



UTTARANCHAL UNIVERSITY

(Established vide Uttaranchal University Act, 2012)

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Arcadia Grant, P.O. Chandanwari, Premnagar, Dehradun, Uttarakhand

SYLLABUS FOR PH.D. ENTRANCE EXAM

SYLLABUS FOR ENTRANCE EXAMINATION FOR Ph.D.

Research Aptitude/ Research Methodology (Common to all)

General aptitude:

1. **General Science:** General understanding of science including matters of everyday observation and experience.
2. **Current events:** Knowledge of significant national and international events.
3. **General mental ability and reasoning:** Reasoning and analytical abilities.
4. **Environmental awareness:** Pollution and its impacts, climate change, sustainable development
5. **Basic Computer Skills:** Basic computer awareness and its uses. Role and use of computers in research.
6. **Interactive English:** Grammar, vocabulary, sentence completion, usage, synonyms, antonyms, one word substitute, idioms/phrases, error detection and comprehension.
7. **Information and Communication Technology (ICT):** Terminology and abbreviations used in ICT, applications of ICT in academics and research.

Research aptitude:

1. Meaning, nature, significance and types of research. synopsis, hypothesis, data collection, literature survey, sampling, interviewing, questionnaire, data processing, interpretation, report writing, bibliography, Article, research paper, seminar, conference, symposium, workshop etc.
2. Role of governing bodies/research organizations like UGC, CSIR, ICAR, ICSSR, ICPR, ISRO, DRDO etc. in research and development.
3. Basic Statistics for Research- Basic of Stats with Mean, Median, Mode, Standard Deviation & Variance. Their applications in research.

Basic concept of Permutation, Combination & Probability.

Discipline/ Subject course syllabus

BIOTECHNOLOGY

Biomolecules (Carbohydrates, proteins, lipids, enzymes), metabolic pathways, Enzyme kinetics and inhibition, immobilized enzymes. Cellular & Molecular Biology- Membrane structure and function; Cell theory; Structural organization and function of intracellular organelles; Cell division and Cell cycle and cancer biology; Structure and types of DNA, RNA; DNA replication, repair, transcription, translation, gene regulation. Immunology: Innate and acquired, Structure & function of antibody, MHC, antigen-antibody interactions. Autoimmunity; vaccines, hypersensitivity. Genetic engineering, gene cloning, transgenic organisms, molecular markers, vectors, methods of gene transfer, molecular farming, Gene therapy. Concepts of genetics. Bacteria, Fungi, viruses, laboratory identification of microbes, sterilization techniques, culture media and types, transformation, conjugation, transduction Host-Pathogen interactions, antibiotics. Fermentation Technology - Basic fermentor (types), downstream processing; Isolation; screening and maintenance of industrially important microbe, scaling up of cell culture, industrial biotechnology products. Electrophoresis, centrifugation, microscopy, biosensors, chromatography, Mass spectrophotometry, PCR, DNA fingerprinting. Bioinformatics- Databases, sequence alignment, search engines, BLAST, FASTA, Phylogenetic analysis. Cell and tissue culture (plant and animal) - Media, different types / methods of culture, applications, cell lines, secondary metabolites, Concept of Intellectual property rights. Environmental biotechnology, Bioremediation, Bioleaching, biopesticides. waste management.

SYLLABUS FOR PH.D. ENTRANCE EXAM- CHEMISTRY

Chemical periodicity, Structure and bonding including shapes of molecules (VSEPR Theory). Main group elements and their compounds: Allotropy, industrial importance of the compounds. Transition elements and coordination compounds: spectral and magnetic properties. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications. Organometallic compounds & applications, bonding and structure, and reactivity. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, nitrogen fixation, metal complexes in medicine. Electron spectroscopy and microscopic techniques.

Basic principles of quantum mechanics: Chemical applications of group theory rules. Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; Chemical thermodynamics: Kinetics and their applications; elementary; phase equilibria solutions. Nernst equation, redox systems, electrochemical cells; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions. Colloids and surfaces.

