabra

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Internal Complaints Committee for Prevention of Sexual Harassment of Women at Work Place

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Student Members: Ms. Debadrita Dutta, Ms. Akshata Anil Kulkarni and Ms. Utsarjana Mutsuddi.

Hyderabad Campus: - Prof. M G Prasuna, Presiding Officer, Prof. Chittaranjan Hota, Member, Dr. Maya Vinai, Member, Ms. B. Haritha, Member, Mr. Ravva Srinivas, Member, Ms. Kondaveeti Satyavathi, External Member.

Student Members: Ms. S Saritha Sasidharan, Ms. Jigna Anand Lakhani, Ms. Bhavya Tibrewala.

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Bibhas Ranjan Sarkar, Prof. Sailaja Nandigama, Prof Kumar Neeraj Sachdeva, Dr. Sangita Yadav

Auxiliary Members (Core Members): Prof Chandra Shekhar, Dr. Sudeshna Mukherjee

Central Analytical Laboratory (CAL)

Head, Dept. of Pharmacy, Dept. of Biological Sciences, Head, Dept. of Chemistry, Head, Dept. of Physics.

Technology Innovation Centre (TIC)

Prof. Hitesh Dutt Mathur

Central Instruments Facility (CIF)

Coordinator: Prof. R. Mahesh

Faculty Incharge :

Dr. Raviprasad Aduri, K K Birla Goa Campus

Teaching Learning Centre (TLC)

Faculty Incharge:

Prof. Shibani Khanra Jha, Pilani Campus

Dr. Maneesha, Dubai Campus

Prof. Senthamarai Kannan Ethirajulu, K K Birla Goa Campus

Prof. Rahul Nigam, Hyderabad Campus

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Dubai Campus:- Dr. Gomathi Bhavani Rajagopalan, Dr. Nishant Harishbhai Pandya, Dr. Sunil Thomas, Dr. Vincent Shantha Kumar

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Members: Prof. Dipendu Bhunia, Prof. Hitesh Dutt Mathur, Dr. Ashish Gupta

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Prof. Bijay Kumar Rout (Coordinator), Prof. Sudeept Mohan (nucleus member), and Dr. Arshad Javed (nucleus member)

Centre for Desert Development Technologies: Prof. Rajiv Gupta (Coordinator), Shri Gyanendra Singh, Shri Shiv N. Sanwal, Shri K. C. Sacheti, Shri Pradeep Bishnoi, Prof. Surekha Bhanot, Prof. Kuldip Singh Sangwan.

Centre for Materials Science & Technology

Prof. Mani Shankar Dasgupta

Centre for Renewable Energy and Environment Development (CREED)

Dr. Manojkumar Surajkaranji Soni (Coordinator), Dr. Hari Om Bansal, Dr. Hitesh Datt Mathur, Dr. Pratik N. Sheth, Dr. Rajneesh Kumar

Embedded Controller Application Centre

Dr. Vinay Chamola, Mr. Devesh Samaiya (Incharge), Dr. Meetha Shenoy

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Pilani Campus: Dr.Guru Prasad Burnwal, Physician(CMO**),** Dr. (Mrs.) Sanjana R. Bhat Gynecologist (Deputy CMO)

Visiting Doctors: Dr. Sanjay Katewa (Dentist), Dr. H.S. Sankhla (ENT Specialist), Dr, Karan Beniwal (Paediatrician) Dr. Diwakar Pathak (Homeopathic Specialist), Dr. Ramesh P Jajoo (Ayurvedic),Dr. Sandip Dudy (Psychiatrist).

K K Birla Goa Campus: Dr. Raghavendra K M (Chief Medical Officer), Dr. Paresh A Mahabal (Dy. Chief Medical Officer) Dr. Nayana V Kantak (Medical Officer), Dr. Steffi Soares (Medical Officer), Dr. Shradha Anand Naik (Medical Officer), Dr. Prajyot S Mahale and Dr. Babasaheb D Kumbhar (Medical Officer, General Duty)

***Visiting Doctors*:** Dr. Sandeep Fowkar (Orthopaedic), Dr. Shailesh Kamat (OBG), Dr. Sreedhara Hande (Paediatrician), Dr. Jis Jolly Jose (Paediatrician), Dr. Parag Sawant (ENT), Dr. Kelly Nortan (Dental Science), Dr. McMascho P Carvalho (Physiotherapy).

Hyderabad Campus:- Dr. Kasimkota Nagajyothi (Medical Officer) & In-charge, Dr. Jenny Mercy Augustine (Medical Officer), , Dr. D Radhika (Medical Officer), Dr. Kandi Madhu (Medical Officer), Dr. Mohd Azhar Kothwal.

Visiting Doctors: Dr. EP Chandrakala (Visiting Gynecologist), Dr. Satyendra Kumar (Visiting Dentist), Dr. B. Shirisha, Physiotherapist, Dr. V Swathi (Visiting Pediatrician), Dr. Sambasiva Rao (Consultant Cardiologist), Dr. R R Krishna Jothi (Visiting Dentist)

Dubai Campus:- ***Visiting Doctors:-*** Dr. Abbas.

CERTAIN OTHER ORGANISATIONS IN PILANI

Birla Sarvajanik Hospital: Dr. R. K. Jain (Sr. General surgeon)/CMO, Dr. B. Pal (Anaesthetist), Dr. Ajay Kumar Agarwal (Orthopeadician), Dr. Srishti Jain (Gynaecologist), Dr. Rajendra Sharma (Physician), Dr. Chaturbhuj Singh Rathore (Paediatrician), Dr. Usha Sehrawat (ENT surgeon), Dr. Kiranmayee Thirunagari (Pathologist), Dr. Pawan Kumar Gupta (GDMO), Dr. Sanjay kumar (GDMO) Dr. Ramesh. P. Jajoo (Ayurveda), Dr. Moin Khan (GDMO), Dr. Hemant Kumar (GDMO), Dr. Rakesh Kumar (Physiotherapist),

Specialist Visiting Doctors: Dr. Mukesh Yadav (Cardiologist), Dr Vijay Binwal (Nephrologists), Dr. Anil Sharma (Urologist), Dr. Anil Kumar Jangir (Gastroenterology and Hepatologist), Dr. Sandeep Dudi (Psychiatrist),

Shri Mahadeo Singhi Eye Hospital: Dr. P.K. Sehgal (CMO), Dr. Amitabh Chakrabarti, Dr. G. B. Mathur, Dr. Basant Sharma (Dental Surgeon).

DISCIPLINE-WISE LIST OF FACULTY

Name	Designation	Campus
BIOLOGICAL SCIENCES		
Suman Kundu, Ph.D.	Director & Senior Professor	Goa
Sanjay Kumar Verma, Ph.D.	Senior Professor	Pilani
Ashis Kumar Das, Ph.D.	Senior Professor	Pilani
Samit Chattopadhyay, Ph.D.	Senior Professor	Goa
Shibasish Chowdhury, Ph.D.	Professor	Pilani
P R Deepa, Ph.D.	Professor	Pilani
Jitendra Panwar, Ph.D.	Professor	Pilani
Vishal Saxena, Ph.D.	Professor	Pilani
Prabhat Nath Jha, Ph.D.	Professor	Pilani
Shilpi Garg, Ph.D.	Professor	Pilani
Rajdeep Chowdhury, Ph.D.	Professor	Pilani
Utpal Roy, Ph.D.	Professor	Goa
Meenal Kowshik, Ph.D.	Professor	Goa
Judith Maria Braganca, Ph.D.	Professor	Goa
Srikanth Mutnuri, Ph.D.	Professor	Goa
Veeky Baths, Ph.D.	Professor	Goa
Anasuya Ganguly, Ph.D.	Professor	Goa
Dibakar Chakrabarty, Ph.D.	Professor	Goa
Vijayashree Nayak, Ph.D.	Professor	Goa
Sumit Biswas, Ph.D.	Professor	Goa
Angshuman Sarkar, Ph.D.	Professor	Goa
Kundan Kumar, Ph.D.	Professor	Goa
Sandhya Mehrotra, Ph.D.	Professor	Goa
Rajesh Mehrotra, Ph.D.	Professor	Goa
Vidya Rajesh, Ph.D.	Professor	Hyderabad
Jayati Ray Dutta, Ph.D.	Professor	Hyderabad
Kumar Pranav Narayan, Ph.D.	Professor	Hyderabad
Sankar Ganesh P, Ph.D.	Professor	Hyderabad
Nishith Gupta, Ph.D.	Professor	Hyderabad
Uma Shukla Dubey, Ph.D.	Associate Professor	Pilani
B Vani, Ph.D.	Associate Professor	Pilani
Pankaj Kumar Sharma, Ph.D.	Associate Professor	Pilani
Sandhya Marathe, Ph.D.	Associate Professor	Pilani
Sudeshna Mukherjee, Ph.D.	Associate Professor	Pilani
Meghana Tare, Ph.D.	Associate Professor	Pilani
Syamantak Majumder, Ph.D.	Associate Professor	Pilani
Rita Sharma, Ph.D.	Associate Professor	Pilani
Malabika Biswas, Ph.D.	Associate Professor	Goa
Sukanta Mondal, Ph.D.	Associate Professor	Goa

Name	Designation	Campus
Indrani Talukdar, Ph.D.	Associate Professor	Goa
Arnab Banerjee, Ph.D.	Associate Professor	Goa
Raviprasad Aduri, Ph.D.	Associate Professor	Goa
Sridev Mohapatra, Ph.D.	Associate Professor	Hyderabad
Naga Mohan Kommu, Ph.D.	Associate Professor	Hyderabad
Debasri Bandyopadhyay, Ph.D.	Associate Professor	Hyderabad
Vivek Sharma, Ph.D.	Associate Professor	Hyderabad
Jamma Trinath, Ph.D.	Associate Professor	Hyderabad
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Balakumaran Chandrasekar, Ph.D.	Assistant Professor, Gr-I	Pilani
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Supratim Ghosh, Ph.D.	Assistant Professor, Gr-I	Hyderabad
BIOTECHNOLOGY		
Dawood Jalaluddin Shariff, Ph.D.	Professor	Dubai
Neeru Sood, Ph.D.	Professor	Dubai
Ramachandran Subramanian, Ph.D.	Professor	Dubai
Trupti Swarup Gokhale, Ph.D.	Professor	Dubai
Pallab Sanpui, Ph.D.	Assistant Professor	Dubai
Mainak Dutta, Ph.D.	Assistant Professor	Dubai
Aditya Sharma, Ph.D.	Assistant Professor	Dubai
CHEMICAL ENGINEERING		
Srinivasan Madapusi Palavedu	Senior Professor & Director	Dubai
Sutapa Roy Ramanan, Ph.D.	Senior Professor	Goa
Suresh Gupta, Ph.D.	Professor	Pilani
Pratik Nitinchandra Sheth, Ph.D.	Professor	Pilani
Smita Raghuvanshi, Ph.D.	Professor	Pilani
Banasri Roy, Ph.D.	Professor	Pilani
Venkata Prasad Bandi, Ph.D.	Professor	Pilani
Prakash Kumar Beri, Ph.D.	Professor	Dubai
Srinivas Krishnaswamy, Ph.D.	Professor	Goa
Sampatrao Dagu Manjare, Ph.D.	Professor	Goa
Saroj Sundar Baral, Ph.D.	Professor	Goa
I Sreedhar , Ph.D.	Professor	Hyderabad

