**Mathematical Methods of Physics**

Dimensional analysis, Vector algebra and calculus, Linear algebra, matrices, Linear ordinary differential equations of first & second order, Special functions, Fourier series, Fourier and Laplace transforms, complex analysis, analytic functions, Taylor & Laurent series, poles, residues and evaluation of integrals, Elementary probability theory, binomial, Poisson and normal distributions, Green's function, Partial differential equations. Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule.

**Classical Mechanics**

Newton's laws, Dynamical systems, Phase space dynamics, stability analysis, Central force motions, Two body Collisions, Non-inertial frames and pseudoforces, Variation principle, Generalized coordinates, Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws, small oscillations, normal modes. Special theory of relativity, Poisson brackets and canonical transformations, Symmetry, invariance and Noether's theorem, Hamilton-Jacobi theory.

**Electromagnetic Theory**

Electrostatics, boundary value problems, Magnetostatics, Electromagnetic induction. Maxwell's equations in free space and linear isotropic media, Scalar and vector potentials, gauge invariance. EM waves, Dielectrics and conductors, Reflection, refraction, polarization, Fresnel's law, interference, coherence and diffraction, Dynamics of charged particles, Dispersion relations, Lorentz invariance of Maxwell's equation, Transmission lines and wave guides, Radiation- from moving charges and retarded potentials.

**Quantum Mechanics**

Wave-particle duality, Schrödinger wave equation, Eigenvalue problems, Tunneling, Wave-function in coordinate and momentum representations, Commutation relations, Heisenberg uncertainty, Dirac notation, Motion in a central potential, Hydrogen atom, Stern-Gerlach experiment, perturbation theory, Variational method, Fermi's golden rule, selection rules, Identical particles, Pauli exclusion principle, spin-statistics connection, Spin-orbit coupling, fine structure, WKB approximation, scattering, Born approximation, Relativistic quantum mechanics, Semi-classical theory of radiation.

**Thermodynamic and Statistical Physics**

Laws of thermodynamics and their consequences, Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria, Phase space, ensembles, partition functions, Free energy, Classical and quantum statistics, Ideal Bose and Fermi gases, Blackbody radiation, Planck's distribution, phase transitions, magnetism, Ising model, Bose-Einstein condensation, Random walk problem.

**Electronics and Experimental Methods**

Semiconductor devices, characteristics, frequency dependence and applications, Opto-electronic devices, Operational amplifiers, Digital techniques and applications, A/D and D/A converters, Microprocessor,

Precision and accuracy, Error analysis, propagation of errors, Least squares fitting, Linear and nonlinear curve fitting, chi-square test, Transducers, High frequency devices.

**Atomic & Molecular Physics**

Quantum states of an electron in an atom, Electron spin, Spectrum of helium and alkali atom, Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings, Zeeman, Paschen-Bach & Stark effects,

Electron spin resonance, NMR, chemical shift, Frank-Condon principle, Born-Oppenheimer approximation, Electronic, rotational, vibrational and Raman spectra,, lasers, coherence length.

**Condensed Matter Physics**

Bravais lattices, Reciprocal lattice, Diffraction and the structure factor, Bonding of solids. Elastic properties, phonons, lattice specific heat, Free electron theory, electrical and thermal conductivity, Hall effect, Electron motion in a periodic potential, band theory of solids, Superconductivity, Josephson junctions, Superfluidity, Defects and dislocations, Ordered phases of matter, Quasi crystals.

**Nuclear and Particle Physics**

Basic nuclear properties, 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, Evidence of shell structure, single-particle shell model, its validity and limitations, Rotational spectra, Elementary ideas of alpha, beta and gamma decays and their selection rules, Fission and fusion, Nuclear reactions, reaction mechanism, compound nuclei and direct reactions.

Classification of fundamental forces, Elementary particles and their quantum numbers, Gellmann-Nishijima formula, Quark model, baryons and mesons, C, P, and T invariance, Application of symmetry arguments to particle reactions, Parity non-conservation in weak interaction, Relativistic kinematics.