IUPAC nomenclature of organic molecules including Regio- and stereoisomers. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Common named reactions and rearrangements – applications in organic synthesis. Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Principles and applications of photochemical reactions in organic chemistry. Structure determination of organic compounds by IR, UV-Vis, ^1H & ^{13}C NMR and Mass spectroscopic techniques. Principles of qualitative and quantitative analysis; acid-base, oxidation reduction and precipitation reactions; use of indicators; nuclear reactions & applications of isotopes.

SYLLABUS FOR PH.D. ENTRANCE EXAM-COMPUTER SCIENCE & ENGINEERING

C Programming and Data structure: Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs

Operating Systems: Process and memory management, Concurrent processing, Scheduling, Multiprocessor Operating Systems and related Thread Handlings

Software Engineering: Models, Process and Project Metrics, Analysis Concepts and Principles, Measures, Metric Indicators, Software Quality Assurance, Software Prototyping.

DBMS: DBMS design, Distributed Databases, Client/Server Architecture, ODBMS and RDBMS, Data Warehousing and Data Mining

Network and Information Security; Concept of layering, Flow and error control techniques, Switching, IPv4/IPv6, Routing and routing algorithms, Basics of network and information security, Introduction to intelligent networking, Performance analysis of networks

Theory of Computation: Models of computation, Automata Languages accepted by models, Grammars, Languages, Non-computability and Examples of non-computable problems, Turing machine, Compiler design

SYLLABUS FOR PH.D. ENTRANCE EXAM- CIVIL ENGINEERING

Section 1: Environmental Engineering

Water and Waste Water: Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, effluent discharge standards. Domestic wastewater treatment, quantity and characteristics of domestic wastewater, primary and secondary treatment. Unit operations and unit processes of domestic wastewater, sludge disposal.

Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle energy recovery, treatment and disposal).

Noise Pollution: Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

Section 2: Transportation Engineering

Transportation Infrastructure: Highway alignment and engineering surveys; Geometric design of Highways - cross-sectional elements, sight distances, horizontal and vertical alignments; Geometric design of railway track; Airport runway length, taxiway and exit taxiway design.

Highway Pavements: Highway materials - desirable properties and quality control tests; Design of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible pavement using IRC: 37-2012; Design of rigid pavements using IRC: 58-2011; Distresses in concrete pavements.

Traffic Engineering: Traffic studies on flow, speed, travel time - delay and O-D study, PCU, peak hour factor, parking study, accident study and analysis, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Control devices, signal design by Webster's method; Types of intersections and channelization; Highway capacity and level of service of rural highways and urban roads.

Section 3: Geomatics Engineering

Principles of surveying; Errors and their adjustment; Maps - scale, coordinate system; Distance and angle measurement - Levelling and trigonometric levelling; Traversing and triangulation survey; Total station; Horizontal and vertical curves.

Remote sensing and GIS: Principles and fundamentals of Image Processing; Geographical Information Systems-Fundamentals and Advances, Surveying-Advances and GNSS, Photogrammetry -principles and applications Geographical Positioning system (GPS)

Section 4: Structural Engineering

Structural Mechanics : Analysis of Flexure, Torsion, Shear, Compression and Tension - Analysis of Structures-Force and Stiffness methods - Concrete making materials and Technology- Design of Concrete , Steel Structures- Plastic analysis and design-Prestressed Concrete- simple and continuous beams- Structural Dynamics- Analysis of Free and Forced vibrations-Damping- Seismic design- Modal analysis-Finite Element method - Theory of Elasticity-Analysis of Stress and Strain.

Construction Materials and Management: Construction Materials: Structural steel - composition, material properties and behaviour ; Concrete - constituents, mix design, short-term and long-term properties; Bricks and mortar; Timber; Bitumen.

Section 5: Geotechnical Engineering

Soil Mechanics: Origin of soils, soil structure and fabric; Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Darcy's law; Seepage through soils - two-dimensional flow, flow nets, uplift pressure, piping; Principle of effective stress, capillarity, seepage force and quicksand condition; Compaction in laboratory and field conditions; One- dimensional consolidation, time rate of consolidation; Mohr's circle, stress paths, effective and total shear strength parameters, characteristics of clays and sand.

