Admission Brochure for PhD Admission Test: Second Semester 2015-16

INDEX

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Programmes offered</td>
</tr>
<tr>
<td>2.</td>
<td>Eligibility Criteria for Admissions</td>
</tr>
<tr>
<td>3.</td>
<td>Test Details</td>
</tr>
<tr>
<td>4.</td>
<td>Some Important dates and deadlines</td>
</tr>
<tr>
<td>5.</td>
<td>Syllabus for Test</td>
</tr>
</tbody>
</table>
Programmes offered

Applications are invited for admission to PhD programme at Pilani, Goa and Hyderabad campuses under 'Full Time' and 'Part Time' scheme in following Departments during Second Semester 2015-16

<table>
<thead>
<tr>
<th>Departments</th>
<th>BITS Pilani campus at</th>
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<tbody>
<tr>
<td></td>
<td>Pilani</td>
<td>Goa</td>
<td>Hyderabad</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Full Time</td>
<td>Part Time</td>
<td>Full Time</td>
<td>Part Time</td>
<td>Full Time</td>
</tr>
<tr>
<td>Biological Sciences</td>
<td>Yes</td>
<td>NO</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Chemical Engg.</td>
<td>Yes</td>
<td>NO</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Yes</td>
<td>NO</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Civil</td>
<td>Yes</td>
<td>NO</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>CSIS</td>
<td>Yes</td>
<td>NO</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>EEE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Humanities &amp; Social Sciences</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Economics &amp; Finance</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Management</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>Yes</td>
<td>NO</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Physics</td>
<td>Yes</td>
<td>NO</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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</table>
Eligibility Criteria for Admissions

Any Higher Degree such as M.E./M.Pharm./MBA/M.Phil of BITS or its equivalent with a minimum of 60% aggregate in the qualifying examination. Candidates with an M.Sc./B.E./B.Pharm or an equivalent degree with a minimum of 60% aggregate may also be considered for Ph.D. admission subject to their suitability and competence. For Ph.D. Programme in Humanities and Social Sciences, candidates with an M.A. and with minimum of 55% aggregate may also be considered. Shortlisted candidates will be called for a written test/interview for selections.

**Full time students:** Candidates are required to devote their full time towards Ph.D. Selected candidates will be provided 90% tuition fee waiver. Short listed candidates will be required to come to Pilani / Goa / Hyderabad campuses for test and/or interview. The seats under full time schemes are limited so preference will be given to candidates working in ongoing sponsored projects in the Institute, and the CSIR/UGC-NET qualified candidates.

**Part time students:** Candidates working in organizations situated in close vicinity of campuses of BITS Pilani will be admitted under this scheme. They will be provided 80% waiver in tuition fee.

**Assistantship (Fee Waiver and Stipend):** Those admitted to full time PhD programme will be considered for Project/Research Assistantships to the tune of Rs. 13,200/- to Rs. 18,200/- per month or more in addition to tuition fee waiver (as above). Selected candidates will be required to participate in teaching and other developmental programme of the institute under the guidance of a mentor.

**Fee structure: (For the academic year 2015-16):**

<table>
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<tr>
<th></th>
<th>Full-Time</th>
<th>Part-Time</th>
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</thead>
<tbody>
<tr>
<td>Ph D application fees (one time)</td>
<td>2090</td>
<td>2090</td>
</tr>
<tr>
<td>Admission fees (one Time)</td>
<td>25500</td>
<td>25500</td>
</tr>
<tr>
<td>Tuition fees per semester *</td>
<td>10025 (actual fee to be paid per semester)</td>
<td>20050 (actual fee to be paid per semester)</td>
</tr>
<tr>
<td>Institute caution deposit</td>
<td>3000</td>
<td>3000</td>
</tr>
<tr>
<td>Hostel Fee, Mess &amp; electricity advance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hostel, ICT, Infra Structure Modernization Fees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>student aid fund</td>
<td>Applicable as per campus rules</td>
<td>---</td>
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</tbody>
</table>

* The above prescribed semester fees is for student admitted in the academic year 2015-16. For these students, the semester, term, and admission fees will be revised upward every year, but will not increase beyond 15% each year (unless the government announces any new lavy/tax, which will be passed on to all existing students irrespective of their year of entry.*
TEST DETAILS

(I) Candidates shortlisted for Test in any of the following disciplines:
Biological Science/Chemistry/Mathematics/Physics will have to write two tests. Test-I will be common to all disciplines and Test-II will be discipline specific. The details of the tests are as follows:

Test-I question paper consists of 30 multiple-choice type questions pertaining to General Science, Quantitative Reasoning & Analysis and Research Aptitude. The candidate is required to answer all the questions in allotted 1 hr time. Each correct answer will be awarded two marks. 0.5 marks will be deducted for every wrong answer.

