

PHYSICS

B.Sc. - I (2002-03)

Paper - I Mechanics and Special Theory of Relativity

M.M.33

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, Inertial and Non-inertial frames, Pseudo forces, Rotating reference frame, Centrifugal force, Coriolis Force.

System of particles, Center 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 uniform spherical shell and solid sphere, conservation Laws.

Unit 2. Motion Under a Central Force : Two-particle problem, reduced mass, lab and center of mass co-ordinate 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 Mechanics : Ideal fluids, Equation of continuity, Streamline flow, Rotational and irrotational flows, Euler's equation, Bernoulli'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

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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

M.M. 33

Unit I : Cardinal Points of coaxial optical systems, Simple problems on
combination of thin lenses, Eyepieces, Aplanatic 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 phenomena).

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

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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

M.M. 34

Unit 1. Thermodynamics : Thermodynamic systems, macroscopic and microscopic variables, thermodynamical equilibrium, thermodynamical state, Zeroth law of thermodynamics and concept of temperature, heat and work and their path-dependence, 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-Claperyron's equation, specific heat of saturated vapour.

Unit 2. Clausius theorem, Clausius inequality, Entropy, calculation of entropy in various processes, entropy and un-available energy, physical significance of entropy, second law of thermodynamics, conditions for natural changes.

Thermodynamic 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 equations.

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 electromagnetic waves, emissive and

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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 constant 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. II (2003-04)

Paper - I Oscillations, Waves and Electromagnetism **M.M. 33**

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, measurement 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 distributions,

Electrostatics in Dielectrics : Polarization, polarization charges, field D, Gauss flux law-integral and differential forms and simple applications, energy of charge 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 particles, 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 uniform 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, $M \leq \sqrt{L_1 L_2}$ 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 M.M. 33

Unit 1. Electrical Circuits : Circuit parameters, R, L. and C, Kirchoff's law

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for a loop and junction, solutions by determinant and matrix method:
application to T, π 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 : AC 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 sensitivity conditions for AC bridge, measurement
of L by Maxwell's bridge, measurement of C by Schering's bridge.

Unit 4. Basic Semi-conductor Electronics - 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 parameters, their interrelationships,

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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. circuit linear, diode detector.

C.R.O. : working of cathode ray tube, block diagram of CRO, typical application of CRO.

Paper III : Atomic and Nuclear Physics

M.M 34

Unit 1. Atomic Physics : Bohr-Sommerfield model (historical developments) Bohr model and the spectra of hydrogenic atoms, critical resonance and ionization potentials, Frank-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 : diamagnetism, Larmor's theory and diamagnetic susceptibility, paramagnetism, Langevin's theory and Curie-Weiss Law.

Unit 3 . Quantum Concepts : particle nature of radiation, photoelectric effect and Compton effect, wave nature of particles, de-Broglie waves, Davisson-Germer experiment, wave packets, phase velocity and group

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velocity, Heisenberg's uncertainty principle and applications, 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 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.

Classification of Elementary Particles.

PHYSICS

B.Sc. III (2004-05)

Paper - I Classical Mechanis & Quantum Mechanics **M.M.: 50**

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, Schrodinger equations 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 Schrodinger equation, 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 L^2 , L_z & ladder L_+ , L_- operators, spherically symmetric potentials, complete solution of hydrogen atom problem, Identical particles, symmetric and anti symmetric wave functions, Pauli's exclusion principle.

Paper - II Statistical mechanics & Solid State

M.M. 50

Unit-I. Microscopic & macroscopic systems, phase space representation, division of phase space into cells, Liouville theorem & 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, calculation of entropy of perfect monoatomic 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, Lattices 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, cohesive 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 lattice 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 and Photonic Devices **M.M. 50**

Unit - 1 : 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

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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 2 : 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.

Unit 3 : 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.

Unit 4 : Combinational logic circuits : Half-adder, full adder, parallel and series additon, Half and full subtractor, BCD adder.

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

Unit 5 : 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, diode Laser.

List of Experiments as recommeded by Allahabad University*

1. Compound Pendulum
2. Rectangular Lamina
3. Maxwell's Needle
4. η by torsion Table
5. η by statical method
6. γ, η, σ by searle's method
7. γ by bedingof a beam
8. M.I. of a fly wheel
9. Coefficient of viscosity of water
10. Force constant of a spiral spiring
11. Surface Tension of Water
12. Thermal Conductivity of Rubber
13. Thermal Conductivity by Lee's Disc Method
14. Verification of Stefan's Law
15. Thermal conductivity of Copper by Searle's Method
16. Thermocouple
17. Dispersive power of the Material of Prism by Spectrometer

18. Wavelength of Spectral Lines of Hg using Grating
19. Newton's Rings
20. Fresnel's Biprism
21. Polarimeter
22. Brewster's Law
23. Single Slit
24. Nodal Slide
25. Sextant
26. Fresnel's Diffraction at a wire
27. Resolving Power of a Telescope

List of Experiments

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B.Sc. Pt- II Physics

1. Characteristics of pn junction diode
2. Characteristics of Zener diode
3. Characteristics of a Transistor (CB and CE Configurations)
4. Calibration of Energy meter.
5. Current sensitivity of a moving coil Galvanometer.
6. Student's Potentiometer
7. P.O. Box

8. Common Power Supply
9. LCR Circuit
10. RC time constant
11. Helmholtz Galvanometer
13. Use of CRO for Calibrating an Oscillator

Experiments Using Ballistic Galvanometer

14. Self Inductance
15. Mutual Inductance
16. Capacity of a Condenser
17. High resistance by Leakage
18. Earth Inductor
19. Search Coil

AC Bridges

20. Schering Bridge
21. Maxwell's Bridge

Modern Physics

22. Ionization Potential

Waves and Oscillations

23. AC Frequency by Sonometer
24. AC Frequency by Melde's experiment or electrical vibrator

Electronics

1. Band gap and Bias Stabilization
2. DTL and TTL (Switching and Fan out)
3. RTL (Switching and Fan out)
4. FET Characteristics and FET as an amplifier
5. CE amplifier
6. Hysteresis Loss by CRO
7. Verification of Richard Dushman Equation
8. Velocity of sound using CRO
9. Interstage Audio Transformers

Optics

10. μ of material of Prism and of water by Spectrometer
11. Michelson Interferometer
12. Diffraction of Light by Ultrasonic
13. Plane Reflection Grating using laser.
14. Fraunhofer diffraction at double slit using laser.
15. Refractive Index gradient using laser
16. Calibration of constant deviation spectrometer.

17. Photo cell and Plank constant
18. Cornu's fringes and Elastic constant
19. Young's Modulus by Newton's Ring (Searle's apparatus)
20. Photo diode and Photo transistor

Atomic Physics

21. e/m by Magic Eye
22. Magnetic susceptibility by Quincke's Tube

* पाठ्यक्रम समिति की दि० 25.01.2002 को सम्पन्न हुई बैठक में बी०एस-सी० प्रथम, द्वितीय एवं तृतीय वर्ष के भौतिकी विषय के प्रैक्टिकल्स के बारे में प्रस्ताव स्वीकृत किया गया कि इलाहाबाद वि०वि० द्वारा प्रस्तावित प्रैक्टिकल्स को पाठ्यक्रम में रखा जायेगा । अतः मैंने इलाहाबाद वि०वि० द्वारा प्रस्तावित प्रयोगों की सूची यहाँ प्रस्तुत की है ताकि इसे सिलेबस में समाविष्ट किया जा सके ।