Physics
B.Sc.Part I

Paper I : Mechanics and Special Theory of Relativity

Unit 1. Mechanics :

Background of Vector calculus: Concepts of gradient, Divergence and curl ; Line, Surface and Volume Integrals, Frame of Reference, Galilean transformation, Galilean Invariance, Intertial and Noninternal frames, Pseudo forces, Rotating reference frame, Centrifugal force, Coriolis Force.

System of particles, Centre of Mass, Linear momentum, Centre of mass frame, Rotational motion in two and three dimensions, Angular momentum, Moment of inertia, Tensor, Central forces, Conservative forces, Potential energy, Gravitational potential and field due to a unifrom spherical shell and solid sphere, Conservation Laws.

Unit 2. Motion Under a Central Force :

Two-particle problem , Reduced mass, lab and centre of mass coordinate systems, Motion in an inverse square field, Kepler's law, Motion of Satellite, Geostationary Satellite.

Unit 3. Mechanics of Non-Rigid Bodies : Strain and Stress in an isotropic homogeneous medium, Elastic moduli and relations between them,Torsion of cylinders, Bending of beams, Internal energy of a strained body.

Unit 4. Fluid Mechanis : Ideal fluids, Equation of continuity, Streamline flow, Rotational and irrotational flows, Euler's equation, Bernouli's Theorem, Viscous fluids, Poiseuille's equation, Viscosity by rotating cylinder method.

Unit 5. Special Theory of Relativity : Inference of Michelson-Morley Experiment, Postulates of special relativity, Lorentz transformations, Length contraction, Time dilation, Simultaneity in relativity theory, Addition of velocities, Relativistic dynamics, Variation of mass with velocity, Mass-Energy relation, Relativistic Doppler shift, Aberration.

Paper II: Optics

Unit 1 :Cardinal Points of coaxial optical system, simple problems on combination of thin lenses, Eyepieces, Aplantic points, Nature

of light, Elementary ideas of electromagnetic wave and photon theories of light, Complex representation of waves and its application (to be used in the theory of various phenomenona).

Unit 2. Conditions for observing interference, Degree of coherence and visibility of fringes, Production of interference fringes and

determination of wavelength, Michelson interferometer and its uses, Colour of thin films,Newton's Rings,Theory of Multiple Reflections, FP Etalon.

Unit 3. Fresnel's theory of diffraction, Half-period elements, Diffraction from circular obstacle and aperture (Elementary theory), Zone plate, Fresnel diffraction by straight edge and single slit.

Unit 4. Fraunhofer's diffraction by single slit and double slit, Theory of plane grating, Width of principal maxima, Rayleigh's criterion of resolution, Resolving power of prism, Grating and FP etalon.Limit of resolution for telescope, Concave grating (elementary theory), and its mountings.

Unit 5. Unpolarised, Polarised and Partially Polarised lights. Polarisation by Reflection, Double refraction by Uni-axial crystals, Polaroids, Huygen's Theory of Double Refraction,Half and quarter Waveplates, Production of Elliptically Polarised light, Analysis of Elliptically Polarised Light by using a Nicol and a quarter wave Plate, Optical activity,Fresnel's theory of Optical Rotation, Specific rotation, Biquartz and Laurent's half-shade polarimeters.

Paper III: Thermal Physics

Unit 1. Thermodynamics : Thermodynamic Systems, Macroscopic and Microscopic Variables, Thermodynamical Equilibrium, Ther modynamical State Zeroth law of thermodynamics and concept of temperature, Heat and work and their path, Depend ence, Thermal processes, First Law of Thermodynamics and Internal Energy, Joule's Law, Applications of First Law,Carnot Cycle, Carnot Engine and Refrigerator, Reversible and Irreversible Process, Carnot Theorem, Thermodynamical Scale of Temperature, Clausius-Clapeyron's Equation, Specific Heat of Saturated Vapour.

Unit 2. Clausius Theorem, Clausius Inequality, Entropy, Calculation of Entropy in various processes, Entropy and unavailable energy, Physical Significance of Entropy, Second law of Thermo dynamics, Conditions for Natural Changes, Thermodynamical Potentials and Maxwell's Equations, Application of Maxwell's equations, Joule-Thomson Effect Inversion Temperature, Change of Phase, First and Second Order Phase Transitions and Ehrenfest's Equation.

Unit 3. Kinetic Theory of Gases : Maxwell-Boltzmann Law of Distribution of Molecular Velocities, Evaluation of r.m.s. velocity, Average and Most Probable Speeds, Mean Free Path, Transport Phenomenon.

Unit 4. Conduction of Heat : Fourier equation for one dimensional flow of heat and its steady state solution,periodic flow of heat (only sinusoidal heat current).

Unit 5. Radiation : Radiation as electromagenatic waves, Emissive and Absorptive Powers, Radiation in a hollow enclosure, Black Body Radiation, Kirchoff's Law , Intensity and Energy Density, Pressure and Energy density,Stefan-Boltzmann Law,Solar con stant and temperature of Sun,Temperature of Non black bodies, Distribution of energy in the spectrum of black body radiation,Adiabatic Expansion of black body radiation, Wein's Distribution Law, Wein's displacement law, Wein's formula, Rayleigh- Jean's law, Plank's law.

