

Higher Degree

(Electrical and Electronics Engineering Department)

M.E. in Communication Engineering

M.E. in Embedded Systems

M.E. in Microelectronics



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The department of EEE offers three extensive and rigorous streams for the students of higher degree. The students are exposed to plethora of cutting edge technologies, that are on par with industrial standards in the form of coursework and projects which in turn expose them to the current trends in the industry. The students also undertake a research practice course to understand various practices followed in the Research field under the guidance of an experienced faculty from the department. The students with inclination towards research are also given the opportunity of registering for research oriented courses in the cutting edge technological domains. The students also undertake a research practice and are given an opportunity to be a part of practice school or dissertation depending upon their interests. The practice school also offers the opportunity for securing pre-placement offers for students.

The institute provides plethora of opportunities for placements in diverse technological application areas, including software and core based leading industries. The department is well equipped with state-of-the art laboratories in the field of communication engineering, microelectronics and embedded systems.

The HD courses is particularly designed to hone the skill sets of the students in the following cutting edge technology. Specially, the HD courses offer exposure to state of-the art numerical simulation tools in the areas of Device, Circuit and Systems. Furthermore, the hardware based laboratory components offers hands-on-exposure on Antenna Design, FPGA/Microcontroller based System Design, Microelectronic Fabrication techniques.



# A few of our Recruiters

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# ME Laboratory Infrastructure: at Hyderabad Campus.

- Analog IC Design Lab
- Communication Systems Lab
- Embedded System Design Lab
- Internet of Things Lab
- Microelectronics Circuits Lab
- Mobile and Personal Communications Lab
- Optical Communication Lab
- RF & Microwave Engineering Lab
- Signals and Systems Lab



# **ME Simulation Tool Sets**



# **ME Communication Engineering**

# **Overview:**

With the proliferation of wireless communication-based technologies and systems in our everyday life, communication engineering has been one of the most significant streams in the present academic and industrial scenario. The course structure offered by the institute covers the detailed fundamental technological aspects of communication engineering as well as the state-of-the-art communication standards suitable for R&D of the leading companies working in both software and hardware domains, defense and space-related organizations and to pursue higher studies in the leading institutes worldwide.

# **Course Structure**

	Semester 1		Semester II	
	Course	Credits	Course	Credits
Year I	EEE G613 Advance Digital Signal Processing	5	BITS G540 Research Practice	4
	EEE G581 RF and Microwave Engineering	5	EEE G592 Mobile and Personal Communication	5
	EEE G612 Coding Theory and Practice	5	EEE G622 Advanced Digital Communication	5
	Elective 1	*	Elective 2	*
		17		17

	Semester 1		Semester II	
Year II	Course	Credits	Course	Credits
	EEE G591 Optical Communication	*	BITS G629T Dissertation BITS G639 Practice School	16/20
	Elective 3	*		
	Elective 4	*		
	Elective 5	*		
		14		16/20

# **Core Courses**

- EEE G613 Advance Digital Signal Processing
- EEE G581 RF and Microwave Engineering
- EEE G612 Coding Theory and Practice
- EEE G592 Mobile and Personal Communication
- EEE G622 Advanced Digital Communication
- EEE G591 Optical Communication
- BITS G540 Research Practice

# **Elective Courses (any five)**

- BITS F415 Introduction to MEMS
- BITS G553 Real Time Systems
- BITS G554 Data Compression
- CS F303 Computer Networks
- CS F401 Multimedia Computing

- CS F413 Internetworking Technologies
- CS G541 Pervasive Computing
- CS G553 Reconfigurable
   Computing
- CS G555 Systems Specification

andModeling

- EEE F414 Telecom Switching Systemsand Networks
- EEE F472 Satellite Communication
- EEE F474 Antenna Theory and Design
- EEE G510 RF Microelectronics
- EEE G512 Embedded System Design
- EEE G521 Optoelectronic Devices, Circuits and Systems
- EEE G522 Advanced SatelliteCommunication
- EEE G582 Telecom NetworkManagement
- EEE G626 Hardware Software Co-Design
- EEE G627 Network EmbeddedApplication
- IS F462 Network Programming
- MEL G621 VLSI Design
- MEL G622 Introduction to ArtificialNeural networks

# **ME Embedded Systems**

# **Overview:**

Embedded systems are found in many of the products that we use every day, from television sets to copiers. Embedded systems range from those low in complexity, with a single microcontroller chip, to very high with multiple units, peripherals and networks. The combination of computer science (software) and electrical engineering (hardware) in these types of equipment requires an integrated approach towards the design process. That in turn requires a new type of engineer who has a knowledge of both software and hardware. This ME program in Embedded Systems offered by the institute provides a thorough understanding of the embedded system design process, from concept to implementation and testing. It also provides strong hardware design skills and software development knowledge along with the interface standards backed with application-led modules. This program acts as a Launchpad to work in various embedded industries and to pursue higher studies.

