

Syllabus for PhD Physics written test

- a) **Mathematical methods:** Functions of complex variable, complex integrals, Fourier and Laplace transforms, series expansions, second order linear differential equations, vector calculus, vector spaces and matrices, elementary probability theory, error analysis.
- b) **Classical Mechanics:** Newton's laws of motion, generalized co-ordinates, variational principle, Lagrangian and Hamiltonian formulations, central forces, small oscillations and normal modes, rigid body motion, special relativity: Lorentz transformations, relativistic kinematics, mass-energy equivalence.
- c) **Quantum Mechanics:** Wave-particle duality, Heisenberg's uncertainty principle, operators, eigenvalues and eigenfunctions, Schrodinger's equation for simple one-dimensional problems and central potentials, Hydrogen atom, orbital and spin angular momentum and their algebra, matrix formulation, commutator algebra, variational method, time-independent & time-dependent perturbation theories, quantum mechanical scattering theory.
- d) **Thermodynamics and Statistical Mechanics:** Laws of thermodynamics, kinetic theory, Maxwell-Boltzmann distribution, Maxwell's equations, Statistical approach to a system, Ensemble theory: canonical ensemble, grand-canonical ensemble, partition functions, classical and quantum statistics, Fermi and Bose gases.
- e) **Electromagnetic theory:** Electrostatics and magnetostatics, dielectrics and conductors, Biot-Savart's and Ampere's laws, Faraday's law, Maxwell's equations and continuity equation, Vector potentials, Lorentz and Coulomb Gauges, Poynting's theorem, electromagnetic wave propagation in media: reflection, refraction, interference, polarization.
- f) **Solid State Physics:** Crystal structure and diffraction, lattice vibrations in periodic structures and thermal properties of solids, Electrical properties of metals, Fermi distribution, band theory of solids, magnetism in matter, semiconductor physics, elements of superconductivity.
- g) **Electronics:** LCR circuits, transistors, operational amplifiers, timers, logic circuits, flip-flops, filters and oscillators, rectifiers, power supplies, optoelectronics and communication techniques.
- h) **Atomic and Molecular Physics:** Atomic spectra, many electron atoms: coupling schemes for spin and orbital angular momenta, effect of electric and magnetic field on atoms, Molecular spectra, Raman effect, lasers.
- i) **Nuclear physics:** Static properties of nuclei, radioactive decay, alpha, beta and gamma emission, liquid drop model, semi-empirical mass formula, Fermi Model, shell model, Fermi's theory of beta decay, nuclear reactions and conservation laws, elements of nuclear fission, particle accelerators and detectors.