

PhD Entrance Syllabus

Structure of the PhD Entrance Test (100 Marks)

Section A: Aptitude and Reasoning – Common to all candidates (50 Marks)

Section B: Subject-Specific (Physics) (50 Marks)

Section A: APTITUDE & REASONING (Common to ALL)

Unit-1: Verbal Reasoning

Navigating Directions and Mastering Distances, Blood Relations, Logical Puzzles and Problem Solving- Floor Based, Month and Year Based. Seating Arrangements - Circular, Linear, Decoding the Code- Letter Coding, Number Coding, Letter and Number Coding.

Unit-2: Number System

Mastering Quick Calculations, BODMAS Simplified, Exploring Numbers and Division Rule, Unit Digits Decoded, Unlocking Divisibility and Counting Zeroes, "Mastering LCM and HCF: Foundations of Factorization, Uncovering Factors, Exploring Remainders.

Unit-3: Arithmetic Ability-1

Percentages - Fraction, Decimal, Percentage Change, Concept of 'By' and 'To', Product Constancy, All About Averages, Profit & Loss Essentials, Articles, False Weight, and Discount Insights - Discount, Simple Interest: Calculations and Applications, Compound Interest: Calculations and Applications, Relationship between SI and CI.

Unit-4: Arithmetic Ability-2

Ratio, Proportion, Partnership, Problems on Ages, Time and Work - Concept of Efficiency, Smart Work with Time and work, Negative Work, Chain Rule, Pipes and Cisterns, Time, Speed & Distance, Problems based on Trains, Problems based on Boats and Streams.

Unit-5: Critical Reasoning

Analogy and Classification, Sequence and Series Logic, Syllogisms - Types of statements, Venn diagrams using statements, Method to solve problems Two Statements and Two Conclusions, EITHER-OR Conclusions, Four Statements and Two Conclusions.



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Section: B Physics Syllabus for Ph.D. Admission Eligibility Test (any 5 modules)

Module I: Mathematical Physics

linear vector space: basis, orthogonality and completeness; matrices; similarity transformations, diagonalization, eigenvalues and eigenvectors; linear differential equations: second order linear differential equations and solutions involving special functions; Laplace transform, Fourier analysis; elementary ideas about tensors.

Module II: Classical Mechanics

D'Alembert's principle, Euler-Lagrange equation, Hamilton's principle, symmetry and conservation laws; central force motion; small oscillations; rigid body dynamics: orthogonal transformations, Euler angles, Torque free motion of a symmetric top; Hamiltonian and Hamilton's equations of motion; Liouville's theorem; canonical transformations: action-angle variables, Poisson brackets, Hamilton-Jacobi equation. Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Module III: Electromagnetic Theory

Electrostatic and magnetostatic; separation of variables; dielectrics and conductors; magnetic materials; Maxwell's equations; scalar and vector potentials; electromagnetic waves in free space, non-conducting and conducting media; reflection and transmission at normal and oblique incidences; polarization of electromagnetic waves; Poynting vector, Poynting theorem, energy and momentum of electromagnetic waves.

Module IV: Quantum Mechanics

Postulates of quantum mechanics; uncertainty principle; Schrodinger equation; Dirac notation, linear vectors and operators in Hilbert space; one dimensional potentials: step potential, tunneling from a potential barrier, particle in a box, harmonic oscillator; concept of degeneracy; hydrogen atom; angular momentum and spin; addition of angular momenta; variational method and WKB approximation, time independent perturbation theory; Born approximation; symmetries in quantum mechanical systems.

Module V: Thermodynamics and Statistical Physics

Laws of thermodynamics; macrostates and microstates; phase space; ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, phase equilibria, critical point.



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Module VI: Atomic and Molecular Physics

Spectra of one-and many-electron atoms; spin-orbit interaction: fine and hyperfine structures; Zeeman and Stark effects; electric dipole transitions and selection rules; rotational and vibrational spectra of diatomic molecules; electronic transitions in diatomic molecules, Franck-Condon principle; Raman effect; EPR, NMR, ESR, X-ray spectra; lasers: Einstein coefficients, population inversion.

Module VII: Solid State Physics

Elements of crystallography; diffraction methods for structure determination; bonding in solids; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; conductivity, mobility and effective mass; Optical properties of solids; dielectric properties of solid; polarizability, ferroelectricity; magnetic properties of solids; superconductivity: Type-I and Type II superconductors, Meissner effect, London equation, BCS Theory,

ModuleVIII: Electronics

Semiconductors in equilibrium: electron and hole statistics in intrinsic and extrinsic semiconductors; metal-semiconductor junctions; Ohmic and rectifying contacts; PN diodes, bipolar junction transistors, field effect transistors; negative and positive feedback circuits; oscillators, operational amplifiers, active filters; basics of digital logic circuits, combinational and sequential circuits, flip- flops, timers, counters, registers, A/D and D/A conversion.

ModuleIX: Nuclear and Particle Physics

Nuclear radii and charge distributions, nuclear binding energy, electric and magnetic moments; semi- empirical mass formula; nuclear models; liquid drop model, nuclear shell model; nuclear forces; alpha decay, beta-decay, electromagnetic transitions in nuclei; Rutherford scattering, nuclear reactions, conservation laws; fission and fusion; particle accelerators and detectors; elementary particles; quark model; conservation laws.