Physics
B.Sc.Part II

Paper - I Oscillations, Waves and Electromagnetism

Unit 1. Oscillations : Simple Harmonic Motion,Damped motion, Steady Forced Oscillations,Resonance,Fourier series decomposition, simple cases of square, saw-tooth and rectified sinusoidal waves.

Unit 2. One-dimensional Wave-motion in Non-dispersive Media: Wave equation,progressive wave solution,particle velocity and wave velocity, equation for wave in fluids and on strings,specific acoustic impedance of fluids and characteristic impedance of strings,energy density,intensity of energy transfer,reflection and transmission of plane waves at a discontinuity,standing wave solutions,modes of natural oscillations,energy considerations. Ultrasonics : Generation and detection,measurements of velocity in liquids, applications.

Unit 3. Electrostatics in free space : Coulomb law,electric field, simple cases of charge distributions,Gauss flux law-integral and differential forms, electric dipole in electrostatic field,irrotational nature of electrostatic potential,simple cases of charge distribution. Electrostatics in Dielectrics : Polarization, polarization charges, field D, Gauss flux law-integral and differential forms and simple applications,energy of change distribution,energy as an integral over the field,simple problem parallel plate condenser,uniformly charged spherical surface and volume.

Unit 4. Electrical Current : Current density vector,equation of continuity, Ohm and Joule's laws - integral and differential forms. Magnetostatics: Ampere's law, Biot Savart's law of force in magnetic field on currents and charged particle, magnetic field due to a straight infinite wire magnetic field due to circular loop and solenoid at axial points, vector potential and its evaluation for unifrom magnetic field and for straight infinite wire, divergence and curl of B,distant field due to a loop of current,magnetic moment, magnetic materials and magnetization, magnetization current field H, curl of H and calculation of H.

Unit 5. Time Varying Fields : Displacement current , curl of H , Faraday's law-integral and differential forms, self and mutual inductances, energy of coupled circuits and current distribution, $M \leq \sqrt{(L1\ L2)}$ energy as integral over the magnetic field,energy of solenoid.Electromagnetic Waves in Free-Space:Maxwell equations, plane polarized plane wave solution, characteristics of these electromagnetic waves.

Paper - II Electrical Circuit and Basic Semiconductor Electronics

Unit 1. Electrical Circuits : Circuit parameters, R , L and C, Kirchoff's law for a loop and junction, solutions by determinant and matrix method :application to T, p and bridge circuits , Norton and Thevenin's theorem, maximum power transfer theorem.

Unit 2 : Difference between steady state and transient, growth and decay of current in an inductive circuit, charging and discharging of a capacitor through a resistor and through inductor and resistor in series, ballistic galvanometer, Cs and Qs, measurement of capacity and of high resistance by leakage method.

Unit 3 : A.C. Analysis (Vector Treatment only): Complex impedance and phasor notations, impedance and admittance operators, vector diagram for voltage and current in LR, CR and LCR in series and parallel, power consumed in the circuit, series and parallel resonance, Q of a coil, transformer-its equivalent circuit. AC Bridges: Balance and sensitibity conditions for AC bridge, measurement of L by Maxwell's bridge, measurement of C by Schering's bridge.

Unit 4. Basic semi-conductor Electonics- Conduction in solids: Conductor,insulator and semi conductor,electrons and holes as charge carriers, intrinsic and extrinsic semi-conductors,conductivity and mobility ,conduction by diffusion and drift.P.N. Junction: Built in-voltage and charge depletion region, statement of diode equation and diode characteristics, forward and reverse resistance, Zener diode:its characteristics, filtering by RC and LC circuit, Regulation voltage regulation using Zener diode.

Unit 5. BJT : NPN and PNP transistor action,characteristics in CB and CE configuration, hybrid,alpha and beta paramters,their interrelationships, load line, small signal hybrid equivalent circuit, CE amplifier, middle frequency response, practical amplifier circuit, principles of feedback, Barkhausen criteria for sustained oscillations, qualitative discussion of collector tuned oscillator,circuits of Hartley and colpitts oscillator. Modulation: Need for modulation, three types of modulation. Frequency spectrum and power in a.m. wave, a typical a.m. circuitt linear, diode detector. C.R.O.:Working of cathode ray tube, block diagrom of CRO,typical application of CRO.

Paper - III Atomic and Nuclear Physics

Unit 1. Atomic Physics: Bohr-Sommerfeld model (historical developments) Bohr model and the spectra of hydrogenic atoms,critical resonance and ionization potentials, Franck-Hertz experiment, characteristic and continuous X-rays, Moseley's law,Bragg's law, space quantization, vector atom model and quantum numbers, magnetic moment of the electrons and magneton, Larmor precession, electron spin, Stern-Gerlach experiment,qualitative concept of various quantum number of an electron, Pauli's exclusion principle and electronic configuration of atoms.