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Jaideep Chatterjee, Ph.D.	Professor	Hyderabad
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Pradipta Chattopadhyay, Ph.D.	Associate Professor	Pilani
Manjuri Kumar, Ph.D.	Associate Professor	Goa
Vivek Rangarajan, Ph.D.	Associate Professor	Goa
Anirban Roy, Ph.D.	Associate Professor	Goa
Sharad Mahadeo Sontakke, Ph.D.	Associate Professor	Goa
Jegatha Nambi Krishnan, Ph.D.	Associate Professor	Goa
Pradeep Kumar Sow, Ph.D.	Associate Professor	Goa
Richa Singhal, Ph.D.	Associate Professor	Goa
D Purnima, Ph.D.	Associate Professor	Hyderabad
Karthik Venkateshan, Ph.D.	Associate Professor	Hyderabad
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Afkham Mir, Ph.D.	Assistant Professor, Gr-I	Hyderabad
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Murchana Changmai, Ph.D.	Assistant Professor	Dubai
Souvik Kumar Paul, Ph.D.	Assistant Professor	Dubai
Jayita Chopra, Ph.D.	Visiting Faculty	Goa
CHEMISTRY		
G Sundar, Ph.D.	Senior Professor & Director	Hyderabad
Ram Kinkar Roy, Ph.D.	Senior Professor	Pilani
Dalip Kumar, Ph.D.	Senior Professor	Pilani
Sunil Bhand, Ph.D.	Senior Professor	Goa
N Rajesh, Ph.D.	Senior Professor	Hyderabad
D Ramaiah, Ph.D.	Senior Professor	Hyderabad
Mahipal Reddy Benjaram, Ph.D.	Sr. Professor Emeritus	Hyderabad
Seshadri C. Sivasubramanian, Ph.D.	Professor	Pilani
Saumi Ray, Ph.D.	Professor	Pilani
Anil Kumar, Ph.D.	Professor	Pilani
Ajay Kumar Sah, Ph.D.	Professor	Pilani
Bharti Khungar, Ph.D.	Professor	Pilani
I R Laskar, Ph.D.	Professor	Pilani
Madhushree Sarkar, Ph.D.	Professor	Pilani
Indresh Kumar, Ph.D.	Professor	Pilani
Surojit Pande, Ph.D.	Professor	Pilani
Rajeev Sakhuja, Ph.D.	Professor	Pilani
Shamik Chakraborty, Ph.D.	Professor	Pilani
Raghu Nath Behera, Ph.D.	Professor	Goa
Narendra Nath Ghosh, Ph.D.	Professor	Goa
Anjan Chattopadhyay, Ph.D.	Professor	Goa
Ranjan Dey, Ph.D.	Professor	Goa
Bhavana P., Ph.D.	Professor	Goa
Prakash Halan, Ph.D.	Professor	Goa
Mainak Banerjee, Ph.D.	Professor	Goa
Amrita Chatterjee, Ph.D.	Professor	Goa
Anupam Bhattacharya, Ph.D.	Professor	Hyderabad
K V G Chandra Sekhar, Ph.D.	Professor	Hyderabad
Sumithra Kanakamma, Ph.D.	Professor	Hyderabad
Subbalakshmi Jayanty, Ph.D.	Professor	Hyderabad
Manab Chakravarty , Ph.D.	Professor	Hyderabad
Ramakrishnan Ganesan, Ph.D.	Professor	Hyderabad
Amit Nag, Ph.D.	Professor	Hyderabad
Sounak Roy, Ph.D.	Professor	Hyderabad
Subit Kumar Saha, Ph.D.	Professor	Hyderabad

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Rashmi Chauhan, Ph.D.	Associate Professor	Goa
Subhadeep Banerjee, Ph.D.	Associate Professor	Goa
Krishnan R, Ph.D.	Associate Professor	Hyderabad
Balaji Gopalan, Ph.D.	Associate Professor	Hyderabad
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Subhasish Roy, Ph.D.	Assistant Professor, Gr-I	Goa
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Uttara Basu, Ph.D.	Assistant Professor, Gr-I	Goa
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Sandip Kumar Nandi, Ph.D.	Assistant Professor, Gr-I	Goa
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Sourav Bag, Ph.D.	Assistant Professor, Gr-I	Hyderabad
CIVIL ENGINEERING		
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Rajiv Gupta, Ph.D.	Senior Professor	Pilani
Ajit Pratap Singh, Ph.D.	Senior Professor	Pilani
S B Singh, Ph.D.	Senior Professor	Pilani
Komaragiri Srinivasa Raju, Ph.D.	Senior Professor	Hyderabad
Anshuman, Ph.D.	Professor	Pilani
Manoj Kumar, Ph.D.	Professor	Pilani
Anupam Singhal, Ph.D.	Professor	Pilani
Ravi Kant Mittal, Ph.D.	Professor	Pilani

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V Vinayaka Ram, Ph.D.	Professor	Hyderabad
Vasan A , Ph.D.	Professor	Hyderabad
Jagadeesh Anmala, Ph.D.	Professor	Hyderabad
Sridhar R, Ph.D.	Professor	Hyderabad
Muthukumar G, Ph.D.	Associate Professor	Pilani
Shuvendu Narayan Patel, Ph.D.	Associate Professor	Pilani
Shibani Khanra Jha, Ph.D.	Associate Professor	Pilani
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Mohan S C, Ph.D.	Associate Professor	Hyderabad
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Rajesh Kumar, Ph.D.	Assistant Professor, Gr-I	Pilani
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Mukund Lahoti, Ph.D.	Assistant Professor, Gr-I	Pilani
Rallapalli Srinivas, Ph.D.	Assistant Professor, Gr-I	Pilani
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Sayantan Chakraborty, Ph.D.	Assistant Professor, Gr-I	Pilani
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Pubali Mandal, Ph.D.	Assistant Professor, Gr-I	Pilani
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K Rajitha, Ph.D.	Assistant Professor, Gr-I	Hyderabad
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Ishant Sharma, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Akshay Gundla, Ph.D.	Assistant Professor, Gr-I	Hyderabad
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Vivek Balachandra Kartha, Ph.D.	Assistant Professor	Dubai
Deepthi Mary Dilip, Ph.D.	Assistant Professor	Dubai
Brij Kishor Pandey,Ph.D.	Assistant Professor	Dubai
Akshay Venkateshwaran, Ph.D.	Assistant Professor	Dubai

Name	Designation	Campus
COMPUTER SCIENCE, INFORMATION SYSTEMS & SOFTWARE SYSTEMS		
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Ashwin Srinivasan, Ph.D.	Senior Professor	Goa
Chittaranjan Hota, Ph.D.	Senior Professor	Hyderabad
Janardan Prasad Misra, M.E.	Professor	Pilani
Sudeept Mohan, Ph.D.	Professor	Pilani
Mukesh Kumar Rohil, Ph.D.	Professor	Pilani
Poonam Goyal, Ph.D.	Professor	Pilani
Yashvardhan Sharma, Ph.D.	Professor	Pilani
Gopalakrishnan Venkiteswaran, Ph.D.	Professor	Pilani
Sangili Vadivel, Ph.D.	Professor	Dubai
Vijayakumar Balakrishnan, Ph.D.	Professor	Dubai
Neena Goveas, Ph.D.	Professor	Goa
Bharat Madhusudan Deshpande, Ph.D.	Professor	Goa
Sanjay Kumar Sahay, Ph.D.	Professor	Goa
Biju K. Raveendran Nair, Ph.D.	Professor	Goa
Vinayak Shashikant Naik, Ph.D.	Professor	Goa
Snehanshu Saha, Ph.D.	Professor	Goa
Santonu Sarkar, Ph.D.	Professor	Goa
G Geethakumari, Ph.D.	Professor	Hyderabad
Aruna Malapati, Ph.D.	Professor	Hyderabad
Lalita Bhanu Murthy Neti, Ph.D.	Professor	Hyderabad
Tathagata Ray, Ph.D.	Professor	Hyderabad
Hari Babu Kotakula, Ph.D.	Associate Professor	Pilani
Virendra Singh Shekhawat, Ph.D.	Associate Professor	Pilani
Vishal Gupta, Ph.D.	Associate Professor	Pilani
Sundaresan Raman, Ph.D.	Associate Professor	Pilani
Kamlesh Tiwari, Ph.D.	Associate Professor	Pilani
Ashutosh Bhatia, Ph.D.	Associate Professor	Pilani
Amit Dua, Ph.D.	Associate Professor	Pilani
Pratik Narang, Ph.D.	Associate Professor	Pilani
Sujala Deepak Shetty, Ph.D.	Associate Professor	Dubai
Raja Muthalagu, Ph.D.	Associate Professor	Dubai
Siddhaling Urolagin, Ph.D.	Associate Professor	Dubai
Basabdatta Bhattacharya, Ph.D.	Associate Professor	Goa
R Gururaj , Ph.D.	Associate Professor	Hyderabad
Barsha Mitra, Ph.D.	Associate Professor	Hyderabad
Subhrakanta Panda, Ph.D.	Associate Professor	Hyderabad
Manik Gupta, Ph.D.	Associate Professor	Hyderabad
K Venkatasubramanian, M.E.	Associate Professor-Off Campus	Pilani
Y V K Ravi Kumar, Ph.D.	Associate Professor-Off Campus	Pilani