Test-II will be subject-based and will consist of 70 multiple-choice type questions covering the prescribed syllabus as given below. The candidate is required to answer all the questions in allotted 2 hr time. Each correct answer will be awarded two marks. 0.5 marks will be deducted for every wrong answer.

(II) Candidates shortlisted for Test in any of the following disciplines:
Languages/Humanistic Studies/Economics will have to write two tests. Test-I will be common to all disciplines and Test-II will be discipline specific. The details of the tests are as follows:

Test-I will comprise of the following components:

1. Reading Comprehension: 2 Passages (5Qs each=10 Qs) 20 mts
2. Logical Reasoning 10 question 10 mts
3. Analytical Reasoning 15 question 15 mts
4. General Awareness 10 question 15 mts

50 Qs. 60 mts

Test-II will be discipline specific (60 questions)

(III) Candidates shortlisted for Test in Pharmacy:
The Pharmacy test would be a 2 Hours test consisting of two parts. Part-A would be common to all and would consist of questions in general Pharmacy subjects and Part-B will be based on subject taken by students in their MPharm Degree Program.

(IV) Candidates appearing for interview for Ph.D. program in the Department of Management will be required to take a written case analysis (Duration: 1 hour)

(V) Candidates appearing for interview for Ph.D. program in the Department of CSIS with highest degree as BE will be required to take a 2 hours objective type written test.

(VI) Candidates appearing for interview for Ph.D. program in the Department of Chemical Engineering with highest degree as BE will be required to take a 2 hours objective type written test.

Based on the tests there may be shortlisting of candidates for Interview

All notices/shortlists will be put on admission website www.bitsadmission.com. Candidates are advised to check this website regularly. No written communication will be sent to candidates.
### Some Important Dates

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
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<tbody>
<tr>
<td>Last date for completed application form to reach admission office</td>
<td>5.00 PM on 14/12/2015</td>
</tr>
<tr>
<td>Declaration of shortlist to candidates (through BITS website)</td>
<td>20/12/2015</td>
</tr>
<tr>
<td>Test / Interviews:</td>
<td>5/1/2016</td>
</tr>
<tr>
<td>Announcement of admission offers to PhD Programmes</td>
<td>7/1/2016</td>
</tr>
<tr>
<td>Reporting of Selected students</td>
<td>15/1/2016</td>
</tr>
<tr>
<td>Registration for courses</td>
<td>18/1/2016</td>
</tr>
</tbody>
</table>
Syllabus for Test

**Biological Sciences**

<table>
<thead>
<tr>
<th>Genetics</th>
<th>Laws of inheritance and genetic interaction, Genetic mapping in Virus. Bacteria, &amp; Eukaryotes, Gene expression in prokaryotes and eukaryotes, Control of gene expression in prokaryotes eukaryotes and Viruses., Population and evolutionary genetics</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Molecular Technique:</th>
<th>Restriction endonucleases, Vectors and cloning, Blotting technique, PCR, Sequencing</th>
</tr>
</thead>
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<thead>
<tr>
<th>Biological Chemistry:</th>
<th>Chemistry of Biomolecules, Enzymes, Vitamins &amp; Coenzymes, Bioenergetics and biological oxidation, Metabolism of Biomolecules, Photosynthesis</th>
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</thead>
</table>

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<thead>
<tr>
<th>Microbiology:</th>
<th>Fundamentals of Microbiology, A survey of the microbial world, Host-Microbe interaction, Microbes and Human disease, Environmental and applied microbiology</th>
</tr>
</thead>
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<tr>
<th>Ecology</th>
<th>Abiotic factors, Ecosystem ecology and energy flow, Community ecology and population ecology, Regional Ecology (Terrestrial and Aquatic), Regional Ecology (Terrestrial and Aquatic)</th>
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</thead>
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<tr>
<th>Plant Physiology:</th>
<th>Transport and translocation of water and solutes, Essential elements and their function, Plant development and PGRs, Ascent of sap and translocation in phloem, Movement in plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference books:</td>
<td><em>Plant physiology</em>, 3rd edition by Salisbury &amp; Ross - CBS Publisher and Distributor.</td>
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<thead>
<tr>
<th>Biophysics:</th>
<th>Chemical properties of basic unit of life, energy forces, bonds., Conformation of Biomolecules, Biological membranes and Biomechaniques, Physiochemical techniques to study biomolecules, X-ray crystallography, NMR, molecular modeling.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference books:</td>
<td>Biophysical chemistry by Cantor and Schimmel.</td>
</tr>
<tr>
<td></td>
<td>Biophysics by Rodney Cotteril.</td>
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</tbody>
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<thead>
<tr>
<th>Developmental Biology:</th>
<th>Model systems- Vertebrates, Invertebrates and Plants, Axis and germ layers, The mesoderm and early nervous system, Morphogenesis and cell differentiation, Organogenesis, germ cells and sex.</th>
</tr>
</thead>
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<tr>
<th>Cell Biology:</th>
<th>Preview of cell, cellular membranous systems, Transport, Mitochondria, Chloroplast, energy transducing organelle, Golgi, Nucleus, Cytoskeletal network, Cell growth &amp; proliferation, Cell Immunity</th>
</tr>
</thead>
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<tr>
<th>Animal physiology:</th>
<th>Digestive and Respiratory system, Circulatory system, Excretory system, Nervous and Endocrine system, Body Immune system</th>
</tr>
</thead>
</table>
**Chemistry**

