SECTION-II

Syllabus for PhD Admission Test

Chemical Engineering

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; Use of tie components; recycle, bypass and purge calculations; Degree of freedom analysis. First and Second laws of thermodynamics. First law application to close and open systems. Second law and Entropy; Thermodynamic properties of pure substances: Equation of state and departure function, Properties of mixtures: Partial molar properties, fugacity, excess properties and activity coefficients; Phase equilibria; Chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics; Newtonian and non- Newtonian fluids; Bernoulli equation; Friction factor; Energy balance; Dimensional analysis; Shell balances; Flow through pipeline systems; Flow meters, Pumps and compressors, Packed and fluidized beds, Elementary boundary layer theory, Size reduction and size separation; Free and hindered settling; Centrifuge and cyclones; Thickening and classification; Filtration; Mixing and agitation; Conveying of solids.

Heat Transfer: Conduction, convection and radiation; Heat transfer coefficients, Steady and unsteady heat conduction; Boiling, condensation and evaporation; Types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; Momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; Kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, nonideal reactors; Residence time distribution, single parameter model; Non-isothermal reactors; Kinetics of heterogeneous catalytic reactions; Diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, transfer functions and dynamic responses of simple systems, process reaction curve, controller modes (P, PI, and PID); Control valves; analysis of closed loop systems including stability, frequency response and controller tuning, cascade, feed forward control.

Plant Design and Economics: Process design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; Principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in design.

Chemical Technology: Inorganic chemical industries:- sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); Natural products industries (Pulp and Paper, Sugar, Oil, and Fats); Petroleum refining and petrochemicals; Polymerization industries; Polyethylene, polypropylene, PVC and polyester synthetic fibers.

SECTION-II

Syllabus for PhD Admission Test
Civil Engineering

Structural Engineering:
Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.
Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.
Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns isolated footings); basic elements of prestressed concrete: Construction Technology and Management- CPM/PERT analysis, Cost Analysis, Mass Haul Diagram.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

Geotechnical Engineering:
Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.
Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

Water Resources Engineering:
Fluid Mechanics and Hydraulics: Hydrostatics applications of Bernoulli equation, Laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of Momentum equation, Potential flow, Kinematics of flow; Velocity triangles and specific speed of pumps and turbines.
Hydrology: Hydrologic cycle; Rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, Estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Design of weirs on permeable foundation, Irrigation methods.

Environmental Engineering:
Water Requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: Quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

Transportation Engineering:
Highway planning, Geometric design of Highways, Testing and specifications of paving materials, Design of flexible and rigid pavements.

SECTION-II

Syllabus for PhD Admission Test

Computer Science and Engineering

Data Structures :

Complexity of Algorithm. Algorithm Design Paradigms. Stack. Queues. Hash Table. Binary Search, AVL. Red-black. Splay. Skip. B-Trees. Skip-lists. Priority Queue. Graph: Shortest Path, MST, Depth-first and Breadth-first Algorithms. Advanced Sorting Methods. Multi-Dimensional, Kinetic Data Structures.

Algorithms :

Analysis, Asymptotic notation, Notions of space and time complexity, Worst and average case analysis; Design: Greedy approach, Dynamic programming, Divide-and-conquer; Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching. Asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, Basic concepts of complexity classes - P, NP, NP-hard, NP-complete. Series Evaluation, Algorithm Correctness and Efficiency. Growth of Functions. Amortized Analysis. Recurrences. Search Pruning. Matrix Operations. String Matching. Computational Geometry, Heuristic Methods.

Computation Theory :

Regular Languages and Finite Automata (Mealy, Moore, Hybrid FSM, Exposed FSM, Encapsulated FSM, Static State Instantiation FSM). Context free Languages and Pushdown Automata. Recursively Enumerable sets and Turing Machines. Undecidability.

