JEST-2015

Syllabus for Physics

Mathematical Methods

Vector algebra and vector calculus; linear vector spaces, linear operators, matrices and Eigen value problem; Sturm–Liouville theory, classical orthogonal polynomials; linear ordinary differential equations, exact and series methods of solution; linear partial differential equations, solution by separation of variables; complex variables, analytic functions, Taylor and Laurent expansions, contour integration; Fourier and Laplace transforms.

Classical Mechanics

Newton's laws, conservation of energy and momentum, collisions; generalized coordinates, principle of least action, Lagrangian and Hamiltonian formulations of mechanics; symmetry and conservation laws; central force problem, Kepler problem; rigid body motion; small oscillations and normal modes; special relativity in classical mechanics.
The uncertainty principle; conceptual basis of quantum mechanics; Schrodinger equation, problems in one, two and three dimensions, bound states and tunnelling, particle in a box, harmonic oscillator, hydrogen atom; matrix formulation of quantum theory, unitary transformations and Hermitian operators and their properties; orbital and spin angular momenta, addition of angular momenta; time independent and time dependent perturbation theory, Fermi golden rule; elementary scattering theory.

Electromagnetic Theory

Laws of electrostatics and magnetostatics, methods of solving boundary value problems, multipole expansion; fields in conducting, dielectric, diamagnetic and paramagnetic materials; Faraday's law and time varying fields; conservation of charge, displacement current; Maxwell's equations; energy and momentum of electromagnetic fields, Poynting theorem; propagation of plane electromagnetic waves, reflection and refraction of plane electromagnetic waves, electromagnetic waves in dispersive and conducting media; scalar and vector potentials, Coulomb and Lorentz gauge, wave equation in terms of electromagnetic potentials; radiation from moving charges, retarded and advanced potentials, Lienard-Wiechert potentials, multipole radiation, Larmor's formula.

Quantum Mechanics

The uncertainty principle; conceptual basis of quantum mechanics; Schrodinger equation, problems in one, two and three dimensions, bound states and tunnelling, particle in a box, harmonic oscillator, hydrogen atom; matrix formulation of quantum theory, unitary transformations and Hermitian operators and their properties; orbital and spin angular momenta, addition of angular momenta; time independent and time dependent perturbation theory, Fermi golden rule; elementary scattering theory

Thermodynamics and Statistical Physics

Laws of thermodynamics; work and heat; thermodynamic potentials, Maxwell's relations; statistical ensembles; partition function; classical ideal gas, harmonic oscillators; classical and quantum statistics; Fermi and Bose gases; black body radiation; first and second order phase transitions.

Solid State Physics

Simple crystal structures and X-ray diffraction; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; basic electrical, optical and magnetic properties of solids; elements of superconductivity.

Electronics

Diodes, rectifier circuits, junctions, transistors and field effect devices; device characteristics, frequency dependence and applications like active filters and oscillator circuits; solar cells, photo detectors, and LEDs; operational amplifiers and their applications; Boolean algebra, digital techniques and applications: registers, counters, comparators and similar circuits; A/D and D/A converters; microprocessor and microcontroller basics.

Nuclear and Particle Physics

Structure of the nucleus; binding energy, nuclear fusion and fission; radioactive decay, barrier penetration by alpha particles; classification of elementary particles and fundamental interactions, leptons and hadrons, elementary ideas of quark model; conservation laws in particle reactions.

Atomic and Optical Physics

Interference, diffraction and polarization of light; photoelectric effect; spectra of single and multiple electron atoms; Zeeman and Stark effects; electric dipole transition and selection rules; hyperfine structure; spontaneous and stimulated emission. Experimental data and error analysis

Probability theory

Gaussian and Poisson distributions; error analysis; propagation of errors; significant figures; least square fitting.