### Chemical Kinetics:

**Reference books:**

### Chemical Thermodynamics:

**Reference books:**
- Donal A. McQuarrie & J. D. Simon, Molecular Thermodynamics Viva Book Pvt Ltd., New Delhi, 2004
- R. C Srivastava, S K Saha, A K Jain, Thermodynamics, 2004

### Quantum Chemistry and Atomic and Molecular Structure:
Mathematical and Physical Foundations of Quantum Chemistry. Simple potential problems in one, two and three dimension including particle in a box, harmonic oscillator, potential barrier, rigid rotator hydrogen atom, He-atom, effective nuclear charge. Slater orbitals, electron spin, Solution of Hartree-Fock equation for He-atom, self-consistent field, Two electron system, Slater determinants, Hartree-Fock method. Approximation methods, variation, perturbation theory angular momentum, Atomic structure, Molecular structure.

**Reference books:**

### Structure and Reactivity of Organic Compounds:

**Reference books:**

### Instrumental methods of analysis:
Magnetic Resonance Spectroscopy (1H NMR, 13C NMR, EPR), IR Spectroscopy, Mass Spectrometry, Ultraviolet and visible spectroscopy, fluorescence spectroscopy, chromatography and other separation techniques, Structure Resolution by combination of techniques.

**Reference books:**

### Bonding in inorganic compounds:
Point Groups and Molecular Symmetry, Character Tables and applications of point group symmetry, Ionic bond; Polarization, Covalent bond; VB and MO theories, Coordination Compounds bonding and spectra.

**Reference books:**

### Chemical experimentation:
Acid base titrations, Complexometric titrations, Synthesis of organic compounds and functional group identification, Study of kinetics of chemical reactions, Determination of partition function, Adsorption isotherm, Synthesis and characterization of nanomaterials, Qualitative analysis of salts/mixture of salts.

**Reference books:**
- Vogel’s textbook of practical organic chemistry 5th edition
- Vogel’s textbook of quantitative inorganic analysis
- Vogel’s qualitative inorganic analysis, 7th edition

### Synthetic organic Chemistry:
One Group C-X Disconnections, Two Group C-X Disconnections, One Group C-C Disconnections, Two Group C-C Disconnections, Ring Synthesis and Synthesis of Heterocyclic Compounds.

**Reference books:**
## Basic organic and inorganic chemistry:

- **Stereochemistry (Isomerism, chirality, origin of optical activity, stereochemistry of cyclic compounds, resolution), Conformations (Rotation around sigma bonds, conformational analysis of butane, cyclohexane, and substituted cyclohexanes), Name reactions (Diels–Alder reaction; Friedel–Crafts (acylation and alkylation) reaction; Clemmensen reduction; Wittig reaction; Claisen condensation; Hofmann and Cope eliminations), Co-ordination chemistry, Chemistry of main group elements.**

**Reference books:**

## Chemistry of Organic Compounds:

- Carboxylic acid and carboxylic acid derivatives, Chemistry of aliphatic and aromatic amines, Structure, property and reactions of five and six membered heterocyclic compounds containing O, N and S, Organometallic compounds in organic synthesis: Organolithium, Organomagnesium, Organozinc and Organocopper, Carbohydrates

**Reference books:**

## Economics

### Principles of Economics:

- Demand, Supply, Elasticity, Consumer Behavior, Analysis of Production and Cost Analysis, Markets, Basics of Macroeconomics, Economics of Public Goods

