BITS, PILANI

PhD Admission Test - I Semester 2012- 13: Brochure

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 awarded two marks. 0.5 mark 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 awarded two marks. 0.5 mark 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.

SYLLABUS FOR TEST

Biological Sciences

Genetics :
Laws of inheritance and genetic interaction, Genetic mapping in Virus. Bacteria, & Eukaryotes, Gene expression in prokaryotes and eukaryotes, Control of gene expression in prokaryotes eukaryotes and Viruses., Population and evolutionary genetics **Reference books:** Principles of Genetics –Robert H. Tamarin, 7th edition, Tata McGraw –Hill,2002.
Molecular Technique:
Restriction endonuleases, Vectors and cloning, Blotting technique, PCR, Sequencing **Reference books:** Principles of Gene Manipulation- R.W.Old & S.B.Primrose, 7th Edition
Biological Chemistry:
Chemistry of Biomolecules, Enzymes, Vitamins & Coenzymes, Bioenergetics and biological oxidation, Metabolism of Biomolecules, Photosynthesis **Reference books:** Principle of Biochemistry-Lehninger, Macmillan Worth Publication, 3rd edition
Microbiology:
Fundamentals of Microbiology, A survey of the microbial world, Host-Microbe interaction, Microbes and Human disease, Environmental and applied microbiology **Reference books :** Microbiology-An introduction (8th edition)- Tartora,Funk & Cane-Pearson publishing house.
Ecology :
Abiotic factors, Ecosystem ecology and energy flow, Community ecology and population ecology, Regional Ecology (Terrestrial and Aquatic), Regional Ecology (Terrestrial and Aquatic) **Reference books :** Concepts of Ecology by E J Kormondy Fundamentals of ecology by E. P. Odum .
Plant Physiology :
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 **Reference books:** Plant physiology, 3rd edition by Salisbury & Ross- CBS Publisher and Distributor.
Biophysics :
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. **Reference books :** Biophysical chemistry by Cantor and Schimmel. Biophysics by Rodney Cotteril.
Developmental Biology :
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. **Reference books:** Principles of Development –Lewis Wolpert-Oxford University Press, 2nd edition
Cell Biology:
Preview of cell, cellular membranous systems, Transport, Mitochondria, Chloroplast, energy transducing organelle, Golgi, Nucleus, Cytoskeletal network, Cell growth & proliferation, Cell Immunity **Reference books:** Cell and Molecular Biology-Philip Sheeler & Donald E. Bianchi. 3rd edition, John Wiley Publication.
Animal physiology:
Digestive and Respiratory system, Circulatory system, Excretory system, Nervous and Endocrine system, Body Immune system **Reference books :** Animal Physiology by Sherwood et al, 1st edition- Thomson Publication. Animal Physiology by Sherwood et al, 1st edition- Thomson Publication.

Chemistry

Chemical Kinetics:
Integrated rate laws for simple and complex reactions. Integrated rate laws in terms of properties dependent on concentrations of reactants and/or products. Effect of temperature on reaction rates, Theories of reaction rates: Collision theory and transition state theory, Rate laws and reaction mechanism. Unimolecular, bimolecular and trimolecular reactions. RRK theory of unimolecular reaction, Reactions in solution. Reactions in excited state. Fast reaction kinetics, Homogeneous and heterogeneous catalysis Reference books: Principles of Genetics –Robert H. Tamarin, 7th edition, Tata McGraw –Hill,2002.
Chemical Thermodynamics:
Concept and laws of thermodynamic, Thermodynamics of gases, Thermodynamics of non-ideal and electrolyte solutions, Statistical thermodynamics, Non-equilibrium thermodynamics **Reference books:** Ira N. Levine, Physical Chemistry, Tata McGraw Hill, 2002, 5th edition 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 :** 'Quantum Chemistry', Donald A. McQuarrie, University Science Books (First Indian Edition 2003, Viva Books Private Limited). 'Quantum Chemistry', Ira N. Levine, Pearson Education Inc. (2000) (First Indian Reprint, 20033. Molecular Quantum Mechanics", P.W. Atkins and R.S. Friedman, 3rd Ed. OUP (1997). [4th ed. Has come out]. Elementary Quantum Chemistry" F.L. Pilar, 2nd ed., McGraw Hill (1990). Quantum Chemistry", John P. Lowe, 2nd ed., Pearson Education Inc.
Structure and Reactivity of Organic Compounds :
Aliphatic & Aromatic Nucleophilic Substitutions, Aromatic Electrophilic Substitution, Addition to carbon-carbon multiple and carbon-heteromultiple bonds, Eliminations, Orbital symmetry in organic reactions **Reference books:** March Jerry, Advanced Organic Chemistry, John Wiley & Sons, 4th edition, 1992 Morrison and Boyd, Organic Chemistry, Prentice & Hall, 6th edition, 1992
Instrumental methods of analysis:
Magnetic Resonance Spectroscopy (^{1}H NMR, ^{13}C 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 :** William Kemp, "Organic Spectroscopy", Macmillan, 3rd ed. , 1991
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 :** Huheey, J. E. and others, "Inorganic Chemistry", Pearson Edu., 4th ed., 1993
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 :

R.O.C.Norman, Principles of Organic Synthesis, 2nd edition., Chapman & Hall, 1978.