Name	Designation	Campus
Venkateswara Rao Thunuguntla, M.Tech.	Associate Professor-Off Campus	Pilani
Chandra Shekar R K, M.Tech.	Associate Professor-Off Campus	Pilani
Pradheep Kumar K, Ph.D.	Associate Professor-Off Campus	Pilani
Anita Ramachandran, M.Tech.	Associate Professor-Off Campus	Pilani
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Sugata Ghosal, Ph.D.	Associate Professor-Off Campus	Pilani
Chetana Anoop Gavankar, Ph.D.	Associate Professor-Off Campus	Pilani
Ramakrishna Dantu, Ph.D.	Associate Professor-Off Campus	Pilani
Nishit Narang, Ph.D.	Associate Professor-Off Campus	Pilani
Srinath R.Naidu, Ph.D.	Associate Professor-Off Campus	Pilani
Shreyas Suresh Rao, Ph.D.	Associate Professor-Off Campus	Pilani
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S Gurunarayanan, Ph.D.	Senior Professor	Hyderabad
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Anu Gupta, Ph.D.	Professor	Pilani
Karunesh Kumar Gupta, Ph.D.	Professor	Pilani
Dheerendra Singh, Ph.D.	Professor	Pilani
Hari Om Bansal, Ph.D.	Professor	Pilani
Hitesh Datt Mathur, Ph.D.	Professor	Pilani
Abhijit Rameshwar Asati, Ph.D.	Professor	Pilani
Surekha Bhanot, Ph.D.	Professor	Pilani
Navneet Gupta, Ph.D.	Professor	Pilani
Sindhu S, Ph.D.	Professor	Pilani
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Jagadish Nayak, Ph.D.	Professor	Dubai
Kalaichelvi Venkatesan, Ph.D.	Professor	Dubai
Mukund Keshavrao Deshmukh, Ph.D.	Professor	Goa
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Ramesha C.K., Ph.D.	Professor	Goa
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Sanket Goel, Ph.D.	Professor	Hyderabad
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Mridula Goel, Ph.D.	Professor	Goa
Aswini Kumar Mishra, Ph.D.	Professor	Goa
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Vivekananda Mukherjee, Ph.D.	Professor	Hyderabad
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Krishna Muniyoor, Ph.D.	Associate Professor	Pilani
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China Hussain Yaganti, Ph.D.	Associate Professor	Hyderabad
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Sudatta Banerjee, Ph.D.	Associate Professor	Hyderabad
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Virendra S Nirban, Ph.D.	Professor	Pilani
Pushp Lata, Ph.D.	Professor	Pilani
Sushila Shekhawat, Ph.D.	Professor	Pilani
Shazi Shah Jabeen, Ph.D.	Professor	Dubai
Rudra Prasad Pradhan, Ph.D.	Professor	Goa
Shalini Upadhyay, Ph.D.	Professor	Goa
Reena Cheruvalath, Ph.D.	Professor	Goa
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Geetha Bakilapadavu., Ph.D.	Professor	Goa
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Biswanath Dash, Ph.D.	Associate Professor	Hyderabad
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Shamshad Ahmad Khan, Ph.D.	Assistant Professor	Dubai
Sayantan Chakraborty, Ph.D.	Assistant Professor	Dubai
Faisal Nazir Zargar, Ph.D.	Assistant Professor	Dubai
Asgar Ali, Ph.D.	Assistant Professor	Dubai
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Kumar Karuppusamy, Ph.D.	Professor	Dubai
Ramadoss Roopkumar, Ph.D.	Professor	Dubai
Somasundaram Arumugam, Ph.D.	Professor	Dubai
Geetha Kannan, Ph.D.	Associate Professor	Dubai
Maneesha, Ph.D.	Associate Professor	Dubai
Vijaya Ilango, Ph.D.	Associate Professor	Dubai
Suhel Ahmad Khan, Ph.D.	Associate Professor	Dubai
Rusal Raj Francis, Ph.D.	Assistant Professor	Dubai
Baskaran Sriramulu, Ph.D.	Assistant Professor	Dubai
Amaranath Govindolla, Ph.D.	Assistant Professor	Dubai
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Pravin Madanrao Singru, Ph.D.	Professor	Goa
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Prateek Kala, Ph.D.	Associate Professor	Pilani
Arun Maity, Ph.D.	Associate Professor	Pilani
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Amol M Marathe, Ph.D.	Assistant Professor, Gr-I	Pilani
Murali P, Ph.D.	Assistant Professor, Gr-I	Pilani
Venkatesh K P, Ph.D.	Assistant Professor, Gr-I	Pilani
Aakash Chand Rai, Ph.D.	Assistant Professor, Gr-I	Pilani
Gaurav Watts, Ph.D.	Assistant Professor, Gr-I	Pilani
A R Harikrishnan, Ph.D.	Assistant Professor, Gr-I	Pilani
Aneesh A M, Ph.D.	Assistant Professor, Gr-I	Pilani
Faizan Mohammad Rashid, Ph.D.	Assistant Professor, Gr-I	Pilani
Saket Verma, Ph.D.	Assistant Professor, Gr-I	Pilani
Suvanjan Bhattacharyya, Ph.D.	Assistant Professor, Gr-I	Pilani
Amit Rajnarayan Singh, Ph.D.	Assistant Professor, Gr-I	Pilani
Radha Raman Mishra, Ph.D.	Assistant Professor, Gr-I	Pilani
Tribeni Roy, Ph.D.	Assistant Professor, Gr-I	Pilani
Geeta Bhatt, Ph.D.	Assistant Professor, Gr-I	Pilani
Amit Kumar, Ph.D.	Assistant Professor, Gr-I	Pilani
Anuj Sharma, Ph.D.	Assistant Professor, Gr-I	Pilani
Kiran Dinkar Mali, Ph.D.	Assistant Professor, Gr-I	Goa
Sandeep Jose, Ph.D.	Assistant Professor, Gr-I	Goa
Pritanshu Ranjan, Ph.D.	Assistant Professor, Gr-I	Goa
Vadiraj Anant Hemadri, Ph.D.	Assistant Professor, Gr-I	Goa
Siddhartha Tripathi, Ph.D.	Assistant Professor, Gr-I	Goa

Name	Designation	Campus
Devendra Gokul Patil, Ph.D.	Assistant Professor, Gr-I	Goa
Biswajit Das, Ph.D.	Assistant Professor, Gr-I	Goa
Nilesh Dadasaheb Pawar, Ph.D.	Assistant Professor, Gr-I	Goa
Iniyan Thiruselvam N., Ph.D.	Assistant Professor, Gr-I	Goa
Vaibhav Joshi, Ph.D.	Assistant Professor, Gr-I	Goa
Ganesh Madhav Bapat, Ph.D.	Assistant Professor, Gr-I	Goa
Ashwin K.P., Ph.D.	Assistant Professor, Gr-I	Goa
Sudhy S. Panicker, Ph.D.	Assistant Professor, Gr-I	Goa
Anandteerth, Ph.D.	Assistant Professor, Gr-I	Goa
Amal S. Siju, M.Tech.	Assistant Professor, Gr-II	Goa
Ravi Shanker Vidyarthy, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Pardha Saradhi Gurugubelli Venkata, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Piyush Chandra Verma, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Brajesh Kumar Panigrahi, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Kundan Kumar Singh, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Vuppuluri Amol, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Prabakaran Saravanan, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Mrinal Ketan Jagirdar, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Abhishek Sarkar, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Sayan Das, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Punnag Chatterjee, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Jayaprakash K S, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Anirudh Udupa, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Arnab Guha, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Priyank Upadhyaya, Ph.D.	Assistant Professor	Dubai
Naveen Kumar Shrivastava, Ph.D.	Assistant Professor	Dubai
Gulshan Kumar, Ph.D.	Assistant Professor	Dubai
Majid Hassan Khan, Ph.D.	Assistant Professor	Dubai
Harpreet Singh Bedi, Ph.D.	Assistant Professor	Dubai
Ravindra Giriraj Bhardwaj	Assistant Professor	Dubai
Pavan Kumar Potdar, Ph.D.	Assistant Professor, Gr-I (OC)	Pilani
K Santosh Sopanrao, M.E.	Assistant Professor, Gr-I (OC)	Pilani
Samata Satish Mujumdar, M.E.	Assistant Professor, Gr-I (OC)	Pilani
Nithin Tom Mathew, Ph.D.	Assistant Professor, Gr-I (OC)	Pilani
Glynn John, Ph.D.	Assistant Professor, Gr-I (OC)	Pilani
Panchagnula Jayaprakash Sharma, Ph.D.	Assistant Professor, Gr-I (OC)	Pilani
Prakruthi Hareesh, Ph.D.	Assistant Professor, Gr-I (OC)	Pilani
Bharathi R, M.E.	Assistant Professor, Gr-I (OC)	Pilani
Rajiv Ranjan Gupta, M.E.	Assistant Professor, Gr-II (OC)	Pilani
Sameer Gupta, M.E.	Associate Professor (OC)	Pilani
Amar Singh, M.Tech.	Associate Professor (OC)	Pilani
Chennu Ranganayakulu, Ph.D.	Visiting Professor	Pilani
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Akhilesh Kishorrao Bhatkar, M.Tech.	Visiting Faculty (OC)	Pilani
Sanjai K, M.E.	Visiting Faculty (OC)	Pilani
Gondu Vykunta Rao, M.Tech.	Visiting Faculty (OC)	Pilani
Sanju Sharma, B.Tech.	Instructor (OC)	Pilani
Thangella Pally Swapna, B.Tech.	Instructor (OC)	Pilani
Parjanya Yaragani, B.E.	Instructor (OC)	Pilani
PHARMACY		
Radhakrishnan Mahesh, Ph.D.	Senior Professor	Pilani
Dharmarajan Sriram, Ph.D.	Senior Professor	Hyderabad
P Yogeeswari, Ph.D.	Senior Professor	Hyderabad
Ahmed Kamal, Ph.D.	Sr. Professor Emeritus	Hyderabad
Hemant Jadhav, Ph.D.	Professor	Pilani
S Murugesan, Ph.D.	Professor	Pilani
Rajeev Taliyan, Ph.D.	Professor	Pilani
Gaikwad Anil Bhanudas, Ph.D.	Professor	Pilani
Punna Rao Ravi, Ph.D.	Professor	Hyderabad
A Sajeli Begum, Ph.D.	Professor	Hyderabad
Venkata Vamsi Krishna Venuganti, Ph.D.	Professor	Hyderabad
Swati Biswas, Ph.D.	Professor	Hyderabad
Onkar P Kulkarni, Ph.D.	Professor	Hyderabad
Arti Dhar, Ph.D.	Professor	Hyderabad
Paul Atish Tulshiram, Ph.D.	Associate Professor	Pilani
Anil Jindal, Ph.D.	Associate Professor	Pilani
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Anupama Mittal, Ph.D.	Associate Professor	Pilani
Gautam Singhvi, Ph.D.	Associate Professor	Pilani
Aniruddha Roy, Ph.D.	Associate Professor	Pilani
Balaram Ghosh, Ph.D.	Associate Professor	Hyderabad
M M Pandey, Ph.D.	Assistant Professor, Gr-I	Pilani
Sandeep Sundriyal, Ph.D.	Assistant Professor, Gr-I	Pilani
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Abhijeet Rajendra Joshi, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Yuvraj Singh, Ph.D.	Assistant Professor, Gr-I	Hyderabad
PHYSICS		
Souri Banerjee, Ph.D.	Senior Professor	Hyderabad
Rashmi Ranjan Mishra, Ph.D.	Professor	Pilani
Debashis Bandyopadhyay, Ph.D.	Professor	Pilani
Anshuman Dalvi, Ph.D.	Professor	Pilani
Rakesh Choubisa, Ph.D.	Professor	Pilani
Raj Kumar Gupta, Ph.D.	Professor	Pilani

