Syllabus: Doctoral Entrance Test (DET)

Mathematical Physics

Vector calculus, Special functions and applications (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions, Partial differential equations (Laplace, wave and heat equations in two and three dimensions).

Quantum Mechanics

Inadequacy of classical mechanics, Plank quantum hypothesis and radiation law, Photoelectric effect, de-broglie's theory. Schrödinger equation, continuity equation, Ehrenfest theorem, admissible wave functions, stationary states, one-dimensional problems; walls and barriers, Schrödinger equation for harmonic oscillator and its solution, uncertainty relations, states with minimum uncertainty product, three-dimensional square-well potential and energy levels the hydrogen atom; solution of the radial equation, energy levels and stationery state wave functions, discussion of bound states, degeneracy.

Condensed Matter Physics

Crystal Lattices, Lattice Planes and Miller Indices, Bravais Lattices and Crystal Structures, Crystal Defects and Surface Effects, Some Simple Crystal Structures, Bragg Diffraction, Laue Method, Reciprocal Lattice, Brillouin Zones, Diffraction by a crystal Lattice with a Basis, lattice specific heat, Free electron theory and electronic specific heat. Drude model of electrical and thermal conductivity, Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity.

Semiconductor Physics and Electronic Devices

Semiconductors- types, device physics, fabrication techniques, and characterization methods. P-N Junction diode, Special purpose electronic devices, Rectifiers, Filters, Bipolar Junction Transistor, FET, Amplifiers, Devices: MOSFET Structure and Operation, Ideal MOSFET: I-V Characteristics and Transconductance Nonideal/Secondary Effects. CMOS logic: CMOS Inverter DC characteristics & Digital logic design using CMOS Technology.

Material Characterization Techniques

Particle and radiation interaction with material, detectors: thermal, photon and electron detectors, Solid State and scintillation detectors, multi-channel analyzers(MCA), physical property measurements (DSC, DTA, TGA), X-ray diffraction, Transmission Electron Microscopy, Scanning Electron Microscopy, Infrared and ultraviolet/visible (IR, UV/Vis) absorption spectroscopy, Raman and Fluorescence spectroscopy, elementary idea of laser-based non-linear techniques, electrochemical techniques for energy and sensor technologies.