	Semester 1		Semester II	
	Course	Credits	Course	Credits
Year I	EEE G553 Real Time Systems	5	BITS G540 Research Practice	4
	EEE G512 Embedded System Design	4	CS G523 Software for Embedded	5
			Systems	
	Elective 1	*	MEL G642 VLSI Architecture	5
	Elective 2	*	Elective 3	*
		17		18
	Semester 1		Semester II	
	Course	Credits	Course	Credits
	EEE 626 Hardware Software Co-	5	BITS G629T Dissertation	16/20
Year II	Design			
	Elective 4	*		
	Elective 5	*	BITS G639 Practice School	
	Elective 6	*		
		17		16/20

# **Course Structure**

# **Core Courses**

- 1. EEE G553 Real Time Systems
- 2. EEE G512 Embedded System Design
- 3. CS G523 Software for Embedded Systems
- 4. MEL G642 VLSI Architecture
- 5. EEE 626 Hardware Software Co-Design
- 6. BITS G540 Research Practice

# **Elective Courses (any six)**

- BITS F415 Introduction to MEMS
- CS G541 Pervasive Computing

- CS G553 Reconfigurable Computing
- CS G611 Distributed Processing Systems
- CS G612 Fault Tolerant
   System Design
- EEE F434 Digital Signal Processing
- EEE G547 Device Drivers
- EEE G594 Advanced VLSI
   Devices
- EEE G595 Nano electronics and Wano photonics

- EEE G613 Advanced Digital Signal Processing
- EEE G625 Safety Critical EmbeddedSystem Design
- EEE G627 Network Embedded Application
- MEL G531 Testable Design and FaultTolerant Computing
- MEL G621 VLSI Design
- MEL G622 Introduction to ArtificialNeural Networks
- MEL G623 Advanced VLSI Design
- MEL G624 Advanced VLSI Architectures
- MEL G626 VLSI Test and Testability
- MSE G511 Mechatronics

# **ME Microelectronics**

# **Overview:**

The ever-increasing footprint of microelectronic circuits in everyday life is rapidly increasing the demand for well-trained professionals in the microelectronic industry at different technological levels. At the same time, swiftly evolving research scenarios in microelectronics set advanced technological knowledge and skill-sets as basic requirements for aspiring researchers. The ME (Microelectronic) course structure has been carefully designed to cater to the requirements of both industry and academia in the national and global contexts.

# **Course Structure:**

	Semester 1		Semester II	
Year I	Course	Credits	Course	Credits
	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	5	MEL G641 CAD for IC Design	5
	Microelectronic Devices		-	
	Elective 1	*	Elective 2	*
		19		18
	Semester 1		Semester II	
Year II	Course	Credits	Course	Credits
	Elective 3	*	BITS G629T Dissertation	16/20
	Elective 4	*		
	Elective 5	*	BITS G639 Practice School	
	Elective 6	*		
		13		16/20

# **Core Courses:**

- MEL G611 IC Fabrication Technology
- MEL G621 VLSI Design
- MEL G631 Physics and Modelling of Microelectronic Devices
- MEL G632 Analog IC Design
- MEL G641 CAD for IC Design
- BITS G540 Research Practice

# Electives (any six):

- BITS F415 Introduction to MEMS 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
- EEE F434 Digital Signal Processing 3 1 4
- EEE G510 RF Microelectronics 5
- EEE G512 Embedded System Design 3 1 4
- EEE G522 Advanced Satellite Communication 5
- EEE G572 Digital Signal Processing 3 2 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
- MEL G512 Optoelectronic Devices Circuits and Systems 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

# **Detailed Course Contents**

# Core Courses: Communication Engineering

#### EEE G613 Advanced Digital Signal Processing

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 variancealgorithm, stochastic approximation method and maximum likelihood method, simultaneousstate and parameter estimation of extended kalman-filter, non-linear identification, quasi linearization, numerical identification methods.

#### EEE G581 RF & Microwave Engineering

Introduction to radio frequency engineering; advantages; various frequency bands; propagation; transmission lines; microwave waveguides an components; theircharacterizations; s-parameters and their use; microwave transistor; FETs, Gunn diode, IMPATT diode s; microwave tubes; Klystron; two cavity Klystron amplifier analysis; reflex Klystron; TWTs; high power tubes; cross field tubes; microstrip lines; MMICs; microwave measurements; microwave antennas and microwave communication system; microwave applications; ISM applications; introduction to EMI and EMC; microwave hazards.

#### EEE G612 Coding Theory & Practice

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; p rivate-key cryptosystems; affine codes; twisted codes; one-time-pads; public-key cryptosystems based on large primes and discrete logarithms.