W.A.Smit, A.F.Bochkov and R.Caple, Organic Synthesis: The Science Behind the art, 1st edition, The Royal society of chemistry, 1998.

Stuart Warren, Designing Organic Syntheses: A Programmed Introduction to the Synthon Approach, John Wiley and sons Ltd., 1978.

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:

W. Graham Solomons and Craig B. Fryhle, 'Organic Chemistry', 8th Edition, John Wiley & Sons, Inc. New York, 2004.

J.D. Lee, 'Concise Inorganic Chemistry', 5th edition, Blackwell Science, Oxford, 1999.

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:

F A Carey, Organic Chemistry, 5th Edition, Tata McGraw-Hill Publications Company Ltd., 2003.

P A Bruice, Organic Chemistry, 3rd Edition, Reason Edution, Inc. 2001.

Wade, Organic Chemistry, 5th Edition, Reason Edution, Inc. 2003

Economics

Principles of Economics :

Demand, Supply, Elasticity, Consumer Behavior, Analysis of Production and Cost Analysis, Markets, Basics of Macro economics, 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

Bhole L.M, Financial Institution & Market Structure: Growth & Innovation, Tata McGraw Hill, 4th ed. 2004**.**

Microeconomics :

Theory of Consumer Behaviour, Topics in Consumer Theory, Theory of Firm, Theory of Market Structure, General Equilibrium, Welfare Economics**,** Externalities, Common & Public Goods

Reference books

Henderson J M and Quandt R E , Microeconomic Theory : A Mathematical Approach , McGraw Hill 3rd ed. 1980.

Macroeconomics:

Macroeconomic System- Measurement, I-O System, Flow of Funds, Keynesian System – Demand, Money, Interest , Income, Output, Inflation& Unemployment, Money Supply, Consumption and Investment, Consumption and Investment

Reference books :

Froyen, Richard T Macroeconomics: Theories & Policies Pearson Education, 8th ed. 2005.

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 :

Johnston J and John Dinardo, Econometric Methods McGraw Hill International, 4th ed. 1997.

Money Banking & Financial Markets :

Money and its Functions, Money Markets, Financial Markets and Financial Institutions, Foreign Exchange Markets, International Monetary Financial System, Banking Business, Bank Management , Financial Derivatives, Money, prices, economic activity; IMF

Reference books :

Mishkin, Frederic S The Economics of Money, Banking and Financial Markets: A Global Perspective Addison Wesley,

7th ed. 2004.
Public Finance – Theory and Practice :
Scope of Public Finance, Allocation, Distribution & Public Choices, Equity in Distribution, Public Choice & Fiscal Policy, Public Expenditure – Structure, Growth & Evaluation**,** Public Revenue, Principles of Taxation, Role of Fiscal Policy in India, Budgeting in India **Reference books:** Musgrave, R.A and Musgrave, P.B Public Finance : Theory and Practice McGraw Hill Book Co. 1999.
Economics of Growth and Planning :
Economic Growth Models – Harrod-Domar, Neo-classical, Two sector Models, The Fel'dman Model of Economic Growth, Samuelson Model of Economic Growth, Kaldor's Model of Income, Population, Environment, Inequality and Development, Planning in India **Reference books :** Jones H.G.An Introduction to Modern Theories of Economic Growth, McGraw Hill, Kogakusha Ltd. 1976., Devraj Ray Development Economics OUP, Delhi 1998
International Trade and Balance of Payments:
International Economics, Trade Theories, International Trade – Comparative Advantage, Heckscher –Ohlin (H-O) Model, Modern Theories of International Trade, Tariffs, Quotas, FDI, BOP, GATT, WTO, International Monetary System **Reference books:** Salvatore.D. International Economics WSE 8th ed. 2004
Issues in Indian Economy:
India's Economic Growth & Development, Significant Aspects of Indian Economy – Agriculture, Infrastructure, Private & Public Sector, Industrial Growth, Import- Exports, Unemployment, Commercial Banking & Finance, Inflation& Income Growth, Money Supply, Monetary Control, India's Trade, External Aid, Public Debt **Reference books:** Agarwal.A.N, Indian Economy – Problems of Development & Planning Wishwa Prakashan, A division of New Age International(P) Ltd.,2005

