26. PHYSICS

DETAILS OF SYLLABUS

I. BASIC MATHEMATICAL METHODS

Vector algebra and vector calculus, matrices, tensors (elementary methods), Linear differential equations, Fourier-series, Elementary complex analysis, Error analysis in experiments.

II. CLASSICAL MECHANICS

Basic principles of classical dynamics, Lagrangian and Hamiltonian Formulations, symmetries and conservation laws, Motion in a central force field, collisions and scattering, wave motion, wave equation, phase velocity and group velocity, special theory of Relativity-Lorentz transformations, mass-energy equivalence.

III. ELECTROMAGNETICS

Electrostatics - Laplace and Poisson equations, boundary value problems (simple cases), magnetostatics - Ampere's theorem, Biot-Savart law, time varying fields, Maxwell's equations and conditions at a Boundary, Scalar and vector potentials, Electromagnetic waves, reflection and refraction at perfect conductor and dielectric, Rectangular waveguides - TE and TM waves. Electro dynamics of a charged particle in electric and magnetic fields, Poyting's vector.

IV. THERMODYNAMICS AND STATISTICAL PHYSICS

Laws of thermodynamics , Thermodynamic potentials, Maxwell relations, Chemical potential, Phase space - concept of ensembles, partition function, Classical and quantum statistics, degenerate electron gas, black body radiation and Planck's law, Bose-Einstein condensation.

V. QUANTUM MECHANICS

Wave particle duality, uncertainity principle, Schrodinger equation, particle in a box, Harmonic oscillator, Quantum mechanical tunneling, Orbital angular momentum, Angular momentum algebra, Spin, Addition of angular momenta, Schrodinger, Heisenberg and interaction pictures.
Matrix representation, Dirac's bra and ket notation , Hydrogen atom, Spin – orbit coupling, Fine structure, Variational method, Time independent perturbation theory.

VI. ELECTRONICS

Physics of p-n junctions, Diode and a circuit element, clipping, clamping and rectification, Regulated power supply, Transistor and a circuit element, CC, CE and CB configurations, Feedback in amplifiers. FET. Operational amplifier and its applications - inverting and non-inverting amplifiers, Adder, Integrator, Differentiator, Oscillators. Transistor as a switch, OR, AND and NOT gates, Digital integrated circuits – NAND and NOR as universal building blocks, X-OR gates, simple combinational circuits. Half & full adder, Flip-Flops, Shift-registers and counters, A/D and D/A converters.
Opto electronic devices including solar cells, Photo detectors and LEDs. Communication - analog and digital, modulation - elementary ideas of amplitude, frequency and phase modulation. Demodulation. Space communication - Satellite communication. Line communication and Optical communication.

VII. ATOMIC AND MOLECULAR PHYSICS

Spectra of hydrogen atom, hydrogen - like ions, spin - orbit interaction, fine structure, hyper fine structure, two electron systems - LS and jj couplings, Zeeman, Paschen - Back effects, Stark effect (One electron only)
Principles of light emissions and absorption, spontaneous and stimulated emission, Einstein' A and B coefficients, Lasers. Rotational spectra of molecules, vibrational spectra, rotational - vibrational spectra, electronic spectra of molecules - Franck - Condon principle - IR and Raman spectra - elementary ideas of NMR, ESR and Mossbauer spectroscopy.

VIII. CONDENSED MATTER PHYSICS

Crystal classes and systems, Crystal structure, X-ray diffraction methods, Bragg and Laue defraction, structure factor, reciprocal lattice. Lattice vibrations of monoatomic and diatomic lattices, phonons, specific heat of solids. Free electron theory, Fermi-Dirac statistics of electron gas , Specific heat of solids - Einstein's and Debye's models. Electron motion in periodic potential, band theory - metals, insulators and semiconductors. Electrical conductivity, Hall effect. Dielectrics - polirization mechanisms, Piezo, pyro and ferro electricity, Dia and para magnetisms. Super conductivity - Meissner effect, Type I and Type II super conductors. Cooper pairs, BCS theory (elementary ideas).

IX. NUCLEAR AND PARTICLE PHYSICS

Basic nuclear properties - size, shape, charge distribution, spin and parity. Characterestis of nuclear force, Deuteron problem. Radioactivity. Nuclear reactions, elementary ideas of reaction mechanism, compound nucleus. Nuclear fission - neutrons released in fission, cross sections, liquid drop models, semi - empirical mass formula. Principles of Nuclear Fusion. Nuclear shell model.

Interaction of radiation with matter, particle detectors - GM counter, ionisation chamber, scintillation counter.

Particle physics - symmetries and conservation laws, classification and properties, isospin, strangeness, Elementary ideas of Quark model.