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Manjuladevi V., Ph.D.	Professor	Pilani
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Jayendra Nath Bandyopadhyay, Ph.D.	Professor	Pilani
S Gangopadhyay, Ph.D.	Professor	Pilani
Amol Ramdas Holkundkar, Ph.D.	Professor	Pilani
Arun Venkatesh Kulkarni, Ph.D.	Professor	Goa
Radhika Vathsan, Ph.D.	Professor	Goa
P. Nandakumar, Ph.D.	Professor	Goa
Gaurav Dar, Ph.D.	Professor	Goa
Raghunath Anand Ratabole, Ph.D.	Professor	Goa
Prasanta Kumar Das, Ph.D.	Professor	Goa
Ram Shanker Patel, Ph.D.	Professor	Goa
Senthamarai Kannan Ethirajulu, Ph.D.	Professor	Goa
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Kannan Ramaswamy, Ph.D.	Professor	Hyderabad
B. Harihara Venkataraman, Ph.D.	Professor	Hyderabad
Sarmistha Banik, Ph.D.	Professor	Hyderabad
Aranya Bhuti Bhattacharjee, Ph.D.	Professor	Hyderabad
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Madhukar Mishra, Ph.D.	Associate Professor	Pilani
Kaushar R Vaidya, Ph.D.	Associate Professor	Pilani
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Sunilkumar Vattezhath., Ph.D.	Associate Professor	Goa
Teny Theresa John, Ph.D.	Associate Professor	Goa
Chandradew Sharma, Ph.D.	Associate Professor	Goa
Tarun Kumar Jha, Ph.D.	Associate Professor	Goa
Kinjal Banerjee, Ph.D.	Associate Professor	Goa
Aravinda Narayanan Raghavan, Ph.D.	Associate Professor	Hyderabad
Meenakshi V, Ph.D.	Associate Professor	Hyderabad
Satya Narayana Murthy Vemulapati, Ph.D.	Associate Professor	Hyderabad
Sashideep Gutti, Ph.D.	Associate Professor	Hyderabad
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Rahul Nigam, Ph.D.	Associate Professor	Hyderabad
Subhash Narayan Karbelkar, Ph.D.	Associate Professor	Hyderabad
Srijata Dey, Ph.D.	Assistant Professor, Gr-I	Pilani
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Deepak Narayana Murthy Pachattu., Ph.D.	Assistant Professor, Gr-I	Goa

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Indrani Chakraborty, Ph.D.	Assistant Professor, Gr-I	Goa
Indrakshi Raychowdhury, Ph.D.	Assistant Professor, Gr-I	Goa
Arnab Roy, Ph.D.	Assistant Professor, Gr-I	Goa
Sanjib Dey, Ph.D.	Assistant Professor, Gr-I	Goa
Asrarul Haque, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Prasant Kumar Samantray, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Swastik Bhattacharya, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Davuluri Subrahmanya Bhima Sankar, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Subhadeep Roy, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Rickmoy Samanta, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Suvadip Das, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Prasand Anant Naik, Ph.D.	Visiting Professor	Goa
Arunav Kundu, Ph.D.	Visiting Professor	Goa

OTHER ACADEMIC STAFF		
Ranjan Sinha Thakur, Ph.D.	Librarian	Pilani
Jayachandran Krishnasamy, M.Phil	Librarian	Dubai
Deepak Mehta, M.PHIL.	Dy. Librarian	Pilani
Anupratim Ghosh, M.LIB.	Dy. Librarian	Pilani
Anuradha Voolapalli, Ph.D.	Dy. Librarian, Gr-I	Goa
Bidi Ramesh, M.Phil.	Asst. Librarian	Hyderabad
Pintu Modak, Ph.D.	Sr. Physical Education Officer	Pilani
Ajaykumar Rajpati Kewat, B.P.Ed.	Physical Education Instructor, Gr-II	Goa
Bhavesh Verma, Ph.D.	Physical Education Instructor	Pilani
Gnana Prasad Reddy M	Physical Education Instructor	Hyderabad

SCIENTISTS / PROFESSIONALS PARTICIPATING IN SPECIFIC COLLABORATIVE PROGRAMMES:

The list of scientistis / professionals from industries / collaborating organizations who are currently involved and actively participating in running specific collaborative programmes is given below:

BITS - Oracle India, Bangalore, Collaboration: M.Tech. Software Engineering

Organization Professionals:

Mr. Vinodkumar Chithambaram, Mr. Mukul Goswami

Guest Faculty

Prof Ajit Kumar Sarangi	Computer Science
Prof Nagarajan R	Computer Science

BITS – SAP Labs, Bangalore, Collaboration: M.Tech. Software Engineering

Organisation Professionals:

Markus Bell, Pooja Suresh, Zoya Kapoor

Guest Faculty

Mr. Ajay Misra, Ms. Anitha N, Mr. Badari Jallipalli, Mr. Bhaskar Zaminder, Mr. Bhupinder, Mr. K Bhaskar, Mr. Love Arora, Ms. Manjula Sanjay Koti, Ms. Meena, Ms. Mohana Murali, Ms. Neha Garg, Mr. Parthasarathy P D, Mr. R Chandrashekhar, Mr. Rajat Raghuvanshi, Ms. Sheetal, Mr. Srevats, Mr. Vadivelan, Mr. Vijayrajan

BITS - UTAS, Bangalore, Collaboration: M.Tech. Embedded Systems

Organization Professionals:

Basavaraj Gadigeppagoudar, Della Thomas

Guest Faculty:

Prof. Shirdinath Tekur, Mr. Ajay Sood

BITS - CISCO, Bangalore, Collaboration: M.Tech. Software Systems

Organization Professionals:

Mr. Vipin Thomas, Ms. Lalitha Balasubramanian

Guest Faculty

Prof. S Vagdevi	Computer Science
Prof. Channabasappa Heralgi	Computer Science
Mr. Siva Sankar Anumula	Computer Science
Mr. Kallol Pal	Computer Science
Mr.Jagadeesh B Kanade	Computer Science

BITS - CISCO, Bangalore Collaboration: M.Tech. Embedded Systems

Organization Professionals:

Mr. Srinivasa Krishnamachar, Sr. Director, Supply Chain Operations, Cisco

Guest Faculty

Mr.Arunkumar Jayaprakasam	Electronics
Mr.Krishnendu Mondal	Electronics

BITS - CISCO, Bangalore, Chennai, Pune, Gurgaon, Collaboration: M.Tech. Software Systems

Organization Professionals:

Mr. Christian Barrios, Director Human Resources, Cisco India and SAARC

Guest Faculty:

Mr. A M Prasad, Mr. Ashish Anand Kulkarni, Mr. Siddesh G M, Mr. KV Vamsi Krishna, Mr. SIDDESH G M

BITS-Avaya, Pune, Collaboration: M.Tech. Software Engineering

Organisation Professionals:

Mr. Anirban Mookerjee Mr. Saurabh Amikar

Guest Faculty:

Prof. Arun	Computer Science & Information Systems
Dr. Sunil Dhore	Computer Science & Information Systems
Prof. Sanjeev Pithambrer	Computer Science & Information Systems
Prof. Sourish Banerjee	Computer Science & Information Systems

BITS-Avaya, Pune, Collaboration: M.Tech. Data Science Engineering

Organisation Professionals:

Mr. Anirban Mookerjee Mr. Saurabh Amikar

Guest Faculty:

Mr. Kulkarni Milind Vasantrao, Mr. Deshmukh Sudarshan S., Mr. Manish Kumar Singh

BITS-HCL Technologies, Noida, Collaboration: B.Sc. Desogm & Computing

Guest Faculty:

Mr. M. Sriram, Mr. Gautham Sekar, Mr. M. Sugadev, Ms. C.L Shilaja, Mr. Hannah Sanala Mohan, Mr. S.UdhayaBaskaran, Mr. Chandrashekhar Prabhakaran, Ms. Nilanajana Goswami, Mr. S.Udhayabaskaran, Mr. Prashant Shukla

BITS – BOSCH, Across india

Organisation Professional:

Mr. Purayil Jinesh Kadavath

Guest Faculty:

Mr. Sankarakrishnan	Management
Mrs. Vaishali Pagaria	Management
Mr. Rahul Pratap Singh Kaurav	Management

BITS - Bharat Forge Limited, Pune, Collaboration: B.Tech. Manufacturing Technology

Organisation Professionals:

Mr.Amit Kalyani, Mr.Raju Kalyani, Dr. Raj Kumar Singh Dr. SV Bhave, Mr. G K Agarawal, Dr. Ajay Ingle

Guest Facutly:

Mr. Harish Deshpande	Mechanical
Mr. Anand Mahurkar	Mechanical
Mr. K Deshmukh,	Mechanical
Mr. Srikant Madiwale	Mechanical
Mr. Mukesh Ghogre	Instrumentation
Mr. N K Josh	Mechanical
Mr. Vikas Jadhav	Mathematics
Mr.Amjad Shaik	Mathematics
Mr. Mahadev Chowgule	Electrical & Electronics
Mr. Sandeep Wankhade	Mechanical

CLUSTER PROGRAMME, Pune: M.Tech. Embedded Systems

Guest Faculty:

Prof. S. S. Kendre	Electronics
Prof. Pawan Gupta	Computer Science & Information Systems
Prof. Pushkar Barve	Embedded System
Prof. Narendra Lakal	Mechanical
Prof. Anju Kulkarni	Electronics and Telecommunication
Prof. Pandit Jagtap	Electronics

CLUSTER PROGRAMME, Pune: M.Tech. Design Engineering

Organisation Professionals:

Dr. Raj Kumar Singh Mr. Jitendra Divgi

Guest Faculty:

Mr. N K Joshi	Mechanical
Mr. Ayaz Khan	Mechanical
Mr. Harish Deshpande	Mechanical
Dr. Umesh Chavan;	Mechanical
Dr. Suhas Deshmuk	Mechanical
Mr. Anand Mahulkar,	Mechanical
Mr. KW Deshmukh	Mechanical
Ms Sandhya Pande	Mechanical
Mr. Vikas Jadhav	Mathematics
Dr. Ganesh Kakandekar	Mechanical

BITS-JOHN DEEERE, Pune, Collaboration: M.Tech. Design Engineering; B.Tech. Engineering Technology

Organisation Professionals:

Mr. Lalit Ganwir

Guest Faculty

Mr. Prakash Pednekar	Mechanical
Mr. Prasad Deshpande	Mechanical
Mr. Amjad Sheikh	Mathematics
Mr. NK Joshi	Mechanical
Mr. Milind Ramgir	Mechanical
Dr. Suhas Deshmukh.	Mechanical

BITS - TACO India Ltd., Pune, Collaboration: B.Tech. Manufacturing Technology

Organisation Professionals:

Mr. Ajay Tondon, Mr. Siba Satapathy, Mr. Kanchan Kumar Biswas

Guest Facutly:

Mr Sunil Divekar	Mechanical,
Mr. Anand Mahurakar	Mechanical,
Mr. Amol Shinde	Mechanical,
Mr. Prasad Deshpande	Mechanical,
Mr. Mahadev Chougule	Electrical and Electronics,
Mr. Sandeep Wankhede	Mechanical,
Mr. Harish Deshpande	Mechanical,
Ms. Puja Awachat	Language

BITS - Tata Motor, Pune: Collaboration: M.Tech. Automatic Engineering

Organisation Professionals:

Mr. Sushant Routray, Ms. Anupama Shukla, Mr. Nishant Jaiswal

Guest facuty:

Dr. Benu Madhav	Mechanical
Dr. Ganesh Soni,	Mechanical
Mr. Sarvesh Mahajan,	Mechanical
Mr. Amol Shinde	Mechanical

BITS - Tata Motors (ERC), Pune: Collaboration: M.Tech. Automatic Engineering

Organisation Professionals:

Mr. Angsuman Sharma , Ms. Archana Saraf

Guest Faculty:

Mr. Vijay Sonawane	Mechanical
Mr. Girish Muraleedharakurup	Mechanical
Mr. Shrikant Madiwale	Mechanical
Ms. Sandhya Pande	Mechanical
Mr. Millind Ramgir	Mechanical
Ms. Yogeshri Gaidhani	Mathematics

BITS - Tata Motor, Pune: Collaboration: B.Tech. Manufacturing Technology

Organisation Professionals:

Mr. Gajendra Chandel , Mr. Mukund Vyas, Ms. C. Sneha

Guest faculty:

Mr. Satya Balaji	Mechanical
Mr. Amol Shinde	Mechanical
Mr. Sunil Divekar	Mechanical
Mr. Mahadev Chougule	Electrical & Electronics

BITS - Tata Motors (ERC), Pune: Collaboration: B.Tech. Engineering Technology

Organisation Professionals:

Mr. Angsuman Sharma , Ms. Archana Saraf , Mr. Ashish Sharma

Guest Faculty:

Mr. Amol Shinde	Mechanical
Mr. Sudhir Sindagi	Mechanical
Mr. Millind Ramgir	Mechanical

BITS - Mahindra Vehicles Manufacturing India Ltd., Pune, Collaboration: B.Tech. Manufacturing Technology

Organisation Professionals:

Ms. Shubangi Jagtap, Mr.Mahesh Karindkar,Mr. Sunil Mane.

Guest faculty:

Mr. Sandip Wankhade	Mechanical
Mr. Rahul Kale	Languages
Mr. Wallace Jacob	Management

BITS – Samsung, Noida, Collaboration: M.Tech. Software Systems

Organisation Professionals:

Ms. Anumeha

Guest Faculty:

Mr. Piyush Kulshreshtha- Computer Science & Information Systems

Mr. Sheshadri Chatterjee- Computer Science & Information Systems

Mr. Dhiraj K. Prasad - Computer Science & Information Systems;

BITS - Tata Technologies, Pune, Collaboration: M.Tech. Automotive Engineering

Organisation Professionals:

Mr. Subhendu Ghosh, Mr. Aditya Roy Choudhary, Mr. C. Surendra Nath, Ms. Anumeha Jain, Mr. Indranil Bhattacharya.

Guest faculty:

Dr. Sanjay Pohekar	Mechanical

BITS - Cummins India Ltd., Pune: Collaboration: B.Tech. Manufacturing Technology

Organisation Professionals:

Ms. Gayatri Phadke, Ms. Shabanam Pathan, Ms. Prerna Koppiker

BITS - Tata Motors Limited, Jamshedpur, Collaboration: B.Tech. Manufacturing Technology

Organisation Professionals:

Mr. Sampath Kumar Morri, Mr. Ravi Ranjan, Ms. Nilanjana Mohanty, Mr. Rajiv Ranjan.

Guest Faculty

Mr. Buntu Kumar	Mechanical
Mr. Ashutosh Tripathy	Mechanical
Mr. Subhashis Ghosh	Mechanical

Mr. Rakesh Kumar Sarangi (Electrical & Electronics)

BITS - Verizon Data Services Ltd, Chennai and Hyderabad, Collaboration: M.Tech. in Software Engineering

Organisation Professionals:

Mr. Jose Francis M, Ms. Anisha Joseph

Guest faculty:

Mr. Aravind Appan	Computer Science & Information Systems
Ms. Uma Ganesan	Computer Science & Information Systems
Mr. Mahavir	Computer Science & Information Systems
Mr. Muruganandam	Computer Science & Information Systems
Mr. Raja Chidambaram	Computer Science & Information Systems
Mr. M.J.Shankarraman	Computer Science & Information Systems
Mr. Vijaykumar Athithyan	Computer Science & Information Systems
Mr. Krishnamoorthy Rao	Computer Science & Information Systems
Mr. Balamurugan	Computer Science & Information Systems
Mr. Prabhu Sunderraman	Computer Science & Information Systems

BITS - Chennai Cluster Online Collaboration: M.Tech. in Design Engineering

Guest faculty:

Mr. Sankarakrishnan	Mechanical
Mr.Ven Holalkere	Mechanical

Delhi Cluster: M.Tech. Design Engineering & M.Tech. Embedded System

Guest Faculty

Mr. Amit Sharma	Mechanical

Dr. Ashish Aggarwal	Mechanical
Dr. Umang Soni	Mechanical
Dr. Girish Kumar	Mechanical
Mr. MD Zubair	Mechanical
Mr. Wasim Alram	Mechanical
Mr. GNS Harsha	Electrical & Electronics
Mr. Ravinder Kumar Chahar	Electrical & Electronics

BITS - Maruti Suzuki India Ltd, Gurgaon, Collaboration: B.Tech. Manufacturing Technology

Organization Professionals:

Mr. Deepak Kumar, Mr. L.K. Gupta, Mr. Devanshu Wadhawan, Mr. C D Sharma, Mr N. K. Das

Guest Faculty:

Dr. Umang Soni – Mechanical

Prof. Ashutosh Pandey – Mechanical

Mrs. Monika Garg – Mathematics

Prof. Imran Siraj – Computer Science & Information Systems

Mr Rahul Katna - Mechanical

BITS – BPCL, Mumbai, Collaboration: B.Tech. Process Engineering

Guest Faculty

Prof. Umesh Mahind	Electronics Engg
Prof. Ganesh Dhamal	Mathematics
Prof. Sonal Dhar	Mechanical Engg
Prof. Pramod Bide	Computer Science & Information Systems

BITS – Lupin Ltd., Mumbai, Collaboration: M.Tech. Pharmaceutical Operation and Management

Guest Faculty

Prof. Gokhale Jayanti	Computer Science & Information Systems
Mr. Viswanathan	Management

BITS - Wipro Infotech, Bangalore, Mumbai, Hyderabad, Mumbai, Gurgaon, Collaboration: M.Tech. Systems Engineering, and B.Tech. Information Systems.

Organisation Professionals:

Mr. Ajay Narayanan, Ms. Neha, Ms. Anchal Tripathi, Ms. Ashif Banu Abdul Razak, Ms. P. Monica Prisulla, Ms. Pinky Paresh Bhatt, Ms. Puhpanjali Patnaik.

BITS-Wipro Technologies, Bangalore, Chennai, Hyderabad, Kolkata, Pune, Mysore, Mumbai, Gurgaon, Kochi and Coimbatore.

Collaborations: M.Tech. Software Engineering, M Tech, Computing Systems & Infrastructure, M. Tech. in Software Systems, M.Tech. Microelectronics and B.Tech. Information Systems

Organisation Professionals:

Mr. P B Kotur, Mr. Thirunavukkarasu, Mr. Murali Punniyakodi, Mr. Satheesh Kumar, Mr. Santosh Sridhar, Mr. Nimesh Gala, Mr. Mukesh Verma, Ms. Rajani Satheesan.

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Prof. Santonu Sarkar
Prof. Srinivas Krishnaswamy
Prof. V.V.S.N.V. Prasad Chundru

Hyderabad Campus

Prof. A Sajeli Begum
Prof. I Sreedhar
Prof. Lalita Bhanu Murthy Neti
Prof. Murari Raja Raja Varma
Prof. N Suresh Kumar Reddy
Prof. Nishith Gupta
Prof. Rishi Kumar
Prof. Pradyumn Kumar Sahoo
Prof. Sarmishtha Banik
Prof. Shilpaa Anand
Prof. Sounak Roy
Prof. Subhendu Kumar Sahoo

Dubai Campus

Prof. Ramadoss Roop Kumar (PROF)
Prof. B G Prakash Kumar (PROF)
Dr. Priyank Upadhyaya (ASTP)
Prof. Vijayakumar Balakrishnan (PROF)
Prof. Neeru Sood (PROF)
Dr. Sartaj Rasool Rather (ASTP)
Prof. Kalaichelvi Venkatesan (PROF)
Dr. Vivek Balachandra Kartha (ASTP)

Co-opted Members:

Dr. Madhurima Das
Dr. Mayank Goel, K.K. Birla Goa Campus
Prof. Pradeep Kumar Sow, K.K. Birla Goa Campus
Dr. Dipanjan Chakraborty, Hyderabad Campus
Prof. Archana Srivastava, Hyderabad Campus
Dr. Murchana Changmai (ASTP), Dubai Campus
Dr. Brij Kishore Pandey (ASTP), Dubai Campus

Librarian:

Dr. Ranjan Sinha Thakur, Pilani Campus
Mr. K. Jayachandran, Dubai Campus

Chief Warden:

Prof. Rajesh Prasad Mishra, Pilani Campus
Prof. Sukanta Mondal, K.K. Birla Goa Campus
Prof. Phaneendra Kiran C, Hyderabad Campus
Mr. Harold Franklin, Dubai Campus

Workshop Superintendent:

Shri Rajiv Annarao Shinde, K. K. Birla Goa Campus

Student Member

Chaitanya Sethi, ID No. 2020B3A71961P, Pilani Campus
Zaid Noor, ID No. 2020A4PS0060U, Dubai Campus
Shah Rahil Kirankumar, ID No. 2020B2A71677G, K. K. Birla Goa Campus
Ribhu Jain, ID No. 2020A3PS0382H, Hyderabad Campus

RESEARCH BOARD

Chairman (Vice-Chancellor):

Prof. V Ramgopal Rao

Vice-Chairman-Dean Academic-Graduate Studies and Research (AGSR)

Prof. M B Srinivas

Secretary –Registrar

Col Soumyabrata Chakraborty (Retd)

Directors of all BITS campuses (ex-officio):

1. Prof. Sudhirkumar Barai, Pilani Campus
2. Prof. Srinivasan Madapusi, Dubai Campus
3. Prof. Suman Kundu, K K Birla Goa Campus
4. Prof. G. Sundar, Hyderabad Campus

Deputy Directors (ex-officio):

Vacant

Dean, Sponsored Research and Consultancy (ex-officio):

Prof. Sanket Goel

Faculty Members:

1 Prof. Poonam Goyal, Professor, Department of Computer Science & Information Systems, Pilani Campus

2 Prof. Syamantak Majumder, Associate Professor, Department of Biological Sciences, Pilani Campus

3 Prof. N. N. Ghosh, Professor, Department of Chemistry, K.K. Birla Goa Campus

4 Prof. Nitin Sharma, Associate Professor, Department of Electrical & Electronics Engineering, K.K. Birla Goa Campus

5 Prof. Amit Kumar Gupta, Professor, Department of Mechanical Engineering, Hyderabad Campus

6 Prof. A Sajeli Begum, Professor, Department of Pharmacy, Hyderabad Campus

7 Dr. Raja Muthalagu, Dubai Campus

8 Dr. Kalaichelvi Venkatesan, , Dubai Campus

ACADEMIC COUNSELLING BOARD

I. Pilani Campus:

Chairman: Associate Dean AUGS
Prof. Sachin U Belgamwar

Associate Dean AGSR
Prof. Shamik Chakraborty

Associate Dean, SWD
Prof. Navin Singh

Two Faculty Members
Dr. Gaurav Watts
Dr. Bharti Khungar

Two Student Members
Mr. Rishabh Mallik,
ID No. 2021B3A70990P
Ms. Shripurna Gangopadhyay,
ID No. 2020B1A70603P

II. K K Birla Goa Campus:

Chairman: Associate Dean AUGS
Prof. Biju K. Raveendran Nair

Associate Dean AGSR
Prof. Bharat Madhusudan Deshpande

Associate Dean, SWD
Prof. Angshuman Sarkar

Two Faculty Members
Prof. Shibu Clement,
Prof. Teny Theresa John

Two Student Members
Ms. Krupali Jadav
ID No. 2021B3A71612G
Mr. Divye Goel
ID No. 2021A7PS2908G

III. Hyderabad Campus:

Chairman: Associate Dean AUGS
Prof. Sridhar Raju

Associate Dean AGSR
Prof. Venkata Vamsi Krishna Venuganti

Associate Dean, SWD
Prof. Kannan Ramaswamy

Two Faculty Members
Prof. Prasanta Kumar Sahu
Prof. Sudha Radhika

Two Student Members
Mr. S Ananth,
ID No. 2021A7PS2809H
Ms. Kokil Singh,
ID No. 2020B1A72027H

IV. Dubai Campus:

Chairman: Associate Dean AUGS
Prof. Kumar Karuppusamy

Associate Dean AGSR
Prof. Ramanujam Karthikeyan

Associate Dean, SWD
Prof. Priti Bajpai

Two Faculty Members
Dr. Sunil Thomas
Dr. Deepthi Mary Dilip

Two Student Members
Mr. Cyril Binoy Skariah
ID No. 2020A4PS044U
Ms. Vetha Varshini B P
ID No. 2020A2PS0157U

ACADEMIC MONITORING BOARD

Chairman : Dean, WILPD: Prof. S. Gurunarayanan **Associate Deans, WILPD:** Prof. P. Srinivasan Prof. Anupama Karuppiah Prof. Punna Rao Ravi Prof. Sridhar Raju Prof. Gopalakrishnan Venkiteswaran Prof. Venkataraman P.B.	**Dean, Academic – Under Graduate Studies (AUGS)** Prof. Ajit Pratap Singh **Dean, Practice School Division** Prof. Sinivasa Prakash Regalla **Dean, Academic - Graduate Studies and Research** Prof. M B Srinivas **Associate Dean Academic - Under Graduate Studies (AUGS) (Pilani Campus)** Prof. Sachin U Belgamwar

STANDING COMMITTEE FOR STUDENTS' DISCIPLINE

I. Pilani Campus	**II. K K Birla Goa Campus**
Chairman: Associate Dean, SWD Prof. Navin Singh **Chief Warden:** Prof. Rajesh Prasad Mishra **Faculty Members (2):** 1. Prof. Sushila Shekhawat 2. Prof. Paritosh Shukla **Student Member (2):** 1. Mr. Kamal Chauhan, ID No. 2020B2AA1403P 2. Ms. Aarushi Roy, ID No. 2020ABPS1855P	**Chairman: Associate Dean, SWD** Prof. Angshuman Sarkar **Chief Warden:** Prof. Sukanta Mondal Faculty Members (2) 1. Dr. Bidisha Banerjee 2. Dr. Gautam Guruprada Bacher Student Member (2): 1. Ms. Kuhu Gupta ID No. 2020B4A71524G 2. Mr. Ansh Gupta ID No. 2020A8PS1506G
III. Hyderabad Campus	**IV. Dubai Campus**
Chairman: Associate Dean, SWD Prof. Kannan Ramaswamy **Chief Warden:** Prof. Phaneedra Kiran Chaganti **Faculty Members (2):** 1. Prof. Arkamitra Kar 2. Prof. Amrita Priyadarshini **Student Member (2):** 1. Mr. Aryan Vatsa, ID No. 2020A3PS2124H 2. Ms. Shreya Boggarapu, ID No. 2020AAPS1335H	**Chairman: Dean, SWD** Prof. Priti Bajpai **Chief Warden:** Mr Harold Franklin **Faculty Members (2):** 1. Dr. Maneesha 2. Dr. Sayantan Chakraborty **Student Member (2):** 1. Mr. Samay Kalpesh Patel, 2020A7PS0064U 2. Ms Kirmi Harikrishnabhai Joshi, 2020A9TS0195U

LIBRARY COMMITTEE

I. Pilani Campus:

Department	Name of the member
Biological Sciences	Dr. B. Vani
Civil Engineering	Dr. Sayantan Chakraborty
Chemical Engineering	Dr. Sarbani Ghosh
Chemistry	Dr. Prashant U Manohar
Computer Science & Information Systems	Dr. Bharat Richhariya
Economics & Finance	Dr. Debi Prasad Bai
Electrical & Electronics Engineering	Dr. Rahul Kumar
Humanities and Social Sciences	Dr. Prateek
Mathematics	Dr. Krishnendra Shekhawat
Mechanical Engineering	Dr. Girish Kant Garg
Management	Dr. Rajesh Matai
Pharmacy	Dr. Paul Atish Tulshiram
Physics	Dr. Sandipan Dutta

Dr. Ranjan Sinha Thakur (Librarian) - Chairman of the Library Committee

II. K K Birla Goa Campus:

1.	Biological Sciences	Dr. Tusar Tirtha Saha
2.	Chemical Engineering	Prof. Vivek Rangarajan
3.	Chemistry	Dr. Subhasish Roy
4.	Computer Science & Information Systems	Dr. A. Baskar
5.	Economics	Prof. Aswini Kumar Mishra
6.	Electrical & Electronics Engineering	Prof. Ashish Chittora
7.	Humanities and Social Sciences	Dr. Bidisha Banerjee
8.	Mathematics	Prof. Palla Danumjaya
9.	Mechanical Engineering	Dr. Vadiraj Anant Hemadri
10.	Physics	Prof. Chandradew Sharma

Dr. Anuradha V (Deputy Librarian) - Chairman of the Library Committee

III. Hyderabad Campus:

S.N.	Department	Name of the member
1.	Biological Sciences	Prof. Amartya Sanyal
2.	Chemical Engineering	Prof. D Purnima
3.	Chemistry	Dr. Arijit Mukherjee
4.	Civil Engineering	Prof. Vasan A
5.	CS & IS	Dr. Nikumani Choudhury
6.	Economics & Finance	Dr. Nivedita Sinha
7.	EEE	Dr. Sumit Kumar Chtterjee
8.	Humanities & Social Sciences	Prof. Maya Vinai
9.	Mathematics	Prof. PTV Praveen Kumar
10.	Mechanical Engineering	Prof. Nandanavanam Jalaiah
11.	Pharmacy	Dr. Abhijeet Rajendra Joshi
12.	Physics	Dr. D S Bhima Sankar

Shri Ramesh Bidi (Assistant Librarian) - Chairman of the Library Committee

IV. Dubai Campus:

S.N.	Department	Name of the member
1.	Biotechnology	Dr. Mainak Dutta
2.	Chemical Engineering	Dr. Nishant Harishbhai Pandya
3.	Civil Engineering	Dr. Meghana Charde
4.	Computer Science	Dr. Elakkiya Rajasekar
5.	Electrical & Electronics Engineering, Electronics and Communication Engineering and Electronics and Instrumentation Engineering	Dr. Vilas Haridas Gaidhane
6.	General Sciences	Dr. Baskaran Sriramulu
7.	Humanities and Social Sciences	Dr. Sourjo Mukherjee
8.	Mechanical Engineering	Dr. Majid Hassan Khan

Mr. K. Jayachandran (Librarian) - Chairman of the Library Committee

ACADEMIC GOVERNING COMMITTEE

Dean, Academic – Under Graduate Studies

Prof. Ajit Pratap Singh

Associate Dean, Academic–Undergraduate Studies from each campus

Prof. Sachin U Belgamwar, Pilani Campus
Prof. Biju K. Raveendran Nair, K K Birla Goa Campus
Prof. Sridhar Raju, Hyderabad Campus
Prof. Kumar Karuppusamy, Dubai Campus

Dean, Practice School Divison

Prof. Srinivasa Prakash Regalla, Hyderabad Campus

Dean, Academic - Graduate Studies and Research

Prof. M B Srinivas

Dean, Work Integrated Learning Programmes Division

Prof. S. Gurunarayanan

Professor-incharge BITS Entrance Examinations

Prof. Chittranjan Hota, Hyderabad Campus

Associate Dean, Academic–Graduate Studies and Research from each campus

Prof. Shamik Chakraborty, Pilani Campus
Prof. Bharat Madhusudan Deshpande, K K Birla Goa Campus
Prof. Venkata Vamsi Krishna Venuganti, Hyderabad Campus
Prof. Ramanujam Karthikeyan, Dubai Campus

DOCTORAL COUNSELLING COMMITTEE

Dean, Academic - Graduate Studies and Research (AGSR)