Foundation Engineering: Sub-surface investigations - scope, drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and Coulomb; Stability of slopes - finite and infinite slopes, method of slices and Bishop's method; Stress distribution in soils - Boussinesq's and Westergaard's theories, pressure bulbs; Shallow foundations - Terzaghi's and Meyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations - types of piles, dynamic and static formulae, load capacity of piles in sands and clays, pile load test, negative skin friction.

Section 6: Water Resources Engineering

Fluid Mechanics: Properties of fluids, fluid statics; Continuity, momentum, energy and corresponding equations; Potential flow, applications of momentum and energy equations; Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth.

Hydraulics: Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Kinematics of flow, velocity triangles; Basics of hydraulic machines, specific speed of pumps and turbines; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, slope profile, hydraulic jump, uniform flow and gradually varied flow.

Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, flood estimation and routing, reservoir capacity, reservoir and channel routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's law.

Irrigation: Duty, delta, estimation of evapo-transpiration; Crop water requirements; Design of lined and unlined canals, head works, gravity dams and spillways; Design of weirs on permeable foundation; Types of irrigation systems, irrigation methods; Water logging and drainage; Canal regulatory works, cross-drainage structures, outlets and escapes.

Section 7: Construction Technology and Management

Project Planning & Management-Network Scheduling-PERT, CPM Construction Techniques-RC & PSC, Modular construction practice-Construction Economics & Finance-Depreciation, Project appraisal Quantitative Methods in Construction Management-Linear and Dynamic programming Construction Methods& Equipment- Equipment for Earth moving, Material transport, Pile driving, dewatering-Contract Management & Arbitration- types of contracts, disputes-Construction Materials-Concrete, polymers, Sealants.

SYLLABUS FOR PH.D. ENTRANCE EXAM- ENGLISH

- Drama
- Poetry
- Fiction, Short Story
- Non-Fictional Prose
- Language: Basic concepts, English in use.
- Indian Writing in English
- Literary Criticism
- Literary Theory
- Research Methods and Materials in English

**SYLLABUS FOR PH.D. ENTRANCE EXAM- FOOD SCIENCE &
NUTRITION**

ADVANCE FOOD SCIENCE NUTRITION

Food groups – balanced diet, food pyramid, RDA, BMI, BMR, macro and micro nutrition, Meal Planning, nutraceuticals, Functional foods, Prebiotics, Probiotic. Food microbes, Food toxicology. Major food constituents, their physicochemical properties. Principle of Food Science, Role of water in food. Carbohydrates, proteins and lipids: classification, physical, chemical, nutritional, and functional properties Structural correlations; auto-oxidation of lipids and rancidity Introduction Food science and nutrition,

Diet therapy, fevers, Allergy, Obesity, underweight, lung diseases, GI tract diseases. Nutritional intervention-national nutrition policies and programmes. Food and nutrition security. Quality evaluation of foods- objectives and subjective, Quality attributes; Classification of quality attributes. Food guidelines and safety measurement.

Food processing and preservation Basic concept and technology, Food Adulteration, Health hazards of food adulterants, Food additives, Food Laws and standards.