**Reference books:**
- Lipsey R G & Chrystal K A Economics OUP, 10th ed. 2004

### Fundamentals of Finance & Accounting:

- Basics of Accounting, Financial Statements and Analysis, Introduction to Securities, markets and analysis, Banking System, RBI, Non-bank financial intermediaries, Markets for Future, Options & Derivatives; Foreign Exchange Markets

**Reference books:**
- Horngren, Sundem, and Elliott, Introduction to Financial Accounting, Pearson Education India Ltd. 8th ed. 2004

### Microeconomics:


**Reference books**

### Macroeconomics:


**Reference books**

### Econometrics:

- Basics of Statistics, OLS, k-variable Linear Equation, General Linear Model, Violation of classical Assumptions, Heteroscedasticity, Autocorrelation, Multi co linearity, ARIMA Model, Time Series Analysis, Simultaneous Equation System

**Reference books**

### Money Banking & Financial Markets:


**Reference books**

### Public Finance – Theory and Practice:


**Reference books**

### Economics of Growth and Planning:

### Reference books:

- Devraj Ray *Development Economics* OUP, Delhi 1998
- Salvatore D. *International Economics* WSE 8th ed. 2004
- Topics in Algebra by I.N. Herstein, Vikas Publishing House Pvt Ltd.
- Measure Theory and Integration by G. D. Barra, Willey Eastern.
- Ordinary Differential Equations (ODEs)
  - Existence and uniqueness of solutions of initial value problems for first order ODEs, singular solutions of first order ODEs, system of first order ODEs. General theory of homogeneous and non-homogeneous linear ODEs, variation of parameters, Strum-Liouville boundary value problems, Green’s function.
  - Reference books: Differential Equations by G.F. Simmons.
- Partial Differential Equations (PDEs)
  - Lagrange and Charpit’s methods for solving first order PDEs, Cauchy problem for first order PDEs. Classification of second order PDEs, general solution of higher order PDEs with constant coefficients, method of separation of variables for Laplace, Heat and Wave equations.
  - Reference books: Elements of Partial Differential Equations by I.N. Sneddon, Mc-graw hill Publisher.
- Linear Algebra
<table>
<thead>
<tr>
<th>Complex Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy’s theorem, Cauchy’s integral formula, Liouville’s theorem, maximum modulus principle, Schwarz lemma, open mapping theorem. Taylor’s series, Laurent’s series, calculus of residues. Conformal mappings, Mobius transformations. Reference books: Complex Variables and Applications by James Brown, R. V Churchill.</td>
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<tr>
<th>Numerical Analysis</th>
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<table>
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<tr>
<th>Functional Analysis</th>
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<th>Probability</th>
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<tr>
<th>Optimization</th>
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<th>Operations Research</th>
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<th>Advanced Calculus</th>
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<tr>
<th>Physics</th>
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<tbody>
<tr>
<td>Modern Physics</td>
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| Thermodynamics & Properties of Matter |

**Reference books:**

**Classical Mechanics**
Constraints, Generalized Coordinates, De-Alembert’s principle, Lagranges Equations of Motion, Two-body Central force motion, Rigid Body Kinematics, Rigid Body Dynamics, Hamilton’s Equations of Motion

**Reference books:**

**Electromagnetic Theory**

**Reference books:**

**Quantum Mechanics**

**Reference books:**

**Methods of Mathematical Physics**
Vector Analysis, Curvilinear Coordinates, Matrices and Vector Spaces, Functions of Complex Variables, Ordinary Differential Equations, Sturm-Liouville Theory and Special Functions, Elements of Partial Differential Equations

**Reference books:**

**Statistical Physics**
Elements of Probability Theory, Elementary Kinetic Theory, Microcanonical, Canonical & Grand Canonical Ensembles and Their Applications, Quantum Statistics of Ideal Bose Gases, Quantum Statistics of Ideal Fermi Gases

**Reference books:**

**Solid State Physics**

**Reference books:**
Kittel C., Introduction to Solid State Physics, WSE, 7th ed., 1995

**Optics & Spectroscopy**
Geometrical Optics, Interference, Diffraction, Polarization, Crystal Optics & Lasers, Atomic & Molecular Spectroscopy

**Reference books:**

**Nuclear & Particle Physics**
Nuclear Properties and Nuclear Models, Fission & Fusion, The Quark Model, Elementary Particles, their Classification and Interactions, Particle Accelerators, Conservation Laws of Elementary Particles and Fundamental Interactions