Prof. M B Srinivas

Dean, Sponsored Research and Consultancy

Prof. Sanket Goel

Dean, Academic–Undergraduate Studies (AUGS)

Prof. Ajit Pratap Singh

Associate Dean, AGSR of each campus

Prof. Shamik Chakraborty, Pilani Campus
Prof. Bharat Madhusudan Deshpande, K K Birla Goa Campus
Prof. Venkata Vamsi Krishna Venuganti, Hyderabad Campus
Prof. Ramanujam Karthikeyan, Dubai Campus

One faculty member from each campus to be nominated by the Senate for a period of two years

1. Prof. Deepak Chitkara, Pilani Campus
2. Prof. Shibu Clement, K K Birla Goa Campus
3. Prof. Srikanta Dinda, Hyderabad Campus
4. Dr. Mainak Dutta, Dubai Campus

Convenorship rotates amongst these members depending on the item to be discussed

ADMISSIONS COMMITTEE

Chairman –Vice-Chancellor

Prof. V Ramgopal Rao

Members

Director, Pilani Campus

Prof. Sudhirkumar Barai

Director, K K Birla Goa Campus

Prof. Suman Kundu

Director, Hyderabad Campus

Prof. G. Sundar

Director, Dubai Campus

Prof. Srinivasan Madapusi

Convenor: Professor-incharge BITS Entrance Examinations

Prof. Chittaranjan Hota

Special Invitees:

Dean (AGSR)

Prof. M B Srinivas

Dean (AUGS)

Prof. Ajit Pratap Singh

Faculty-incharge (First Degree Admission Tests)

Prof. Vishal Gupta

Faculty-incharge (Higher Degree Admission Tests)

Prof. Atish T. Paul

Associate Dean (AUGS) Dubai Campus

Prof. Kumar Karuppusamy

ACADEMIC CALENDAR FOR PILANI CAMPUS

SOME IMPORTANT DATES

2023

JULY

Su	M	T	W	Th	F	S
30	31					1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

AUGUST

Su	M	T	W	Th	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

SEPTEMBER

Su	M	T	W	Th	F	S
					1	2
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17	18	19	20	21	22	23
24	25	26	27	28	29	30

OCTOBER

Su	M	T	W	Th	F	S
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15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

NOVEMBER

Su	M	T	W	Th	F	S
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12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

DECEMBER

Su	M	T	W	Th	F	S
31					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

2024

JANUARY

Su	M	T	W	Th	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
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21	22	23	24	25	26	27
28	29	30	31			

FEBRUARY

Su	M	T	W	Th	F	S
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11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29		

MARCH

Su	M	T	W	Th	F	S
31					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

APRIL

Su	M	T	W	Th	F	S
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MAY

Su	M	T	W	Th	F	S
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JUNE

Su	M	T	W	Th	F	S
30						1
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16	17	18	19	20	21	22
23	24	25	26	27	28	29

HOLIDAYS RECESS

First Semester 2023-2024

July 4 (T) - 2023	Registration for Practice School II
July 4 (T)	Practice School II begins
July 29 (S)	Muharram (H)
August 10 (Th)	Freshmen Orientation
August 11 (F)	First Semester begins
August 11 (F)	Registration for all students
August 12 (S)	Class-work begins
August 15 (T)	Independence Day (H)
August 23 (W)	Last day for substitution of courses
August 30 (W)	Raksha Bandhan (Rakhi) (H)
September 07 (Th)	Janmashtami (H)
September 19 (T)	Ganesh Chaturthi (H)
September 28 (Th)	Id-e-Milad (H)
October 02 (M)	Mahatma Gandhi's Birthday (H)
October 09 (M) to October 14 (S)	Mid Semester Exams
October 19 (Th)	Last day for withdrawal from courses
October 21 (S)	Last day of returning evaluated answer scripts of Mid-Semester Test
October 24 (T)	Dussehra (H)
October 30 (M)	Last day of Mid-Semester grading
November 11 (S)	Diwali (H)
November 12 (Su)	Diwali (H)
November 27 (M)	Gurunanak's Birthday (H)
November 30 (Th)	Last day of Pre-comprehensive marks display
December 04 (M)	Last day of class work
December 06 (W)	Comprehensive examination begins
December 21 (Th)	Comprehensive examination ends
December 21 (Th)	Practice School II ends
December 21 (Th)	First Semester ends
December 22 (F) - January 08 (T)	Recess
December 25 (M)	Christmas (H)

Second Semester 2023-2024

January 9 (T) - 2024	Second Semester begins
January 9 (T)	Registration for all students
January 9 (T)	Registration for Practice School II
January 10 (W)	Practice School II begins
January 10 (W)	Class-work begins
January 15 (M)	Makar Sakranti (H)
January 22 (M)	Last day for substitution of courses
January 25 (Th)	Friday timetable is to be followed
January 26 (F)	Republic Day (H)
February 14 (W)	Basant Panchami and Founder's Day (H)
March 08 (F)	Maha Shivratri (H)
March 11 (M) to March 16 (S)	Mid Semester Exams
March 19 (T)	Last day for withdrawal from courses
March 21 (Th)	Friday timetable is to be followed
March 21 (Th)	Last day of returning evaluated answer scripts of Mid-Semester Test
March 25 (M)	Holi (H)
March 27 (W)	Last day of Mid-Semester grading
March 28 (Th)	Friday timetable is to be followed
March 29 (F)	Good Friday (H)
April 11 (Th)	Id-ul-Fitr* (H)
April 14 (Su)	Ambedkar Jayanti (H)
April 17 (W)	Ram Navami (H)
April 21 (Su)	Mahavir Jayanti (H)
April 22 (M)	Registration for Practice School I
April 27 (S)	Last day of Pre-comprehensive marks display
May 03 (F)	Last day for class work
May 06 (M)	Comprehensive Examination begins
May 20 (M)	Comprehensive Examination ends
May 20 (M)	Second Semester ends
May 23 (Th)	Budhha Purnima (H)
May 27 (M)	Summer Vacation begins
May 28 (T)	Summer Term begins
May 28 (T)	Practice School I begins
June 17 (M)	Id-ul-Zuha* (H)
June 20 (Th)	Practice School II ends
July 23 (T)	Practice School I ends
July 23 (T)	Summer Term ends
July 25 (Th)	Summer Vacation ends

*** Observance of the Holiday is subject to the sighting of the Moon**

ACADEMIC CALENDAR FOR K. K. BIRLA GOA CAMPUS

SOME IMPORTANT DATES

2023

JULY

Su	M	T	W	Th	F	S
30	31					1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

AUGUST

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SEPTEMBER

Su	M	T	W	Th	F	S
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24	25	26	27	28	29	30

OCTOBER

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22	23	24	25	26	27	28
29	30	31				

NOVEMBER

Su	M	T	W	Th	F	S
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26	27	28	29	30		

DECEMBER

Su	M	T	W	Th	F	S
31					1	2
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10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

2024

JANUARY

Su	M	T	W	Th	F	S
	1	2	3	4	5	6
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21	22	23	24	25	26	27
28	29	30	31			

FEBRUARY

Su	M	T	W	Th	F	S
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18	19	20	21	22	23	24
25	26	27	28	29		

MARCH

Su	M	T	W	Th	F	S
31					1	2
3	4	5	6	7	8	9
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17	18	19	20	21	22	23
24	25	26	27	28	29	30

APRIL

Su	M	T	W	Th	F	S
	1	2	3	4	5	6
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21	22	23	24	25	26	27
28	29	30				

MAY

Su	M	T	W	Th	F	S
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19	20	21	22	23	24	25
26	27	28	29	30	31	

JUNE

Su	M	T	W	Th	F	S
30						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

HOLIDAYS RECESS

First Semester 2023-2024

July 4 2023 (T)	Registration for Practice School II
July 4 (T)	Practice School II begins
July 29 (S)	Muharram(H)
August 10 (Th)	Freshmen Orientation
August 11 (F)	First Semester begins
August 11 (F)	Registration for all students
August 12 (S)	Class-work begins
August 15 (T)	Independence Day(H)
August 23 (W)	Last day for substitution of courses
August 30 (W)	Raksha Bandhan(H)
September 7 (Th)	Janmashtami (H)
September 15 (F)	Last day for submission of Application for Merit-Cum Need Scholarship (2022 batch onwards)
September 19 (T)	Ganesh Chaturthi(H)
September 28 (Th)	Id-E-Milad (H)
October 2 (M)	Mahatma Gandhi's Birthday (H)
October 08 (Su) to October 15 (Su)	Mid-semester Exam(Class-work suspended)
October 15(Su)	Last day for submission of Application for Merit-Cum Need Scholarship (2021 batch and earlier)
October 19 (Th)	Last day for withdrawal from courses
October 21 (S)	Last day of returning evaluated answer scripts of Mid-Semester Exam
October 24 (T)	Dussehra (H)
October 27 (F) - 29 (Su)	Waves
October 30 (M)	Non instructional day
November 11(S)-12 (Su)	Diwali (H)
November 27 (M)	Guru Nanak's Birthday (H)
November 30 (Th)	Last day of Pre-comprehensive exam marks display
December 04 (M)	Last day for class work
December 06 (W)	Comprehensive Examination begins
December 19 (T)	Goa Liberation Day(H)
December 21 (Th)	Practice School II ends
December 21 (Th)	Comprehensive Examination ends
December 21 (Th)	First Semester ends
December 25 (M)	Christmas (H)
December 22 (F) - January 08 2024(M)	Recess

Second Semester 2023-2024

January 9 (T)-2024	Second Semester begins
January 9 (T)	Registration for Practice School II
January 9 (T)	Practice School II begins
January 10 (W)	Class-work begins
January 15 (M)	Makar Sakranti (H)
January 22 (M)	Last day for substitution of courses
January 26 (F)	Republic Day (H)
February 15 (Th)	Last day for submission of Application for Merit-Cum Need Scholarship (2022 batch onwards)
March 08 (F)	Maha Shivratri (H)
March 10 Su) to March 17 (Su)	Mid Semester Exams (Class-work supended)
March 19 (T)	Last day for withdrawal from courses
March 23 (S)	Last day of returning evaluated answer scripts of Mid-Semester Exam
March 25 (M)	Holi (H)
March 27 (W)	Friday timetable is to be followed
March 29 (F)	Good Friday (H)
April 11 (Th)	Id-ul-Fitr (H)*
April 14 (Su)	Ambedkar Jayanti (H)
April 15 (M)	Last day for submission of Application for Merit-Cum Need Scholarship (2021 batch and earlier)
April 17 (W)	Ram Navami (H)
April 18 (Th)	Monday's timetable is to be followed
April 21 (Su)	Mahavir Jayanti (H)
April 22 (M)	Registration for Practice School I
April 27 (S)	Last day of Pre-comprehensive marks display
May 03 (F)	Last day for class work
May 06 (M)	Comprehensive Examination begins
May 20 (M)	Comprehensive Examination ends
May 20 (M)	Second Semester ends
May 23 (Th)	Budhha Purnima (H)
May 27 (M)	Summer Vacation begins
May 28 (T)	Summer Term begins
May 28 (T)	Practice School I begins
June 17 (M)	Id-ul-Zuha* (H)
June 20 (Th)	Practice School II ends
July 23 (T)	Summer Term ends
July 23 (T)	Practice School I ends
July 25 (Th)	Summer Vacation ends