Operating Systems :

Synchronization Mechanisms. Process Deadlocks. Resource Models. Local and Global states. Distributed Operating Systems. Event Ordering. Timestamps. Distributed Mutual Exclusion. Token and Non-token based Algorithms. Comparative Performance Analysis. Concurrency Control. Shared Memory. File Systems. Agreement Protocols for handling Processor Failures. Coordination of Processes and related Algorithms. Failure Handling and Recovery Mechanisms. Multiprocessor Operating Systems and related Thread Handlings.

Database Systems :

Database design (integrity constraints, normal forms). ER-model, Relational model (relational algebra, tuple calculus) Storage and File Structures. Indexing and Hashing. Transactions and Concurrency control. Recovery. Query Processing. Query Optimization. Object Oriented DBMS. Extended Relational Model. Spatial databases. Multimedia Databases. Distributed Databases. Active Databases. Temporal Databases. Deductive Databases. Mobile Databases and Web-enabled Database Systems.

Computer Organisation and Architecture :

Logic functions, Minimization, Design and synthesis of combinational and sequential circuits; Number representation and computer arithmetic (fixed and floating point). Machine instructions and addressing modes, ALU and data-path, CPU control design, Memory interface, I/O interface (Interrupt and DMA mode), Instruction pipelining, Cache and main memory, Secondary storage. Performance Analysis, Fault Tolerance and Scalability. Modeling Performance. Pipelined Systems. Interconnection Networks. Processor Array. Multi-computers. Multiprocessors. Systolic Array. Vector Processors. Structured Memory Design for Parallel Systems – Symmetric Shared, Distributed Shared, Synchronization. Grid computing.

Software Engineering :

Requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance. Personal Software Process. Team Software Process. Usability. Agile Methods. Process Models- Iterative, Scrum, XP, and Evo. Advanced UML, Petri net. Domain specific modeling. Systems Modeling Language. Meta modeling. Software architecture and design patterns. Software metrics. Software reliability. Advanced testing techniques. Aspect oriented programming.

Computer Networks :

ISO/OSI stack, TCP/IP, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IP(v4), Application layer protocols (icmp, dns, smtp, pop, ftp, http); Basic concepts of hubs, switches, gateways, and routers. Network security.. IPv6 Protocols and its Applications. Real Time Communication Protocols. High speed local and wide area networks. Virtual networks. Broadband networks. Introduction to intelligent networking. Performance analysis of networks.

Compiler Design :

Lexical analysis, Parsing, Syntax directed translation, Runtime environments, Intermediate and target code generation, Basics of code optimization. Operating System: Processes, Threads, Inter-process communication, Concurrency, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security.

Computer Graphics and Web technologies:

Geometrical Objects and Transformations in 2D and 3D, Objects representation, Coordinates transformation, windows and viewports, Viewing in 3D, Orthogonal and projective views, hidden surface removal, Light, Shading , Web multimedia technologies, HTML, XML, basic concepts of client-server computing.

SECTION-II

Syllabus for PhD Admission Test

Electronics and Communication Engineering

Communication Systems :
Basic Analogue and Digital Communication Techniques. Random Signal Theory. Correlation Techniques and Matched Filtering. Linear Predictive and Transform Coding Techniques. M-ary Modulation Techniques including MSK. Orthogonal Coding. Multi Carrier Modulation Techniques – OFDM. Multi-user Detection Theory. Spread Spectrum Techniques.

Digital Signal Processing :
Theory, Techniques and Applications of Digital Filters and Fast Fourier Transforms. Architecture and Features of Different Digital Signal Processors. Optimal, Stochastic and Adaptive DSP Techniques. Multidimensional Filtering and Applications. Wavelet Theory and Applications.

Electromagnetic Theory, Microwave Techniques and Antenna :
Maxwell's Equitation and their Applications. Poynting Theorem, plane-wave propagation, polarization, reflection and refraction. Transmission through Waveguides. S-Parameters. Microwave Components and Sources. Dipole and Other Antennas. Micro strip Lines and Antennas.

Satellite Communication :
Communications Satellites - Architecture, Orbits**,** Frequency Bands. Satellite Power and Bandwidth Link Budget for Different Orbits. Satellite Multiple Access Techniques. Satellite Communication Networks. LEO. MEO. GPS.

Optical Communication :
Loss and Dispersion Mechanism in Optical Fibers. Characteristics and Features of different Optical Wave Length Windows for Communication. Optical Sources, Detectors and Passive Devices & Components. Power and Data Rate Link Budgets. Optical Amplifiers. WDM and DWDM. Optical Networks.

Wireless & Mobile Communication :
Cellular Concept and Engineering. Frequency Bands for Wireless and Mobile Communications. Propagation Models and Fading. GSM, CDMA and 3G Communication Systems. GPRS, Bluetooth, Wi-Fi and WIMAX. Wireless Data Networks and Standards.

Telecommunication Networks :
Circuit and Packet Switching Techniques and Systems. Digital Telephone Networks. Digital Multiplexing Hierarchy. OSI Reference Model. Data Link, Network and TCP/IP Layers and their Standards. Routing Protocols. LAN, MAN and WAN and respective standards. Broadband Telecommunication Networks – ATM and BISDN. Network Security and Network Management.

Information and Coding Theory :
Entropy. Mutual Information. Shannon's Theory – Source and Channel Coding. Discrete and Continuous Channels. Channel Capacity. Ideal Communication Systems, Power – Bandwidth Trade-off. Error Control – Automatic Repeat Request and Forward Error Correction. Block Codes Reed - Solomon. Convolutional Codes. Viterbi Algorithm. Turbo Codes.

VLSI Circuits and Systems :
Building Blocks of VLSI and Simulation Tools. MOS, CMOS and MOSFET Transistors, Circuits and Applications. CMOS Logic Circuits. Semiconductor Memories. VLSI Digital ICs. Fabrication Techniques.

SECTION-II

Syllabus for PhD Admission Test

Mechanical Engineering

MACHINE DESIGN

Strength of Material: Mechanical Properties and Testing, Deflection of Beams, Torsion of Shafts, Columns & Struts, Strain Energy, Pressure Vessels, Composite Materials, its Classification and Processing Methods, Advanced Mechanics of Solids

Theory of Machines: Mechanisms and Machines, Gear and Gear Trains, Cams, Engine Dynamics, Governors, Balancing, Gyroscope

Design of Machine Elements: Design for Production, Belt, Rope and Chain Drives, Design of Shafts, Bearings, Springs, Tribology

Mechanical Vibrations: Fundamentals of Vibration, Vibration of Single Degree of Freedom Systems, Vibration of Multi Degree of Freedom Systems, Vibration of Continuous Systems, Static and Dynamic Testing of Machine Tools

THERMAL ENGINEERING

Thermodynamics and Fluid Mechanics: Zeroth, First and Second Laws of Thermodynamics, Availability & Irreversibility, Pure Substances, Air Standard Cycles,

Fluid Mechanics and Computational Fluid Dynamics

Internal Combustion Engines: Combustion in S.I. & C.I. Engines, Lubrication & Cooling Systems, Engine Testing and Performance, Supercharging, Gas Turbines and Jet Propulsion, Power Plant Engineering, Automobile Engineering

Heat and Mass Transfer: Basic Laws, Conduction, Extended Surface Conduction, Convection, Thermal Radiation, Heat Exchangers, Mass Transfer

Refrigeration and Air-Conditioning: Air Refrigeration System, Vapour Compression Refrigeration System, Vapour Absorption Systems and Refrigerants, Psychrometry, Air Conditioning

PRODUCTION ENGINEERING

Manufacturing Technology: Workshop Practices, Fundamental Machine Tool Operations, Ferrous Materials, Non-Ferrous Metals and Alloys**,** Ceramics, Plastics and Other Materials, Casting, Welding, Bulk Metal Forming Processes, Forging, Extrusion, Rolling, Non-Conventional Manufacturing Processes