**Reference books:**
Griffiths, D J, Introduction to Elementary Particles, WIE, 1st ed., 1987

**Languages**
Modern English Usage, Phonetics and Language, English Literature: Elizabethans and Augustan, Pre-romantics and Romantics, Victorian Literature, Twentieth Century Literature: Poetry and Drama, Twentieth Century Literature: Prose and Fiction, Indian Writing in English, Applied Linguistics, American Literature, Women's Writing, Postcolonial Literature, Canadian Literature

**Humanities**

**Dynamics of social change**
**Concept, Origin, theories, Characteristic, types functions, their changing pattern, Culture, social norms, folkways, mores, social roles, culture and personality, social responsibility, Social stratification: caste, class, function and their changing pattern, Social change: Concept, theories and process of social change, factors, resistance, progress, social development, Industry and social change: modernization and urbanization, Social disorganization and delinquency**

**Reference books:**
- Steve Bruce, Sociology: A very short Introduction, New York: Oxford University Press, 1999

**Conflict Management**

Introductions to conflict Management: An Overview, Characteristics and dynamics of conflict, Reasons for conflict, the value of conflict in social change, The different approaches to addressing and managing conflict. Conflict analysis: Examining the history and impacts of a conflict, identifying the causes of conflict, Identifying who the stakeholder are and their interest, Exploring stakeholder power and relationships. Developing a strategy for Managing conflict, Assessment of options to address conflict, Tools for determining the best strategy, Incentives and methods in getting stakeholder to collaborate, Communication, Mediation and Facilitation, Active listening, Skills in mediation and facilitation, Roles of mediator and facilitator in conflict management, Dealing with emotions and difficult situations, Negotiating Agreements, Planning and preparing for negotiations, Improving negotiation skill to enhance the negotiated result, Joint problem solving approaches, Building agreements, Conflict Anticipation and Prevention, Building conflict management mechanisms, Consensus-building strategies

**Reference books:**
- The Dynamics of Conflict Resolution, San Francisco: Wiley Company, 2000

**Contemporary India**

Society, tradition and autonomy, Changing Social Structure in contemporary India, the explosion of middle class, women: From equality to empowerment, development policy in India, Agriculture and Industry, Democracy: From consolidation to fluidity:, Fundamental rights and duties; Civil service; continuity and change; India’s foreign Policy, Salient features of Indian constitution

**Reference books:**
- Independent India : The First Fifty Years, edited by Hiranmay Kalekar, New delhi, Oxford University Press, 1995

**Computer Science**

The Computer Science test will be based on the following subject:

1. Data structures and Algorithms
2. Operating Systems
3. Computer Organization & Architecture
4. Database systems
5. Software engineering

**Chemical Engineering**

**Chemical Process Calculations**


**Reference books:**

**Fluid Flow Operations**


**Reference books:**

**Chemical Engineering Thermodynamics**

First & Second Laws, PVT behavior & Heat Effects, Properties of pure fluids and thermodynamics of flow processes, Solution thermodynamics, VLE and chemical reaction equilibrium.

**Reference books:**

**Mass Transfer Operations**

Molecular diffusion and mass transfer coefficients, Interphase mass transfer, Gas absorption, Distillation, Liquid extraction and
leaching.

**Reference books:**

**Heat Transfer Operations**
Steady and Unsteady state heat conduction, Natural & Forced convection, Radiation, Condensation, boiling and evaporation, Heat Exchangers.

**Reference books:**

**Selected Chemical Engineering Operations**

**Reference books:**

**Kinetics & Reactor Design**
Mole balances and reactor sizing, Rate laws and stoichiometry, Isothermal reactor design for single and multiple reactions, Analysis of laboratory reactor data, and reaction mechanisms for nonelementary reactions, Non isothermal reactor design for single and multiple reactions, Heterogeneous reactors, Data analysis & design, Non Ideal reactors.

**Reference books:**

**Chemical Process Technology**
Process synthesis concepts for flow sheet generation; species allocation; separation task sequence and task integration, Technologies related to Inorganic Chemical Industries, Technologies related to Natural Product Industries, Technologies related to synthetic organic chemical industries, Technologies related to Polymerization industries.

**Reference books:**

**Process Design Decisions**
Engineering Economics; Economic Decision Making, Input Information and Batch versus Continuous; Input-Output Structure; Recycle Structure; Separation System, Heat Exchanger Networks (Energy Integration), Cost Diagrams; Preliminary Process Optimization; Process Retrofits.

**Reference books:**

**Process Control**
Dynamic modeling and simulation of momentum, energy, mass transfer and reacting systems, Analysis of the dynamic behavior of chemical processes, Analysis and design of simple feedback and advanced control systems, Design of control systems with multiple input and multiple output, Digital sampling, filtering and control.

**Reference books:**