Mathematics

Algebra
Permutations, combinations, pigeon-hole principle, inclusion-exclusion principle, derangements. Fundamental theorem of arithmetic, divisibility in Z, congruences, Chinese Remainder Theorem, Euler ϕ-function, primitive roots. Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equation, Sylow's theorem. Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain. Polynomial rings and irreducibility criteria. Fields, finite fields, field extensions, Galois Theory. Reference books: Topics in Algebra by I.N. Herstein, Vikas Publishing House Pvt Ltd.
Analysis
Elementary set theory, finite, countable and uncountable sets, real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence. Reimann sums and Reimann integral, improper integrals and Reimann Stieltjes integral. Monotonic functions, types of discontinuity, functions of bounded variation. Lebesgue measure, measurable sets, measurable functions, Riemann and Lebesgue integral and their properties. Differentiations, functions of bounded variations, L^p spaces, different modes of convergence, metric spaces, compactness, connectedness. Normed linear spaces, spaces of continuous functions as examples. Reference books: Principle of Mathematical Analysis by W. Rudin, Mc-graw hill Publishers. Measure Theory and Integration by G. D. Barra, Willey Eastern.
Topology
Topological spaces; special topologies, subspaces, product spaces and quotient spaces, continuity and homeomorphisms, connectedness and compactness, fundamental groups of surfaces. Reference books: Topology by J.R. Munkres, Pearson Education publication. Introduction to Topology and Modern Analysis by G.F. Simmons, Mc-graw hill Publishers.
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.

Elementary Differential Equations and Boundary Value Problems, 8th Edition, with ODE Architect CD by G. Krantz, Wiley.
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
Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton's theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis. Quadratic forms, reduction and classification of quadratic forms. Reference books: Linear Algebra by K. Hoffmenn and R. Kunze, Prentice hall of India Pvt Ltd. Linear algebra and matrix theory by J. Gilbert and L. Gilbert, Brooks Cole. Introduction to linear algebra by G. Strang Wellesley Cabridge Press.
Complex Analysis
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.
Numerical Analysis
Computer arithmetic and errors, numerical solutions of algebraic equations, method of iteration and Newton-Raphson method, rate of convergence. Solution of systems of linear algebraic equations by using Gauss elimination and Gauss-Seidel methods. Finite differences, Lagrange, Hermite and spline interpolation, numerical differentiation and integration. Numerical solution of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods. Reference books: Applied Numerical Analysis by Gerald and Wheatley 6/E, Pearson Education.
Functional Analysis
Normed linear spaces, Riesz lemma, Banach spaces, normed linear spaces, continuous linear transformations on normed linear spaces, inner product spaces, Hilbert spaces, orthogonal sets, direct sum, Bessel's inequality, Riesz representation theorem, uniform boundedness principle, open mapping theorem, closed graph theorem. Reference books: Introduction to Functional Analysis by B.V. Limaye, New Age international Publishers 2000. Introductory Functional Analysis with Applications by Erwin Kreyszig.
Probability
Sample space, discrete probability, independent events, Bayes' theorem. Random variables and distribution functions (univariate and multivariate); expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Probability inequalities (Tchebycheff, Markov, Jensen). Modes of convergence, weak and strong laws of large numbers, central limit theorems (i.i.d. case). Reference books: Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences by J. Susan Milton. Schaum's Outline of Probability and Statistics by Murray R Spiegel, John J. Schiller, R. Alu Srinivasan.
Optimization
Modeling with linear programming, general L.P. solution, The simplex method, duality and post optimal analysis, transportation model and its variants, goal programming and integer linear programming, non linear programming algorithms. Reference books: Operations Research: An Introduction by Hamdy A Taha 8/E, Prentice Hall India/Pearson Education.
Operations Research
Queuing systems: Poisson queuing systems, Reliability: reliability and hazard rate function of series and parallel systems, inventory systems: single item inventory models, simulation and game theory, network models and deterministic dynamic programming. Reference books: Operations Research: An Introduction by Hamdy A Taha.
Advanced Calculus

Functions of several variables, directional derivative, partial derivative, and derivative as a linear transformation, inverse and implicit function theorems. Reference books: Thomas's Calculus (11th Edition) by George B. Thomas, Maurice D. Weir, Joel Hass and Frank R. Giordano, Pearson Publication.