Machine Tool Engineering: Fundamental of Metal Cutting, Machine Tool Design, Machine Tool Structures, Gear Box Design, Machine Tool Testing, Vibration in Machine Tools, NC, CNC and DNC Machine Tools, Automation in Manufacturing, FMS, CIMS

CAD/CAM: Fundamentals of Computer Aided Design, Geometric Transformation, Plane Curves, Geometric Modelling, Application of CAD Techniques to Finite Element Mesh Generation, Computer Aided Manufacturing, Additive Manufacturing (Rapid Prototyping),

Robotics & AGVs

Industrial Management: Production and Productivity, Work Study and Ergonomics, Plant Layout and Material Handling, Production Planning and Control, Inventory Control, Computer Aided Process Planning, Group Technology, Concurrent Engineering, Reverse Engineering, Statistical Quality Control, Total Quality Management.

SECTION-II

SYLLABUS FOR THE PH.D. ADMISSION TEST

CHEMISTRY

Physical Chemistry:

Basic principles and applications of quantum mechanics – hydrogen atom, angular momentum. Variational and perturbational methods. Basics of atomic structure, electronic configuration, shapes of orbitals, hydrogen atom spectra. Theoretical treatment of atomic structures and chemical bonding. Chemical applications of group theory. Basic principles and application of spectroscopy – rotational, vibrational, electronic, Raman, ESR, NMR. Chemical thermodynamics. Phase equilibria. Statistical thermodynamics. Chemical equilibria. Electrochemistry – Nernst equation, electrode kinetics, electrical double layer, Debye-Hückel theory. Chemical kinetics – empirical rate laws, Arrhenius equation, theories of reaction rates, determination of reaction mechanisms, experimental techniques for fast reactions. Concepts of catalysis. Polymer chemistry. Molecular weights and their determinations. Kinetics of chain polymerization. Solids - structural classification of binary and ternary compounds, diffraction techniques, bonding, thermal, electrical and magnetic properties. Collids and surface phenomena. Data analysis.

Inorganic Chemistry

Chemical periodicity. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules. Concepts of acids and bases. Chemistry of the main group elements and their compounds. Allotropy, synthesis, bonding and structure. Chemistry of transition elements and coordination compounds – bonding theories, spectral and magnetic properties, reaction mechanisms. Inner transition elements – spectral and magnetic properties, analytical applications. Organometallic compounds - synthesis, bonding and structure, and reactivity. Organometallics in homogenous catalysis. Cages and metal clusters. Analytical chemistry- separation techniques. Spectroscopic electro- and thermoanalytical methods. Bioinorganic chemistry – photosystems, porphyrines, metalloenzymes, oxygen transport, electron- transfer reactions, nitrogen fixation. Physical characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-, NQR, MS, electron spectroscopy and microscopic techniques. Nuclear chemistry – nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

Organic Chemistry

Formations and stabilities of carbonium ions,carbanions, carbenes, nitrenes, radicals and arynes, Reactive intermediates, Nucleophilic,Electrophilic, Radical substitution, Addition and Elimination reactions. Barton,Baeyer-villigier, Birch, Chichibabin, Clemmensen Diels-alder, Friedel crafts, Hoffmann,Hofmann-Loffler-Freytag, Hydroboration, Lossen, Mannich, Michael addition,Meerwein-Ponndorf-Verley, Perkin, Grignard, Reimer-Tiemann, Reformatsky, Storkenamine, Wittig, Wolff-Kishner. Oppenaur oxidations, Robinson annulations, Routine functional group transformations and inter-conversions of simple functionalities, Aldol,Clasien, Stobbe and Dieckmann, Schmidt, Condensations, Beckmann and Fries, Favorski,Curtius Rearrangements. Stereochemistry and Conformational Analysis: Concept of chirality, Asymmetric synthesis (including enzymatic and catalytic nexus) enantio and diastereo-selective synthesis, racemization, resolution, Walden inversion. Effects of conformation on reactivity in acyclic compounds and cyclohexanes, Conformational analysis of cyclohexane. Pericyclic Reactions: Selection rules and stereochemistry of electrocyclic reactions,cycloaddition and