Unit 2: Magnetic Properties of Materials: Dimagnetism,Larmor's theory and diagmagnetic susceptibility,paramagnetism,Langevin's theory and Curie-Weiss Law.

Unit 3: Quantum Concepts: Particle nature of radiation, photoelectric effect and comptom effect,wave nature particles,de-Broglie waves,Davisson-Germer experiment, wave packets, phase velocity and group velocity, Heisenberg's uncertainity principle and applicaions, one dimensional Schrodinger's wave equation and concept of probabilities, amplitude,application to one-dimensional potential step and barrier, quantum mechanical tunneling.

Unit 4. Nuclear Physics:Natural radioactivity,laws a of radioactive disintegration, radioactive series,detection of radiation, GM counter and bubble chamber, scintillation counter, kinematics of nuclear reactions, artificial nuclear transmutation, discovery of neutron, radioactive tracers transuranic elements, Cyclotron.

Unit 5: Constitution of nucleus,binding energy, liquid drop model and the semiempirical mass formula, elementary theory of Alpha decay, Beta-decay and discovery of neutrino, magic numbers and the shell model, fission and fusion, thermonuclear energy. Classificatoin of Elementary Particles.

Physics
B.Sc.Part III

Paper I : Classical Mechanics & Quantum Mechanics

Unit - I : Generalized Co-ordinates, Lagrangian & Lagrange equations,motion under inverse square law of force, Shape of orbits, Keplers law ,Hamiltonian and Hamilton's equations of motion.

Unit - II : Quantum Mechanics : Need of quantum mechanics, Schrodingerequations 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.

Unit - III : Special functions : Legendre, Hermite and Bessel differential equations and solutions, orthonormality.

Unit - IV : Non commutability, Uncertainty, Expectation values, Ehrenfest's theorem, Separation of variables in time dependent Schrodinge requation, Density of states, one dimensional potential barrier, tunneling through square well potential, one dimensional harmonic oscillator, Hermite polynomials. Zero point energy, correspondence with classical theory.

Unit - V : Angular momentum, commutation relations, eigen values & eigen functions of L2 , Lz & ladder L+ , L-operators, spherically symmetric potential, complete solution of hydrogen atom problem , identical particles , symmetric and anti symmetric wave functions, Pauli's exclusion principle.

Paper II : Statistical Mechanics & Solid State

Unit - I : Microscopic & macroscopic systems, phase space representation, division of phase space into cells, Liouville theorem & its consequences, statistical ensembles, equilibrium and fluctuations, distribution probablity, equilibrium between two macro scopic systems in thermal diffusive and mechanical contacts, postulates of quantum statistical mechanics, entropy and probablity , entropy of a perfect gas using the concept of micro-canonical ensemble, Gibbs paradox, partition functions, thermodynamical functions, calculation of entropy of perfect monatomic gas using canonical and grand canonical ensemble.

Unit - II : Principle of equipartition of energy, Maxwell's velocity distribution, distribution function for Bose-Einstein & Fermi-Dirac statistics, simple applications to black body radiations and electronic specific heat.

Unit - III : Solid State Physics : Crystalline amorphous and glassy state of solids.Lattiges translation vector. crystal lattices, primitive lattice cell
Miller indices, inter planer 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.

Unit - IV : Inter atomic forces and classification of solids : Inert gas solids, Vander Walls -London interaction, repulsive interaction and equilibrium lattice constant. Compressibility and bulk modulus. lattice energy of ionic crystals, Madelung constant, cohensive energy, generalized Hook's law, elastic constants of cubic crystals, vibration of monoatomic linear chain dispersion relation, density of modes, group velocity, vibrational spectrum of latice with two atoms per primitive cell (qualitative), acoustic and optical modes. lattice specific heat, Einstein model.

Unit - V : 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 states in a branch, distinction between metal semiconductor and insulator, intrinsic semiconductors, variation of Fermi level with temperature, effective mass.

Paper III : Basic Digital electronics & Photonic Devices

Unit - I : Review of characteristics of a semi-conductor diode : cut-in voltage, explanation of storage and transition capacitance. BJT 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.

Unit - II : Logic circuits : AND, OR, NOR, NOT, NAND AND XOR 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 characteristic, noise margin, rise time, RTL Ex-OR gate.

Unit - III : The diode-transistor gate, fan out. I/O characteristics, the transistor -transis tor Logic, comparison between TTL and DTL, the active pull-up, I/O characteristics.

Unit - IV : Combinational logic circuits : Half-adder, full adder, parallel and series addition, Hall and full subtractor, BCD adder., Integrated circuits : Various techniques of fabrication, LSI and MSI, metal semi conductor contact.

Unit - V : Photonic devices : Photoelectric effect in semi-conductors, Photoresistors and photoconductors, Visible light emitting diodes and displays, photodiode, photo transistor, p-n junction solar cell and its characteristics, diode Laser. List of Experiments as recommended by Allahabad University.