SYLLABUS FOR PH.D. ENTRANCE EXAM- FOOD TECHNOLOGY

Chemistry of Carbohydrates, Proteins, Lipids, Pigments, Food flavours, Enzymatic and non-enzymatic browning; amino acids and fatty acids classifications, Water soluble and fat soluble vitamins, Role of minerals in nutrition, Antinutrients in food, General Characteristics of microorganisms, Microbial growth in food: Intrinsic and extrinsic factors, Microbial Food spoilage, Food borne illness, food fermentation. Food Products Technology: Processing principles: Canning, chilling, freezing, dehydration, control of water activity, CA and MA storage, fermentation, hurdle technology, addition of preservatives and food additives, Food packaging, food laws; Grain products processing: Milling of rice, wheat, and maize, parboiling of paddy, cereal based products bread, biscuits, extruded products and breakfast cereals, Solvent extraction, refining and hydrogenation of oil; ripening of fruits, Fruits, vegetables and plantation products processing: jam, jelly, marmalade, squash, candies, and pickles, tea, coffee, chocolate and essential oils from spices; Milk and milk products processing: Pasteurized and sterilized milk, cream, butter, ghee, ice-cream, cheese and milk powder; Animal products processing: Drying and canning of fish, post mortem changes, tenderization and freezing of meat, egg powder. Basic food engineering - Heat transfer: Heat transfer by conduction, convection, radiation, boiling and condensation, sterilization, evaporation of liquid foods, drying methods, spray and freeze-drying, freezing and crystallization; Mass transfer operations. Novel Thermal

Techniques, dielectric heating, Microwave processing, Infrared heating, ohmic heating, pulse electric field, Properties and functions of various nutraceuticals – functional food ingredients – probiotic, prebiotic and symbiotic and their functional role. Antioxidants, nutraceuticals and functional foods. Analytical Instruments: Ultra violet spectroscopy; infrared absorption spectroscopy; near-infrared absorption spectroscopy; mass spectroscopy; nuclear magnetic resonance spectroscopy. , Biotechnology and food safety.

SYLLABUS FOR PH.D. ENTRANCE EXAM (LAW)

I. Jurisprudence

1. Nature and Sources of Law
2. Schools of Jurisprudence
3. Concept of Rights and Duties
4. Legal Personality
5. Concept of Property, Ownership and Possession

II. Constitutional Law

1. Preamble
2. Fundamental Rights and Duties
3. Directive Principles of State Policy
4. Judiciary

III. Administrative Law

1. Nature , Scope and Importance of Administrative Law
2. Principle of Natural Justice
3. Judicial Review of Administrative Actions

IV. Law of Crimes

1. General Principles of Criminal Liability – Actus reus and mens rea, individual and group liability and constructive liability
2. General Exceptions
3. Theories and Kinds of punishments
4. Compensation to the victims of crime

V. Law of Torts

1. Nature and Definition of Torts
2. General Principles of Tortious liability
3. General defenses

- 4, Strict and absolute liability

VI. Public International Law

1. Definition, Nature and Basis of International Law
2. Sources of International Law

VII. Family Law-I

1. Sources and schools
2. Marriage and Dissolution of Marriage

VIII. Environment and Human Rights Law

1. Meaning and Concept of Environment and Environmental Pollution
2. Concept and Development of Human Rights

IX. Intellectual Property Rights

1. Concept and Meaning of Intellectual Property
2. Theories of Intellectual Property

X. Comparative Public Law and System of Governance

1. Comparative Law – Relevance, Methodology, Problems and Concerns
2. Rule of Law – Formal and Substantive versions

SYLLABUS FOR PH.D. ENTRANCE EXAM – MECHANICAL ENGINEERING

Engineering Mathematics

Linear Algebra: Matrix algebra, systems of linear equations, eigenvalues and eigenvectors.

Calculus: Functions of single variable, limit, continuity and differentiability, mean value theorems, indeterminate forms; evaluation of definite and improper integrals; double and triple integrals; partial derivatives, total derivative, Taylor series (in one and two variables), maxima and minima, Fourier series; gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, applications of Gauss, Stokes and Green's theorems.

Differential equations: First order equations (linear and nonlinear); higher order linear differential equations with constant coefficients; Euler-Cauchy equation; initial and boundary value problems; Laplace transforms; solutions of heat, wave and Laplace's equations.

Complex variables: Analytic functions; Cauchy-Riemann equations; Cauchy's integral theorem and integral formula; Taylor and Laurent series.

Probability and Statistics: Definitions of probability, sampling theorems, conditional probability; mean, median, mode and standard deviation; random variables, binomial, Poisson and normal distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations; integration by trapezoidal and Simpson's rules; single and multi-step methods for differential equations.

Applied Mechanics and Design

Engineering Mechanics: Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.

Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

Fluid Mechanics and Thermal Sciences

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan-Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behaviour of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

Applications: *Power Engineering:* Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. *I.C. Engines:* Air-standard Otto, Diesel and dual cycles. *Refrigeration and air-conditioning:* Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes. *Turbomachinery:* Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines.

Materials, Manufacturing and Industrial Engineering

Engineering Materials: Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials.

Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding.

Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics

of machining; principles of non-traditional machining processes; principles of work holding, design of jigs and fixtures.

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools.

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Inventory Control: Deterministic models; safety stock inventory control systems.

Operations Research: Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

SYLLABUS FOR PH.D. ENTRANCE EXAM- MATHEMATICS

Real numbers system, sequence and series of functions, convergence and uniform convergence. Gauss theorem, Green's theorem, Stoke's theorem. Analytic functions, Cauchy-Riemann equations, Cauchy's theorems, singularities. Groups, Cayley's theorem, Sylow's theorem, Rings, Euclidean domains, unique factorization domains. Algebra of matrices, rank of a matrix, Eigen value and vectors. Vector spaces, basis and dimension, linear transformations, dual space, annihilators and inner product spaces. First order ODE and PDE, Existence and uniqueness of solution. Classification of second order PDE, wave, heat and Laplace equation. Linear integral equation of Fredholm and Volterra type, Variation of calculus, Euler-Lagrange equation. Numerical solutions of algebraic equations, numerical solution of systems of linear algebraic equations, finite differences, interpolation, numerical differentiation and integration, numerical solutions of ODEs. LPP, simplex method, dual of LPP, assignment Problem, transportation problem, queuing theory.

**SYLLABUS FOR PH.D. ENTRANCE EXAM - COMPUTER
APPLICATIONS/COMPUTER SCIENCE**

- 1) Fundamental of Computer Science
- 2) Data Science
- 3) Theory of Computation
- 4) Cloud Computing
- 5) Recent Trends in Computer Science

SYLLABUS FOR PH.D. ENTRANCE EXAM – MANAGEMENT

- 1) General Management
- 2) Marketing
- 3) Human Resource Management
- 4) Finance
- 5) International Business

SYLLABUS FOR Ph.D. ENTRANCE EXAMINATION- PHYSICS

1. Mathematical Methods of Physics: Vector calculus. Matrices and their properties, linear ordinary differential equations of first & second order, Special functions. Fourier series, Fourier and Laplace transforms. Complex analysis, Elementary probability theory, binomial, Poisson and normal distributions.

2. Classical Mechanics: Dynamical systems, Phase space dynamics, stability analysis. Central force motions, Variational principle, Lagrangian and Hamiltonian formalism Small oscillations, Poisson brackets and canonical transformations. Special theory of relativity.

3. Electromagnetic Theory: Electrostatics, Laplace and Poisson equations, Magnetostatics: Biot-Savart law, Electromagnetic induction. Maxwell's equations in free space. Electromagnetic waves in free space. Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction.

4. Quantum Mechanics: One dimensional Schrödinger equation. Commutators and Heisenberg uncertainty principle. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momentum; Hydrogen atom. Time-dependent and independent perturbation theory and applications. Variational method, identical particles.

5. Thermodynamic and Statistical Physics: Laws of thermodynamics. Maxwell relations, Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Classical and quantum statistics, Ideal Bose and Fermi gases. Blackbody radiation and Planck's distribution law.

6. Atomic & Molecular Physics: Quantum states of an electron in an atom. Electron spin, Spectrum of helium and alkali atom. LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electronic rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers.

7. Condensed Matter Physics: Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Free electron theory and electronic specific heat. Band theory of solids Superconductivity:

8. Nuclear and Particle Physics: Basic nuclear properties, Binding energy, semi-empirical mass formula, liquid drop model. Classification of fundamental forces. Elementary particles and their quantum numbers. Quark model, baryons and mesons.

9. Electronics and Experimental Methods: Semiconductor, device structure, device characteristics, frequency dependence and applications. Opto-electronic devices Operational amplifiers and their applications. Digital techniques and applications.