Physics

Modern Physics
Special Theory of Relativity, Particle-like Properties of Waves, Wave-like Properties of Particles, Heisenberg Uncertainty Relation, Bohr's Model of Hydrogen-like Atoms, Schrodinger Equation, Particle in One-dimensional Potential, Particle in One-dimensional Potential, Many Electrons Atoms, Physics of Molecules, Nuclear Transformations **Reference books :** R. Eisberg & R. Resnick, Quantum Physics of Atoms, Molecules & Solids, WSE, 2nd ed., 1985 Arthur Beiser, Concepts of Modern Physics, Tata McGraw-Hill, 6th ed., 2005
Thermodynamics & Properties of Matter
Thermometry, Thermal Expansion, Heat, Work and the First Law of Thermodynamics, Second Law of Thermodynamics, Heat Engines and Entropy, Kinetic Theory, Phase Transformations, General Properties of Matter **Reference books :** Zemansky & Dittman, Heat & Thermodynamics, 6th ed., McGraw-Hill, 1981
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 :** H Goldstein, Classical Mechanics, Pearson Education, 3rd ed., 2002
Electromagnetic Theory
Electrostatics in Free Space, Electrostatics in Matter, Magnetostatics in Free Space, Magnetostatics in Matter, Faraday's Law of Electromagnetic Induction, Maxwell's Equations, Conservation Laws, Electromagnetic Waves, Electromagnetic Potentials, Fields and Radiations **Reference books :** D. J. Griffiths, Introduction to Electrodynamics, Pearson Education, 3rd ed., 1999
Quantum Mechanics
Schrodinger Equation, Eigenvalues, Eigenfunctions, Eigenfunction Expansion, Dirac Notation, Operator Methods, Harmonic Oscillator, Angular Momentum, Central Force Problem, The Hydrogen Atom, Spin, Identical Particles, Time Independent Perturbation Theory **Reference books :** Richard L. Liboff, Introductory Quantum Mechanics, Pearson Education, 4th ed., 2003 Stephen Gisiorowicz, Quantum Physics, John Wiley & Sons Inc., 3rd ed., 2003
Methods of Mathematical Physics
Vector Analysis, Curvilinear Coordinates, Matrices and Vector Spaces, Functions of Complex Variables, Ordinary Differential Equations, Sturm-Lioville Theory and Special Functions, Elements of Partial Differential Equations **Reference books :** Mathew Jon & R. Walker, Mathematical Methods of Physics, Pearson Education, 2nd ed., 1970 Arfken & Weber, Mathematical Methods for Physicists, Academic Press, 6th ed., 2005
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 :** Pathria R K, Statistical Mechanics, Elsevier, 2nd ed., 1996
Solid State Physics
X-ray Diffraction and Crystal Structure, Lattice Dynamics, Free Electron Theory of Metal, Electron in Periodic potential, Energy Bands, Semiconductors, Superconductivity **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:** Ghatak, A K, Optics, Tata McGraw-Hill, 3rd ed., 2005 Banwell C N, Fundamentals of Molecular Spectroscopy, Tata Mc-Graw-Hill, 4th ed.,1994
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 :

Krane K, Introductory Nuclear Physics, John Wiley & Sons, 1st ed., 1988

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

Method, Theories and Movements. Pioneers, Socialization and its theories. Social Group: concept and organization, community and association, institution, Sociology of religion: aspect, origin, Hinduism, Sociology of Education, Family & Marriage: 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 :

.Gisbert, Fundamentals of Sociology, Orient Longman, 3rd ed., 1994

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 listenin,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 :

Contemporary India: Economy, Society, Politics, ed. Neera Chandoke and Praveen Priyadershi, Pearson Education, 2009, Delhi

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
Units and Dimensions, The Chemical Equation and Stoichiometry**,** Material Balances, Energy Balances, Properties of Gases, Vapors, Liquids and Solids, Phase Equilibria, Combustion Calculation, Unsteady-State Material and Energy Balances. **Reference books:** Himmelblau, D. M. "Basic principles & calculations in chemical Engg", PHI, 6th ed., 1997. Felder, R. M. & R. W. Rousseau, "Elementary Principles of Chemical Processes", John Wiley & Sons, Inc., 3rd ed., 2000.
Fluid Flow Operations
Fundamental Concepts and Fluid Statics, Integral and Differential Analyses for Fluid Motion, Internal and External Fluid Flow and Flow through Packed Bed, Dimensional Analysis and Fluid Machinery, Agitation and Introduction to Compressible Flow. **Reference books:** Fox, R. W. and A. T. McDonalds, Introduction to Fluid Mechanics (5th edition) John Wiley and Sons Inc., 2001. McCabe, W. L., J. C. Smith and P. Harriott Unit Operations of Chemical Engineering (7th edition), McGraw Hill Inc., 2005.
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:** J. M.Smith, and Others,"Introduction to Chemical Engineering Thermodynamics", MGHFSE, 6th ed., 2001 YVC Rao, "Chemical Engineering Thermodynamics", Universities Press, 1997. KV Narayanan, "A Textbook of Chemical Engineering Thermodynamics". Prentice Hall of India, 2001.
Mass Transfer Operations
Molecular diffusion and mass transfer coefficients, Interphase mass transfer, Gas absorption, Distillation, Liquid extraction and leaching. **Reference books:** Treybal, R.E., "Mass Transfer Operations," 3rd Ed., McGraw-Hill Book Company, Singapore, 1980. Foust, A. S., Wenzel, L.A., Clump, C.W., Anderson, L.B., "Principles of Unit Operations," 2nd Ed., John Wiley and Sons, New York, 1980.
Heat Transfer Operations
Steady and Unsteady state heat conduction, Natural & Forced convection, Radiation, Condensation, boiling and evaporation, Heat Exchangers. **Reference books:** Holman, J. P., "Heat Transfer (9th Ed.)", McGraw-Hill, 2002. Frank P. Incropera, David P. DeWitt, "Fundamental of Heat & Mass Transfer (6th Ed.)", John Wiley & Sons, 2006. D. Q. Kern, "Process Heat Transfer", Tata McGraw Hill. McCabe & Smith, "Unit Operations of Chemical Engineering (7th ed)", McGraw-Hill, 2004.
Selected Chemical Engineering Operations
Properties and Handling of Particulate Solids, Mechanical Separations, Adsorption and Fixed-Bed Separations, Drying of Solids, Membrane Separation Processes and Crystallization. **Reference books:** McCabe W. L., and Smith J. M., & Harriott P., *Unit Operations of Chemical Engineering*, 7th Ed., McGraw-Hill International Edition, 2006. Chemical Engineering (Volumes 1-6), Coulson J. M., Richardson J. F. & others, Pergamon Press, London, 1978 & 1997.
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:** H. Scott Fogler "Elements of Chemical Reaction Engineering", PHI, 3rd Ed, 2002. O. Levenspiel, "Chemical Reaction Engineering", John Wiley, 3rd Ed., 1999. J.M. Smith, "Chemical Engineering Kinetics", McGraw Hill, 3rd Ed., 1981.
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:** Rao, G. and Sittig M., "Dryden's outlines of chemical technology for 21st century", East West Press, 1997. Austin, G T, "Shreve's chemical process industries", McGraw Hill, 1984.
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:** James M. Douglas. Conceptual Design of Chemical Processes. McGraw-Hill International Editions (Chemical Engineering Series), Mc Graw Hill Book Company, New York, 1988. Max S. Peters, Klaus D. Timmerhaus, Ronald E. West, Max Peters. Plant Design and Economics for Chemical Engineers. 5th Edition, Mc Graw Hill, New York, 2003.
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:** Stephanopoulos, G., "Chemical Process Control: An Introduction to Theory and Practice," Prentice-Hall, Englewood Cliffs, N.J., 1984 Seborg, D.E., Edgar, T.F. and Mellichamp, D.A., "Process Dynamics and Control," 2nd Ed., John Wiley and Sons, 2004. Coughnowr, D. R., and Koppel, I. B., "Process Systems Analysis and Control," 2nd Ed., McGraw-Hill, New York, 1991.

