B.Sc. Part III Syllabus

Paper – I QUANTUM MECHANICS

Need of Quantum Mechanics, Schrodinger Equation and interpretation of wave function.

Observables and Operators, Hermitian operator, Parity operator, Commutation relations, Eigen values and eigen functions, orthonormality and completeness, Dirac Delta function.

Measurement in Quantum Mechanics, Non-Commutability, uncertainty, Expectation values, Ehrenfest's Theorem.

Separation of variables in Time-Dependent Schrodinger Equation. Density of states, One-dimensional Potential Barrier problems. Tunneling through square well potential.

One – dimensional Harmonic Oscillator, Hermite Polynomials, Zero-point energy, Correspondence with Classical theory.

Angular Momentum, Commutation Relations. Eigen Values and Eigen functions of $\hat{L}^2$, $\hat{L}_Z$ and ladder ($\hat{L}_+$, $\hat{L}_-$) operators.

Spherically symmetric potentials, Complete solution of the Hydrogen – Atom Problem, Hydrogen Spectrum.

Elementary concept of spin, Pauli Matrices and spin wave functions. Total angular momentum.

Time-independent, non-degenerate, first – order Perturbation Theory, Spin – Orbit coupling. Ground and excited states of Helium atom and exchange degeneracy.

Qualitative and Elementary Idea about Lamb Shift.

Identical Particles, Symmetric and Antisymmetric wave functions, Pauli's Exclusion Principle.

Paper – II STATISTICAL MECHANICS AND SOLID STATE PHYSICS

Statistical Mechanics:

Elementary concepts of Lagrangian and Hamiltonian, Hamilton equations of Motion, Microscopic and Macroscopic systems, Phase space representation, Division of phase space into cells, Liouville theorem and its consequences, Statistical ensembles, Equilibrium and fluctuations, Distribution probability, Equilibrium between two macroscopic systems in thermal diffusive and mechanical contacts, Postulates of quantum statistical mechanics, Entropy and probability, Entropy of a perfect gas using the concept of micro canonical ensemble, Gibbs Paradox, Partition functions, Thermodynamical functions, Calculations of entropy of perfect monoatomic gas using canonical and grand canonical ensemble. Principle of Equipartition of the energy, Maxwell's velocity distribution, Distribution function for two types of quantum statistics (Bose–Einstein and Fermi-Dirac): Simple applications (Black – body radiations, and Electronic specific heat).

Solid State Physics:

Crystalline amorphous and glassy state of solids, Lattices translation vector, Crystal lattices, Primitive lattice cell, Miller indices, interplaner spacing, Bravais lattices, Crystal structures of s. c., b. c. c., f. c. c., diamond and h. c. p.

Reciprocal Lattice: s. c., b. c. c., and f. c. c. lattices, Brillouin Diffraction conditions in reciprocal lattice, Bragg's law.

Interatomic forces and classification of solids: Inert gas solids, Vander Waals-London interaction, Repulsive interaction and equilibrium lattice constant, Compressibility and Bulk modulus, Lattice energy of ionic crystals. Madelung constant, Cohesive energy, Generalised Hooke's law, Elastic constants of cubic crystals, Vibrations of monoatomic linear chain, Dispersion relation, Density of modes, Group velocity, Vibrational spectrum of lattice with two atoms per primitive cell, acoustic and optical modes. Lattice specific heat, Einstein and Debye models.

Free electron theory: Free electron gas in one dimension: Energy levels and density of states, Fermi Energy, Electrical conductivity,Hall effect.

Band theory of solids: Energy Bands; Kronig – Penny model in one dimension, Energy gap, Number of state in a branch, Distinction between metal, semi-conductor and insulator. Intrinsic semi-conductors, Variation of Fermi level with temperature, Effective mass.

Paper – III BASIC DIGITAL ELECTRONICS AND PHOTONIC DEVICES

Review of characteristics of a semi-conductor diode: cut-in voltage, explanation of storage and transition capacitances.

BJ transistor as a switch, Analytic expression using Ebers-Moll model, saturation properties for normal, inverse and emitter follower mode and their comparisons. Switching speed of a diode, storage and transition time, switching speed of a BJT**.** Metal-semi-conductor junction, Schottky diode and transistor.

Field effect transistor, principle of operation, a practical FET structure, MOSFET, enhancement and depletion modes, their representations. The MOS switch.

Logic Circuits: AND, OR, NOR, NOT, NAND and Ex-OR operations, Truth tables, their representations, Venn diagrams.

Binary notation, Boolean algebra, Karnaugh mapping. The Resistance-transistor logic, RTL nor gates, pull-up resistors, fanout, I/O characteristics, noise margin, rise time, RTL Ex.- OR gate.

The diode-transistor gate, fan out, I/O characteristics. The transistor-transistor logic, comparison between TTL and DTL. The active pull-up, I/O characteristics.

Combinational logic circuits: Half-adder, full adder, parallel and series addition. Half and full subtractor. BCD adder.

Integrated circuits: Various techniques of fabrication, LSI and MSI, metal semi-conductor contact.

Photonic devices: Photoelectric effect in semi-conductors, photoresistors and photoconductors, visible light emitting diodes and displays, Photodiode, phototransistor, p-n junction solar cell and its characteristics.

Paper – IV ELECTROMAGNETIC THEORY, LASER, HOLOGRAPHY AND OPTICAL INSTRUMENTS

Electromagnetic Theory: Electrostatic potential due to a charge distribution, Multipoles and their interaction with electrostatic field, Solution of Laplace Equation by separation of variables in Cartesian Spherical and Polar Coordinates.

Poynting's Theorem, Conservation of energy and momentum for a system of charged particles and electromagnetic fields, Maxwell's stress tensor.

Plane wave solution of Maxwell's equations in source-free space and simple dielectrics.

Polarisation of electromagnetic waves. Plane wave propagation in metal and plasma.

Elementary theory of dispersion.

Boundary condition at a discontinuity, Fresnel's formula.Total internal reflection, Metallic reflection, and skin depth.

Laser: Stimulated and spontaneous emission. Einstein's coefficients, relative contribution of stimulated and spontaneous emissions, population inversion, Laser emission, characteristic of Laser light (including temporal), Amplification in an inverted medium, threshold condition for lasing.

Holography : Basic principles of Holography, Recording and Viewing of a hologram. Thick Hologram, Multiplex hologram, White light reflection holograms.

Optical Instruments: Introduction of multiple beam interferometry, Fabry-perot interferometer and etalon (resolving power and determination of wavelengths), Resolving power of Lumer Gehreck plate, Grating and prism spectrograph for visible, IR and UV regions.