* Observance of the Holiday is subject to the sighting of the Moon

ACADEMIC CALENDAR FOR HYDERABAD CAMPUS

SOME IMPORTANT DATES

2023

JULY

Su	M	T	W	Th	F	S
30	31					1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

AUGUST

Su	M	T	W	Th	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

SEPTEMBER

Su	M	T	W	Th	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

OCTOBER

Su	M	T	W	Th	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

NOVEMBER

Su	M	T	W	Th	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

DECEMBER

Su	M	T	W	Th	F	S
31					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

2024

JANUARY

Su	M	T	W	Th	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

FEBRUARY

Su	M	T	W	Th	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29		

MARCH

Su	M	T	W	Th	F	S
31					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

APRIL

Su	M	T	W	Th	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

MAY

Su	M	T	W	Th	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

JUNE

Su	M	T	W	Th	F	S
30						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

HOLIDAYS RECESS

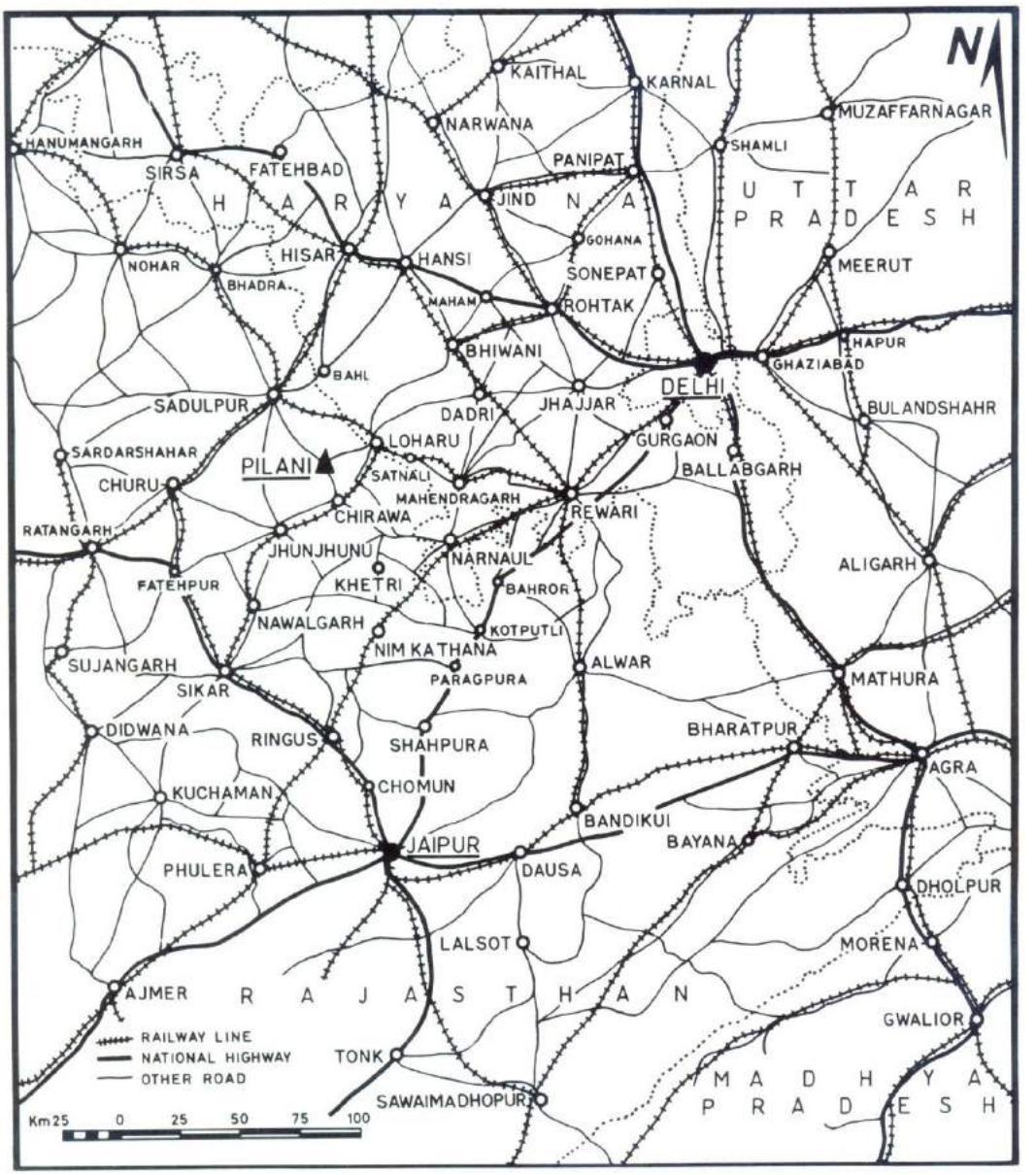
First Semester 2023-2024

July 4 (T)	Registration for Practice School II
July 4 (T)	Practice School II begins
July 29 (S)	Muharram
August 10 (Th)	Freshmen Orientation
August 11 (F)	First Semester begins
August 11 (F)	Registration for all students
August 12 (S)	Class-work begins
August 15 (T)	Independence Day
August 23 (W)	Last day for substitution of courses
August 30 (W)	Raksha Bandhan (H)
September 7(Th)	Janmashtami (H)
September 19 (T)	Ganesh Chaturthi (H)
September 28 (Th)	Id-e-Milad (Prophet Mohammad's Birthday)(H)
October 02 (M)	Mahatma Gandhi's Birthday (H)
October 09 (M) to October 14 (S)	Mid Semester Exams
October 19 (Th)	Last day for withdrawal from courses
October 21 (S)	Last day of returning evaluated answer scripts of Mid-Semester Test
October 24 (T)	Dussehra (H)
October 25 (W)	Tuesday Timetable to be followed
October 30 (M)	Last day of Mid-Semester grading
November 11(S)-12(Su)	Diwali (H)
November 27 (M)	Gurunanak's Birthday (H)
November 30 (Th)	Last day of Pre-comprehensive marks display
December 04 (M)	Last day of class work
December 06 (W)	Comprehensive examination begins
December 21 (Th)	Comprehensive examination ends
December 21 (Th)	Practice School II ends
December 21 (Th)	First Semester ends
December 25 (M)	Christmas (H)
December 22 (F) - January 08 (M)	Recess

Second Semester 2023-2024

January 9 (T)	Second Semester begins
January 9 (T)	Registration for all students
January 9 (T)	Registration for Practice School II
January 10 (W)	Practice School II begins
January 10 (W)	Class-work begins
January 15 (M)	Makar Sankranti (H)
January 22 (M)	Last day for substitution of courses
January 25 (Th)	Friday Timetable to be followed
January 26 (F)	Republic Day (H)
March 8 (F)	Maha Shivratri (H)
March 11(M) to March 16 (S)	Mid Semester Exams
March 19 (T)	Last day for withdrawal from courses
March 21 (Th)	Last day of returning evaluated answer scripts of Mid-Semester Test
March 23 (S)	Monday Timetable to be followed
March 25 (M)	Holi (H)
March 27 (W)	Last day of Mid-Semester grading
March 29 (F)	Good Friday (H)
April 9 (T)	Ugadi (H)
April 10 (W)	Monday Timetable to be followed
April 11 (Th)	Id-ul-Fitr*(H)
April 14 (Su)	Ambedkar Jayanti (H)
April 17 (W)	Ram Navami (H)
April 21 (Su)	Mahavir Jayanti (H)
April 22 (M)	Registration for Practice School I
April 27 (S)	Last day of Pre-comprehensive marks display
May 03 (F)	Last day for class work
May 06 (M)	Comprehensive Examination begins
May 20 (M)	Comprehensive Examination ends
May 20 (M)	Second Semester ends
May 23 (Th)	Buddha Purnima (H)
May 27 (M)	Summer Vacation begins
May 28 (T)	Summer Term begins
May 28 (T)	Practice School I begins
June 17 (M)	Id-ul-Zuha (H)
June 20 (Th)	Practice School II ends
July 23 (T)	Practice School I ends
July 23 (T)	Summer Term ends
July 25 (Th)	Summer Vacation ends

* Observance of the Holiday is subject to the sighting of the Moon



ROUTE TO PILANI

Cultivating Talent Since 1964 and Redefining the Academic Excellence

- Institution of Eminence conferred by Ministry of Education, Government of India
- BITS School of Management (BITSoM) launched in Mumbai campus in 2021
- BITS Law School will be launched in 2023 in Mumbai
- NIRF 2023- University Rank: 20 and Pharmacy Rank: 3
- QS World University Subject Rankings 2024, ranked in 9 subjects with Pharmacy topping the list at a World rank of 101-150 and an India rank of 2.
- Top class faculty, with doctoral and post-doctoral experience in leading world class universities
- 17,500+ on-campus students across 5 campuses
- Curriculum offers hands-on experiential learning and humanities orientation
- Unique Dual-degree option
- Merit and need-based scholarship for UG, PG students
- 72,000 on-campus alumni and over 1.10 L alumni from the Work Integrated Learning Program
- Over 7400 BITSian founders/co-founders of startups globally
- 170 start-ups since inception through Technology Business Incubators in Pilani, Goa and Hyderabad campuses

Setting New Benchmarks in R&D

- Enhanced research outcome, 1800+ doctoral students
- Fast growing sponsored research eco-system
- Technology business incubators and entrepreneurship cell in each campus
- Recipient of Rs 125 Cr DST Grant on Bio-CPS under the NM-ICPS Scheme. Only non-Govt Institute to receive this grant.

Empowering the Industrial Professionals through Formal Education

- Over 44 programs
- Tie up with more than 200 companies
- 37,600+ industry professionals enrolled for a formal degree
- Flexible course programs throughout the academic year

Hand in hand with Leading Global Corporates

- Industry engagement is one of the cornerstones of the educational philosophy through its practice based curriculum and pedagogy, research and consultancy
- Over 1750 pre-placement offers in 2022-23 through Practice School 2
- Industry participation in curriculum design and review
- Unique 7 months industry immersion embedded in the curriculum
- Record of impeccable domestic and International placement

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2023-2024
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