Civil Engineering

Design of Concrete Structures:
Materials for reinforced concrete, Design of concrete Mix, Design philosophies, Design of singly and doubly reinforced rectangular and flanged sections for Flexure using Working stress and Limit State Design approach, Design for bond, anchorage and development length, Design of beams for Shear, serviceability requirements, Design of one way slab, two way slab and staircase, yield line theory, Design for columns, Foundations , retaining walls and introduction to prestressed concretes.. **Reference books**: Limit State Design of Reinforced Concrete, By: P. C. Varghese, PHI, New Delhi. Reinforced Concrete Design by Pillai and Menon, TaTa McGraw Hill, Publication, New Delhi. Reinforced Concrete Design by S. N. Sinha, TaTa McGraw Hill, Publication, New Delhi. Design of Concrete Structures by Nilson, Darwin and Dolan, TaTa McGraw Hill, Publication, New Delhi
Design of Steel Structures (Limit State Design) :
Steel Design Specifications and Connections, Design of Tension and Compression Members, Design of beams and plate girders, Design of Industrial Structures, Introduction to plastic analysis and design. **Reference books**: Teaching Resource for Structural Steel Design, Vol. 1, 2, 3: Institute for Steel Development and Growth, Kolkatta. Design of Steel Structure by N. Subramaniam, 2007, Oxford University Press.
Analysis of Structures:
Statics of Structures and Degree of Indeterminacy, Analysis of Determinate and Indeterminate Structures, Deflection of beams and Frames, Influence lines and its Applications, Introduction to Matrix Methods of Structural Analysis. **Reference books**: Fundamentals of Structural Analysis by Kenneth M. Leet & Chia-Ming Uang, McGraw Hill Publications,

New Delhi.

Transportation Engineering:

Highway Planning and Geometric Design, Highway Materials & Pavement Design, Traffic Engineering & Transport Planning, Railway Engineering, Airport Engineering.

Reference books:

Khanna, S.K. and Justo C.E.G : Highway Engineering,Nem Chand and Bros. Roorkee(U.P.), 5th Edition 1982.

Khanna, S.K., Arora,M.G. and Jain S.S. : Airport Planning and Design, Nem Chand and Bros. Roorkee(U.P.), 4th Edition 1990.

Kadiyali L.R., Principles of Highway Engineering, Khanna Publications, New Delhi 1989.

S.C. Saxena & S Arora, Railway Engineering, Dhanapatrai & Sons, 1986.

Relevant IRC and IS Codes of Practice.

Geodesy:

Chain Survey, Compass Survey & leveling, Theodolite, Tachometric surveying & Traversing, Curve Ranging, Contouring & Plane Tabling, Trigonometric Leveling, Areas and Volumes, Spherical triangle system, astronomical coordinate system, Geodetic surveying, Total Stations and other advancements in surveying.