sigmatropic shifts, sommelet, Hauser and Cope rearrangements. Photochemistry: Cis and trans isomerisation, Paterno buchi reaction, Norrish type I and IIreactions, Photo-reduction of ketones, Di-pimethane rearrangements, Photochemistry of areanes. Dyes: Colour and Constitution, Classification of Dyes, Chemistry of Methyl Orange,Malachite Green, Crystal Violet, Phenolphthalein.

Interdisciplinary topics

Chemistry in nanoscience and technology. Catalysis and green chemistry. Medicinal chemistry. Supramolecular chemistry. Environmental chemistry.

Syllabus and Format for PhD Admission Test: Humanities & Social Sciences

General

The Ph.D. Program at Department of Humanities & Social Science offers the opportunity for highly motivated students to pursue research in areas such as Economics, Human Resource Management and Behavioural sciences, Marketing management and General Management. Students must exhibit the ability to think and write analytically and the eagerness to explore new vistas of knowledge. Strong written and verbal communication skills are mandatory with a commitment to the focused pursuit of a doctoral degree program.

Economics

Demand, Supply and Equilibrium, Cost, Production Theory, Indian economy, Market Structure, Pricing, National Income Accounting, Inflation, Monetary & Fiscal Policy, International Trade and Relations

Human Resource Management and Behavioural sciences

Motivation, Job Satisfaction, Work Life Balance, Leadership, Emotional Intelligence, Learning, Basic Concept of HRM, Human Resource Planning, Change Management, Training and Development, Conflict Management, Stress Management, Laws Related to Employees at Workplace.

Marketing

Basics Concepts of Marketing, Marketing Strategies and Plans, Marketing Research, Customer Value, Satisfaction and Loyalty, Market Segmentation ,Targeting, Positioning, Concepts Related to Brand, Differentiations , Marketing Strategies, Competition, Pricing, e-Commerce, Consumer Behavior.

General Management

Evolution of Management Thought, Management Functions, Decision-Making, Group Dynamics, Work Motivation, Application of Information Technology in Management. Indian Values System and Ethics.

Syllabus for PhD Admission Test

Mathematics

Algebra :

Groups, homomorphism, Sylow theorems. Rings and fields. Vector spaces, subspaces, linear dependence, basis and dimension. Linear transformation, range space, null space, rank and nullity. Matrix representation of a linear transformation. Change of basis. Eigenvalues and eigenvectors. Inner product, orthogonality, Gram-Schmidt process, orthogonal expansion. Quadratic forms, reduction to normal form.

Analysis :

The real number system. Sequences, series and uniform convergence. Continuity and differentiability of functions of real variable. Riemann and Lebesgue integrals. Analytic function, Cauchy Riemann equations, Cauchy's theorem and integral formula, singularities, Taylor's and Laurant's series. Cauchy's residue theorem and applications. Metric spaces.Cauchy sequences and convergence. Completeness. Normed space. Banach space. Inner product space. Hilbert space.

Differential Equations :

Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations. Second order linear differential equations. Variation of parameters. Systems of linear differential equations. Solution by matrix method. Laplace transform methods. Applications. Sturm-Liouville problem. Green's function. First and second order partial differential equations. Method of separation of variables for Laplace, heat and wave equations.

Operations Research :

Linear programming problems, convex set, convex functions, Simplex method and its variants, duality, sensitivity analysis. Transportation problems, initial basic feasible solution and optimal solution, degeneracy. Assignment problems, applications of TP and AP. Nonlinear programming problems, Kuhn-Tucker conditions.

Numerical Analysis :

Approximation of functions, their derivatives and integrals by interpolation. Finite and divided differences. Iterative methods for solving nonlinear and linear equations, convergence. Power method for largest eigenvalue. Numerical Solution of ordinary differential equations. Initial value problems by Runge-Kutta and predictor-corrector methods. Boundary value problems by finite difference methods. Numerical Solution of Laplace and Poisson equations.

Probability and Statistics:

Sample space, events and probability axioms. Random variable and probability distributions. Mean and Variance. Binomial, normal and Poisson distributions. Random sampling, confidence intervals, testing hypotheses, goodness of fit. Regression.

SECTION-II

Syllabus for PhD Admission Test

Physics

Solid State Physics:

Crystal structure; space lattice, basis, bravais lattice, space, coordination number, lattice plane, Miller Indices, inter planar distance, atomic radii, lattice constant and density, reciprocal lattice, Bragg's Law, X-ray diffraction, atomic scattering factor. Origin of energy gap; Bloch theorem, Kronig Penney Model, effective mass of electron. Tight binding approximation; Brillouin zone, nearly free electron model. Polarization mechanism & Dielectric Constant; behavior of polarization under impulse and frequency switching, dielectric loss, spontaneous polarization, piezoelectric and ferroelectric effect. Classification of – dia-, para-, ferro-, antiferro- and ferri-magnetic materials, hysteresis, magnetic storage and surfaces. Photoconductivity.

Atomic and Statistical Physics:

Black body radiation; Rayleigh - Jeans law, Wien's law, Plank's law of radiation ,Stefan's law, Compton scattering, Origin of spectral lines, Atoms in magnetic field; Normal Zeeman effect, Distributions; classical distribution (MB), quantum distributions (BE , FD), applications of quantum distributions (electron gas, average energy). Spectra of one- and many-electron atoms; Stern-Gerlach experiment, LS and JJ coupling, hyperfine structure, Zeeman and Stark effects, electric dipole transitions and selection rules, rotational and vibrational spectra of diatomic molecules, electronic transition in diatomic molecules, Franck-Condon principle, Raman effect, NMR and ESR. Lasers-spontaneous and stimulated emission, optical pumping, population inversion, coherence (temporal and spatial)

Quantum and Advanced Physics:

Wave-particle duality, uncertainty principle. Schrodinger's time dependent and time-independent equations. One, two and three dimensional potential problems, particle in a box, harmonic oscillator and second quantization , concept of Hilbert space, hydrogen atom, angular momentum and spin; time independent perturbation theory. Quantum Wells, quantum dots, quantum wires. Amorphous materials; Electronic density of states.

Electronics:

p-n junction, abrupt junction, linearly graded junction, diffused junction, Diodes; ideal and real diodes, temperature dependence of I-V characteristics, injection, tunnel diode, backward diode, Schottky barrier diode, Ohmic contacts, heterojunctions. Semiconductor surfaces. CV characteristics of MOS capacitor,

$Si\text{-}SiO_2$ system, basic structure and operating principle, I-V charactesitics, frequency limitations, short-channel effects. Solar Cell, Photo detectors, LED, Semiconductor lasers.

Electromagnetism:

Gradient, Divergence and Curl, Coulomb's law and related numerical, Gauss's law, it proof for the charge inside and outside the Gaussian surface, applications of Gauss law i.e. spherical and cylindrical symmetries (all important cases), electric field due to charged conductor, force per unit area on the surface of the charged conductor. Treatment of electrostatic problems by solution of Laplace and Poisson's equations, Biot Savart law, Ampere's law, Maxwell's equations (derivations) in free space and dielectric media. Energy in electromagnetic waves (Poynting vector and Poynting theorem), plane electromagnetic waves in free space, Solution, transverse nature, wave impedance and energy flow, derivations of expressions for energy density and energy flux (Poynting vector) in an electromagnetic field, radiation pressure, boundary conditions across the medium. Optical Fibers; light propagation in fibers and graded index fibers, numerical aperture and attenuation, single and multimode. Wave guides.