#### EEE G592 Mobile & Personal Communication

History of mobile radio; the mobile radio signal environment; review of statistical techniques; path over flat as well as hilly terrain; effects of RF system design on propagation; received signal envelope and phase characteristics; modulation schemes employed; functional designof 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 datatransmission via cellular; spectrum and technology of WLL

#### EEE G622 Advanced Digital Communication p

Introduction to Digital communication, review of probability and statistic processes; review of source coding and characterization of signals; optimum receivers for additive white gaussiannoise 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

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#### EEE G591 Optical Communication

Optical communication systems and components optical sources and transmitters (basic concept, design and applications); modulators (electrooptic, acousto-optic and laser modulation techniques); beam forming; focussing and coupling schemes to optical repeators; optical amplifiers; optical field reception; coherent and non-coherent lightwave systems; fibre optic communication system design and performance; multichannel lightwave systems; longhaul communications; fibre opticnetworks.

#### BITS G540 Research Practice

This course is designed to train the students towards acquiring competence in researchmethodologies. The course will be conducted in terms of actual participation in Research andDevelopment 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.

# **Electives: Communication Engineering**

#### **BITS F415 Introduction to MEMS**

Overview, history and industry perspective; working princ iples; mechanics and dynamics, thermofluid engineering; scaling law; microactuators, microsensors and microelectro mechanical systems; microsystem design, modeling and simulation; materials; packaging; microfabrication: bulk, surface, LIGA etc; micromanufacturing; microfludidics; microrobotics; case studies.

#### BITS G553 Real Time Systems

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 timesystem design, real time communication and security, real time constraints and multi- processing and distributed systems.

#### **BITS G554 Data Compression**

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 discretewavlet transforms. Filter banks and wavelets. Frames and tight frames. Wavelet packets. Wavelet based signal processing. Joint source and channel coding.

#### CS C461 Computer Networks

Evolution of communication and computer networks, protocol layering, network reference models, multiple access protocols, local area networks, packet and circuit switching, switching fabrics, network performance analysis and simulation techniques; addressing, routing, flowand congestion control, IP protocol; Broadband Integrated Services Digital Network (B -ISDN); Asynchronous Transfer Mode (ATM) reference models; network interoperability, traffic management and quality of service in integrated network protocol design and implementation strategies

#### CS C473 Multimedia Computing

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 rate video telephony;

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audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, humanmachine interfaces, spoken language interface; algorithm vs. architecture based approaches, mul timedia processors, performance quantification; case studies, vision 2010.

#### CS C451 Internetworking Technologies

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 G541 Pervasive Computing

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 cardbased authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

#### **CS G553 Reconfigurable Computing**

Overview of Programmable Logics. FPGA fabric architectur es. 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 G555 System Specifications and Modelling

Requirement analysis, specification formalisms, system modeling issues, system modeling languages, Hardware Specification and verification languages, EDA tools and its applications.

#### EEE C414 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

#### EEE F472 Satellite Communication

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; themultiple access techniques like FDMA, TDMA, CDMA,DAMA, etc; the INSAT program; salient features of INSAT – systems and services offered; satellite services offered byINTELSAT, INMARSAT and future satellites like IRIDIUM etc; future trends in satellite communications.

#### EEE F474 Antenna Theory and Design

Introduction into antenna theory and practice, Radiation integrals and auxiliary potentialfunctions; 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

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#### EEE G510 RF Microelectronics

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 G512 Embedded System Design

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 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. Radiationsources. 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**

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 designof 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, theIndian 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

#### EEE G582 Telecom Network Management

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and faultmanagement; security issues; remote network management.

#### EEE G626 Hardware Software Co-Design

FPGA and ASIC based design, Low -Power Techniques in RT Embedded Systems On -chip networking. Hardware Software partitioning and sched uling, Co-simulation, synthesis and verifications, Architecture mapping, HW - SW Interfaces and Re-configurable computing.

#### **EEE G627 Network Embedded Applications**

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

#### IS C462 Network Programming

Overview of computer networks; inter-process communication; network programming; socket interface; clientserver computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design

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#### MEL G621 VLSI Design

Introduction to NMOS and CMOS circuits; NMOS and CMOS processing technology; CMOS circuits and logic design; circuit characterization and performance estimation; structureddesign and testing; symbolic layout systems; CMOS subsystem design; system case studies.

#### MEL G622 Introduction to Artificial Neural Networks

Fundamentals and definitions; Perceptrons, backpropagation and counter propagation 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.

### Core Courses: Embedded Systems

#### BITS G553 Real Time Systems

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.

#### EEE G512 Embedded System Design

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.

#### CS G523 Software for Embedded Systems

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.

#### MEL G642 VLSI Architectures

Overview of CISC processor architectures; Instruction set architecture of CISC processor; hardware flow -charting methods; implementing microprocessor logic from hardware flow charts; RISC instruction set architecture; Pipelined execution of RISC instructions; pipeline execution unit design; control hazards; design of memoryhierarchy.

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#### EEE G626 Hardware Software Co-Design

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.

#### **BITS G540 Research Practice**

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.

#### **Electives: Embedded Systems**

#### **BITS F415 Introduction to MEMS**

Overview, history and industry perspective; working principles; mechanics and dynamics, thermofluid engineering; scaling law; microactuators, microsensors and microelectro mechanical systems; microsystem design, modeling and simulation; materials; packaging; microfabrication: bulk, surface, LIGA etc; micromanufacturing; microfludidics; microrobotics; case studies.

#### CS G541 Pervasive Computing

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 G553 Reconfigurable Computing

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 G611 Distributed Processing Systems**

Concepts of distributed processing, networkable architectures, inter process and processor communication algorithms, process migration and porting techniques etc.

#### CS G612 Fault Tolerant System Design

Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems,

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configurations, design aspects etc.

EEE F434 Digital Signal Processing

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 G547 Device Drivers** 

Introduction to operating system, Introduction to Linux Basics, commands, file system, kernel and introduction to Android, Process Synchronization, Semaphores, Message Passing, Mail- boxes 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 G594 Advanced VLSI Devices

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

darithmetic 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.

#### **EEE G595 Nanoelectronics and Nanophotonics**

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 G613 Advanced Digital Signal Processing

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 G625 Safety Critical Embedded System Design

#### **EEE G627 Network Embedded Application**

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:

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Architectures, Operating System and Applications. Middleware Issues and Design. Security and Encryption.

#### 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 selftests; fault tolerant computing; fault tolerant software.

#### MEL G621 VLSI Design

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, A SIC 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 G622 Introduction to Artificial Neural Networks

Fundamentals and definitions; Perceptrons, backpropagation and counter propagation 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

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, A SIC 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

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 G626 VLSI Test and Testability

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.

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#### **MSE G511 Mechatronics**

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.

### Core Courses: Microelectronics

M EL G621 VLSI Design

#### M EL G611 IC Fabrication Technology

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.

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 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.

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 G641 CAD for IC Design

M EL G632 Analog IC Design

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 testgeneration and testing.

#### **BITS G540 Research Practice**

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.

# **Electives (any six): Microelectronics**

#### EA C415 Introduction to MEMS

Overview, history, and industry perspective; working principles; mechanics and dynamics, thermos-fluid engineering; scaling law; micro-actuators, micro-sensors and micro-electromechanical systems; microsystem design, modeling, and simulation; materials; packaging; microfabrication: bulk, surface, LIGA etc;

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micro-manufacturing; micro-fluidics; micro-robotics; case studies.

CS G553 Reconfigurable Computing

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and SwitchNetworks. 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 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 G612 Fault Tolerant System Design [2 3 5] Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems, configurations, design aspects etc.

#### EEE F434 Digital Signal Processing

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structuresfor 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 G510 RF Microelectronics

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 G512 Embedded System Design

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; powerissues in system design; introduction to software and hardware co-design.

#### **EEE G522 Advanced Satellite Communication**

Radio wave propagation effects, low, medium, and geosynchronous earth orbits and their main characteristics. Various subsystems of the satellite, the outer space, and its impact on the designof 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, theIndian 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

#### EEE G572 Digital Signal Processing

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.

M EL G623 Advanced VLSI Design

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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.

#### EEE G595 Nanoelectronics and Nanophotonics Technology

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 G613 Advanced Digital Signal Processing

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 variancealgorithm, stochastic approximation method and maximum likelihood method, simultaneousstate and parameter estimation of extended kalman-filter, non-linear identification, quasi linearization, numerical identification methods.

#### EEE G626 Hardware Software Co-Design

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 G512 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.

#### MEL 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.

#### MEL G612 Integrated Electronics Systems Design

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 G622 Introduction to Artificial Neural Networks

Fundamentals and definitions; Perceptrons, backpropagation and counter propagation 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

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

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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

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.

#### M EL G625 Advanced Analog and Mixed Signal Design

Mixed-signal blocks and design issues, Design of high-speed comparators, opamps, Design of sample and hold circuits, Different architectures of analog to digital and digital to analog converters, Design of CMOS analog multipliers and dividers, Design of switched capacitor filters, Design of phase locked loop, Layout techniques for analog and mixed-signal design, noise issues. **MEL G626 VLSI Test and Testability**[5]

Fault models and types; automated test generation for combinational logic; test generation for sequential logic; the 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.

#### M EL G642 VLSI Architectures

Overview of CISC processor architectures; Instruction set architecture of CISC processor;hardware flowcharting 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.



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