Reference books:

Arora K.R.; Surveying (in SI units), Standard Publisher., Vol. I, II and III (Latest edition)

Punmia B.C; Surveying; Laxmi Publishers, Vol I, II and III, (1990)

Duggal S.K.; Surveying; Tata McGraw-Hill, New Delhi, Vol I and II (1996)

Mechanics and Strength of Materials :

Fundamental principles of Mechanics, Introduction to Mechanics of Deformable Bodies, Forces and Moments Transmitted by Slender Members, Stress and Strains, Deflections due to Bending.

Reference books :

An Introduction to Mechanics of Solids, Second Edition with SI units Crandall/Dahl/Lardner, Tata McGraw Hill Publication, New Delhi.

Strength of Materials BC Punamia, Ashok Jain, Arun Jain, Laxmi Publications, New Delhi.

Mechanics of Materials Fifth Edition James M. Gere, Thomson Brooks/Cole.

Construction Planning and Technology:

Building materials, Geotechnical materials, compaction & stabilization, Geotechnical materials, compaction stabilization, Construction planning and scheduling, Advanced construction techniques.

Reference books:

Arora. S.P. & S.P. Bindra. 'A Textbook of Building construction,' Dhanpat Rai & Sons, 4th ed., 1988

Penrifoy, R.L., & C.L., Schexnayder, 'Construction Planning, Equipment and Methods', T.M.H., 8th edition, 2003.

Project Management for Construction: Chris Hendrickson First Edition originally printed by Prentice Hall, 1989, http://www.ce.cmu.edu/pmbook/

Gupta R., Construction Planning & Technology', CBS, 1994.

Soil Mechanics and Foundation Engineering:

Index properties, classification and compaction of soil, Effective stress, permeability and seepage through soil., Stresses due to applied load and settlements, Shear strength of soil, stability of slopes and earth pressure, Shallow foundations, deep foundations and soil exploration,

Reference books:

Ranjan, G. and Rao, A.S.R. (2002), "Basic and Applied Soil Mechanics" New Age International Publishers.

Water and Wastewater Treatment :

Introduction to the basics of water supply and wastewater engineering, Natural methods for water and wastewater treatment, Unit operation for water and wastewater treatment, Treatment and disposal of sludge, Advance methods of treatment for water and wastewater, application of hydraulics in designing of sewers and water supply distribution networks

Reference books:

Water Supply Engineering And Wastewater Engineering by B.C.Punmia. Laxmi Publications (P) Ltd., New Delhi. 1995 & 1998.

Water Supply Engineering and Sewage & Wastewater Disposal Engineering by S.K.Garg. Khanna Publishers, Delhi, 1998 & 2000.

Environmental Engineering by H.S. Peavy. McGraw Hill International editions, 1985.

Laboratory Manual for Civil Engineering by H.S.Moondra and R. Gupta. CBS Publishers, 1992.

Relevant IS codes, National and International Journals pertaining to the subject.

Hydraulics and Fluid Mechanics:

Fluid Statics and Fluid Flow Kinematics, Boundary Layer Theory, Flow through pipes and open channels under different conditions & types, Dimensional Analysis and Similitude, Application of both Hydraulic and Hydrologic processes.

Reference books:

Modi P.N. and Seth S.M., "Hydraulics and Fluid Mechanics", Standard Book House, Post Box 1074, New Delhi,2005

Patra K.C., " Hydrology and Water Resources Engineering", Narosa Publishing House, 2001.

Mays L.W., "Water Resources Engineering", John Weley and Sons, 2001.

Electrical and Electronics Engineering

Analog Electronics:

Operational amplifier basics, ideal and practical Op-amp configurations, special purpose linear Op-amp circuits: instrumentation amplifiers, isolation, programmable, negative feedback amplifiers etc., Active filters, IC filters; non-linear operational amplifier circuits, analog multipliers, precision and wave shaping circuits, comparators and Schmitt triggers and applications, Signal generators: sinusoidal and non-sinusoidal oscillators, integrated circuits timers. function generators, PLL, Voltage Regulators; voltage regulator IC, switched capacitor voltage converters, switching regulators, Power amplifiers and output stage circuits, IC power amplifiers, high frequency amplifiers, tuned amplifiers.

Reference books:

L K Maheshwari & M M S Anand " Analog Electronics" PHI Private Ltd. 2005.

Adel S Sedra & K C Smith" Microelectronic Circuits" OUP, 5th edition,2005.

Digital Electronics & Computer Organization:

Number systems & Codes, Boolean algebra & Simplification, Digital Logic Families, Combinational logic Design – Decoders, Encoders, MUX, DeMUX, Arithmetic Circuits, Sequential Logic design- Flip-flops, State machines, ASM

Counters & Registers, PLDs & FPGAs & Computer Organization.

Reference books:

M. Morris Mano, " Digital Design", PHI, 3rd Edition, 2002.

Microprocessors:

Architectures of Intel - x85 & x86 Processors, Instruction set & Assembly Language programming, Memory Interfacing, Data Transfer Schemes, Peripherals & I/O Interfacing using 8255, 8253, 8251, Disk Organization

Reference books:

Barry B Brey, C R Sarma, The Intel Microprocessors. Pearson, Sixth Ed. 2005.

