SABARMATI UNIVERSITY

Research Entrance Aptitude Test (REAT)-(2025-26)

Section B

Physics syllabus

Unit 1 Mathematical Physics

Linear vector space: basis, orthogonality and completeness; matrices; similarity transformations, diagonalization, eigenvalues and eigenvectors; linear differential equations: second order linear differential equations and solutions involving special functions; complex analysis: Cauchy Riemann conditions, Cauchy's theorem, singularities, residue theorem and applications; Laplace transform, Fourier series; elementary ideas about tensors.

Unit 2 Classical Mechanics

Newton’s laws, Phase space dynamics. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics- moment of inertia tensor. Non-inertial frames and pseudo forces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Special theory of relativity- Lorentz transformations, relativistic kinematics and mass–energy equivalence. Poisson brackets and canonical transformations. Hamiltonian and Hamilton's equations of motion; Liouville's theorem; canonical transformations: Poisson brackets, Hamilton-Jacobi equation.

Unit 3 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. Wavefunction in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, Spin-orbit coupling, fine structure. WKB approximation.

Unit 4 Electrodynamics

Solutions of electrostatic and magnetostatic problems including boundary value problems; method of images; separation of variables; dielectrics and conductors; magnetic materials; multipole expansion; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges;

electromagnetic waves in free space, non-conducting and conducting media; reflection and transmission at normal and oblique incidences; polarization of electromagnetic waves;

Poynting vector, Poynting theorem, energy and momentum of electromagnetic waves; radiation from a moving charge.

Unit 5 Thermodynamics & Statistical Physics

Laws of thermodynamics; macrostates and microstates; phase space; ensembles; 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 equilibrium, critical point.

Unit 6 Atomic & Molecular Physics

Spectra of one-and many-electron atoms; spin-orbit interaction: LS and jj couplings; fine and hyperfine structures; Zeeman, Paschen-Bach and Stark effects; electric dipole transitions and selection rules; rotational and vibrational spectra of diatomic molecules; electronic transitions in diatomic molecules, Franck-Condon principle; Raman effect; EPR, NMR, ESR, X-ray spectra; lasers: Einstein coefficients, population inversion, two and three level systems.

Unit 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. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations.

Unit 8 Nuclear & 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, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Shell model. Elementary ideas of alpha, beta and gamma decays. 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. Application of symmetry arguments to particle reactions.

Unit 9 Astronomy & Astrophysics

Celestial Sphere and Time, Apparent and Mean Position of stars, Stellar Distances and Magnitudes, The Earth's Upper Atmosphere, Surface features of the Sun, General features of planets. Asteroids, Meteors, Meteorites and Comets. Types of telescopes.