

Physics Syllabus

Section 1: Mathematical Physics

Linear vector space: basis, orthogonality and completeness; matrices; vector calculus; linear differential equations; elements of complex analysis: Cauchy Riemann conditions, Cauchy's theorems, singularities, residue theorem and applications. Laplace transforms; Fourier analysis; Elementary ideas about tensors: covariant and contravariant tensor, Levi-Civita and Christoffel symbols.

Section 2: Classical Mechanics

Alembert's principle; cyclic coordinates; variational principle; Lagrange's equation of motion; central force and scattering problems; rigid body motion; small oscillations; Hamilton's formalisms; Poisson bracket; Special theory of relativity: Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Section 3: Electromagnetic Theory

Solutions of electrostatic and magnetostatic problems including boundary value problems; dielectrics and conductors; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; Electromagnetic waves and their reflection, refraction, interference, diffraction and polarization; Poynting vector, Poynting theorem, energy and momentum of electromagnetic waves; radiation from a moving charge.

Section 4: Quantum Mechanics

Postulates of quantum mechanics; uncertainty principle; Schrodinger equation; one-, two-, and three-dimensional potential problems: particle in a box, transmission through one dimensional potential barriers, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momenta; time independent perturbation theory; elementary scattering theory.

Section 5: Thermodynamics and Statistical Physics

Laws of thermodynamics; macrostates and microstates; phase space; ensemble; 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.

Section 6: Atomic and Molecular Physics

Spectra of one and many electron atoms; 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, ESR, X-ray spectra; lasers: Einstein coefficients, population inversion, two and three level systems.

Section 7: 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: nearly free electron and tight binding models; metals, semiconductors and insulators; conductivity, mobility and effective mass; Optical properties of solids; Kramer's-Kronig relation, intra- and inter-band transitions; dielectric properties of solid; dielectric function, polarizability, ferroelectricity; magnetic properties of solids; dia, para, ferro, antiferro and ferri-magnetism, domains and magnetic anisotropy; superconductivity: Type-I and Type II superconductors, Meissner effect, London equation, BCS Theory, flux quantization.

Section 8: 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.

Section 9: Nuclear and Particle Physics

Nuclear radii and charge distributions, nuclear binding energy; Electric and magnetic moments; nuclear models, liquid drop model: semi-empirical mass formula; Fermi gas model of nucleus, nuclear shell model; nuclear force and two nucleon problem; alpha decay, beta decay, electromagnetic transitions in nuclei; Rutherford scattering, nuclear reactions, conservation laws; fission and fusion; particle accelerators and detectors; elementary particles, photons, baryons, mesons and leptons; quark model.