Circuits & Signals, Digital Signal Processing:

Linear convolution, Fourier Transforms, DFT & FFT, Laplace Transforms & its application to system analysis, Z-transform & its application to system analysis, Analog & digital filter design (FIR, IIR), Multirate signal processing.

Reference books:

B P Lathi " Signal Processing & Linear Systems" Oxford Univ. Press, 2004.

2.Sanjit K Mitra " Digital Signal Processing" Tata MCGra Hill 3 rd Edition, 2006.

Electrical Sciences:

Basic Circuit elements and laws, Analysis Techniques & Theorems, Time-domain analysis of 1st & 2nd Order Circuits, AC Circuit Analysis, Frequency domain analysis, Series and Parallel RCL Circuit, Important Power Concepts, Semiconductors, Construction, operation and application of Junction Diode, Zener Diode, Transistor (BJT's), FET's, MOSFET etc., Feedback in Amplifier Circuits, AC Generation and Magnetic Circuits, Single- phase circuit analysis**,** Magnetic Circuit Calculations**,** Three- phase Circuit analysis, Electrical Machines (Construction, Operation & usage), Transformers, DC Machines, Three-phase synchronous generator, Three-phase induction motors, Single-phase induction motor, Fractional KW motors**.**

Reference books:

Leonard S Bobrow " Fundamental of Electrical Engineering" OUP, 2nd ed.,1996.

Electronic Devices & Integrated Circuits, Microelectronics Circuits:

Semiconductor materials and their properties, Carrier transport and excess carriers in semiconductors; Single p-n junction devices- rectifier diodes, switching diodes, microwave diodes, optoelectronic devices, Bipolar junction transistors; JFET; MOSFET; MOS and CMOS devices; Device fabrication techniques and introduction to ICs, Basic single and two stage transistor amplifier; current mirrors and current sources; active load biasing in integrated circuits, Voltage sources and voltage references, differential and

multistage amplifiers; frequency response and frequency compensation, Operational amplifiers-2 stage, stability analysis and compensation techniques.

Reference books:

B G Streetman & Sanjay Banerjee" Solid state Electronic Devices" PHI? Pearson Edu, 6th ed.,2006.

Adel S Sedra & K C Smith" Microelectronic Circuits" OUP, 5th edition,2005.

Control Systems, Power Electronics:

Mathematical model of physical systems (Differential equations, Block diagram, signal flow graph, transfer function) feedback characteristics of control systems, control systems components, Time response analysis, stability, Root locus concepts, frequency response (Bode plots, Polar plots, Nyquist plots), state space analysis and compensation concepts, Phase control resistors, DC-DC step down chopper, Step up chopper, inverters.

Reference books:

I. J. Nagrath & M Gopal "Control Systems Engineering" NAIL, 5th Edition, 2007.

N. Mohan, T.M. Undeland, W.P. Robbins, John Wiley, 3 rd edition.

Electromechanical Energy Conversion, Power Systems:

DC Machines, construction, Operation, Characteristics & design, AC motors & generators, Transformers, Transmission lines: modeling & analysis, Steady state power system analysis & load flows.

Reference books:

I.J. Nagrath & D.P. Kothari, "Electric machines" TMH third edition 2004.

I.J. Nagrath and D.P. Kothari, "Power system engineering" TMH.

Communication Systems:

Electromagnetic Fields, Telecom Switching:

Maxwell's equation in free space and time varying fields, plane waves in dielectric and conducting media, wave reflection, refraction, diffraction and polarization, transmission lines and resonators, Smith chart and its application in stub and impedance matching calculations, Antennas and radiation, half-wave dipole, loop, helical, directive antenna, reflector, lens and horn antennas, antenna practice and measurements, Voice digitization, digital transmission and multiplexing, digital switching, Data and asynchronous transfer mode networks, telecommunication traffic analysis.

Reference books:

John D Kraus and D.A. Fleisch, "Electromagnetics & applications".

John C Bellamy "Digital Telephony" John Wiley 3 rd Edition, 2003.

Instrumentation

Analog Electronics:

Operational amplifier basics, ideal and practical Op-amp configurations, Special purpose linear Op-amp circuits: instrumentation amplifiers, isolation, programmable, Negative feedback amplifiers etc., Active filters, IC filters; Non-linear operational amplifier circuits, analog multipliers, precision and wave shaping

circuits, Comparators and Schmitt triggers and applications, Signal generators: sinusoidal and non-sinusoidal oscillators, integrated circuits timers. function generators, PLL, Voltage Regulators; Voltage regulator IC, Switched capacitor voltage converters, Switching regulators, Power amplifiers and output stage circuits, IC power amplifiers, High frequency amplifiers, Ttuned amplifiers.

Reference books:

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Adel S Sedra & K C Smith" Microelectronic Circuits" OUP, 5th edition,2005.

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Reference books:

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Circuits & Signals, Digital Signal Processing:

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Reference books:

B P Lathi " Signal Processing & Linear Systems" Oxford Univ. Press, 2004.

2.Sanjit K Mitra " Digital Signal Processing" Tata MCGra Hill 3 rd Edition, 2006.

Electrical Sciences:

Basic Circuit elements and laws, Analysis Techniques & Theorems, Time-domain analysis of 1st & 2nd Order Circuits, AC Circuit Analysis, Frequency domain analysis, Series and Parallel RCL Circuit, Important Power Concepts, Semiconductors, Construction, operation and application of Junction Diode, Zener Diode, Transistor (BJT's), FET's, MOSFET etc., Feedback in Amplifier Circuits, AC Generation and Magnetic Circuits, Single- phase circuit analysis**,** Magnetic Circuit Calculations**,** Three- phase Circuit analysis, Electrical Machines (Construction, Operation & usage), Transformers, DC Machines, Three-phase synchronous generator, Three-phase induction motors, Single-phase induction motor, Fractional KW motors**.**

Reference books:

Leonard S Bobrow " Fundamental of Electrical Engineering" OUP, 2nd ed.,1996.

Electronic Devices & Integrated Circuits, Microelectronics Circuits:

Semiconductor materials and their properties, Carrier transport and excess carriers in semiconductors;

Single p-n junction devices- rectifier diodes, Switching diodes, Microwave diodes, Optoelectronic devices, Bipolar junction transistors; JFET; MOSFET; MOS and CMOS devices; Device fabrication techniques and introduction to ICs, Basic single and two stage transistor amplifier; Current mirrors and current sources; Active load biasing in integrated circuits, Voltage sources and voltage references, Ddifferential and multistage amplifiers; Frequency response and frequency compensation, Operational amplifiers-2 stage, Stability analysis and compensation techniques.

Reference books:

B G Streetman & Sanjay Banerjee" Solid state Electronic Devices" PHI? Pearson Edu, 6th ed.,2006.

Adel S Sedra & K C Smith" Microelectronic Circuits" OUP, 5th edition,2005.

Control Systems, Power Electronics:

Mathematical model of physical systems (Differential equations, Block diagram, signal flow graph, transfer function) feedback characteristics of control systems, control systems components, Time response analysis, stability, Root locus concepts, frequency response (Bode plots, Polar plots, Nyquist plots), state space analysis and compensation concepts, Converters, Inverters and Choppers, Step up chopper, inverters.

Reference books:

I. J. Nagrath & M Gopal " Control Systems Engineering" NAIL, 5th Edition, 2007.

N. Mohan, T.M. Undeland, W.P. Robbins, John Wiley, 3 rd edition.

Industrial Instrumentation & Control , Analysis Instrumentation

Elements of process control loop, mathematical modeling, dynamic closed loop characteristics, Controller principles & tuning, DDC loop, Hydraulic, Pneumatic, Electronic controller, Complex multivariable control schemes, final control elements, PLCs, DCS, SCADA, AI techniques: Expert system, ANN, Fuzzy Logic, UV/VIS/IR Spectrophotometer, FES/AAS, X-ray analyzers, NMR, Mass spectrometers, Sampling systems for online analyzers, TC analyzer, Paramagnetic O_2 Analyzer, Fluid density monitors, GLC.

Reference books:

Curtis D. Johnson. "Process control instrumentation technology" Prentice Hall of India.

Stephanopolous George, "Chemical process controls.

Computer based industrial control by Krishan Kant, Prentice Hall of India

Analysis Instrumentation by R P Khare (CBS).

Handbook of Instrumental Techniques for analytical Chemistry by Frank Settle (Pearson).

Transducers & Measurement systems :

Generalized measurement system, functional elements, Static and dynamic characteristics, Resistive, inductive, capacitive, piezoelectric, Hall effect, photoelectric, fiber optic transducer, MEMS based transducers, Measurement of Motion, pressure, flow, temperature level, viscosity, pH, humidity, vibration, Signal conducting techniques using op-amps, instrumentation amplifier, bridges, carrier amplifier, chopper amplifier, charge amplifier and Isolation amplifier, Data converter, filters, Data acquisition system, inverse transducers & feed back measurement systems.

Reference books:

Measurement Systems, application and design by E.O Doebelin and Dhanesh N. Manik, Tata McGraw-Hill.

Electronic Instruments and Instrumentation Technology + Medical Instrumentation

Electronic indicating, display, Recording & Analysis instruments, Signal generators, Frequency synthesizers, Counters, Grounding and Shielding techniques, Instrumentation in hazardous areas, Industrial data communication, Transducers for biomedical measurements, Cardio vascular measurements, Patient care monitoring systems, Instrumentation for respiratory and nervous system, clinical lab measurements.

Reference books:

Electronic Instruments and Instrumentation Technology by M.M.S. Anand, Prentice Hall of India.

Biomedical Instrumentation and measurements, by L. Cromwell, et al. PHI.

Introduction to Biomedical equipment & Technology, J.J Carr and J.M. Brown (Pearson).