

Kashi Naresh University, Bhadohi

Department of Physics

Syllabus for Research Entrance Test (RET)

Unit 1: Mathematical Physics

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Theorem. Eigenvalues and eigenvectors, Fourier series, Fourier and Laplace transforms, Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Linear ordinary differential equations of first & second order.

Unit 2: Classical Mechanics

Newton's laws, Central force motions. Rigid body dynamics, Non-inertial and inertial frames Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Canonical transformation and Poisson brackets, Conservation laws and cyclic coordinates. Special theory of relativity-Lorentz transformations.

Unit 3: Electromagnetic Theory

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media, Scalar and vector potentials, gauge invariance, Electromagnetic waves in free space.

Unit 4: Quantum Mechanics

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier, Commutators, Commutation relation and Heisenberg uncertainty principle, Operators, Angular momenta algebra, Pauli spin matrices, Time-independent perturbation theory and applications, Pauli exclusion principle.

Unit 5: Thermodynamics and Statistical Mechanics

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions, Free energy and its connection with thermodynamic quantities, Classical and quantum statistics. Ideal Bose and Fermi gases, Blackbody radiation and Planck's distribution law.

Unit 6: Electronics

Semiconductor devices (diodes, junctions, transistors, field effect devices), device structure, device characteristics, and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Logic gates, Boolean algebra, De Morgan Theorem, Half adder, Full adder, Flip flop, Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits).

Unit 7: Atomic and Molecular Physics

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom, hyperfine structure and isotopic shift, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Frank-Condon principle. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation, Different types of lasers.

Unit 8: Condensed Matter Physics

Crystal structure, Bravais lattices, Reciprocal lattice, Diffraction and the structure factor. Free electron theory and Fermi and mean energy of electrons, Electron motion in a periodic potential, Bloch theorem, band theory of solids, Effective mass. Superconductivity: Meissner effect, type-I and type-II superconductors, Josephson junctions. Defects and dislocations.

Unit 9: Nuclear and Particle Physics

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions. Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance.