

**B. Sc. Part - I:- PHYSICS (HONOURS)****PAPER - I(Theory)****GROUP - A :Special Theory of Relativity**

Galilean Transformation, Inertial frame of reference, Michelson-Morley experiment, Lorentz-Fitzgerald contractions, Einstein postulates, Lorentz Transformations and its consequences, Length contraction and time dilation, Addition of velocities, Dragging of light by moving medium, Relativistic Doppler effect of propagation of light waves, Aberration of light, variation of mass with velocity, Mass energy relation.

**GROUP - B : Mechanics and Properties of Matter**

Inertial frame of reference and non-inertial frame reference, Coriolis & Centrifugal forces and their simple applications, Generalized co-ordinates, Constraints (holonomic & nonholonomic) D'Alembert's principle and Lagrange's equations of motion, Hamilton's equation of motion and their simple applications.

Gravitational potential and field due to bodies of regular geometrical shapes, Motion in central field due to bodies of regular geometrical shape, Motion in central field, Kepler's laws, two particles motion in central field.

Elasticity and elastic constants, Relation between elastic constants, Bending of beams and cantilevers, Torsion of cylinder and rigidity modulus by flat spiral spring.

Surface tension and Surface energy, Principle of virtual works and its application to surface tension, Ripple and gravity waves, Surface tension by the method of ripples, Effect of temperature and pressure on surface tension.

**Group – C (Waves and Vibration)**

2 questions to be set, one to be answered differential equation of wave, Equation of progressive waves, Stationary Waves, Compression Waves in fluids and in external solids free, damped and forced oscillations in one dimension. Fourier series and its applications to rectangular and saw tooth waves, vibration of string, Intensity and loudness of sound and their measurements, Acoustics of buildings.

**PAPER - II (Theory)**

Derivation of Maxwell's law of distribution of velocities and its experimental verifications, Equipartition of energy, Mean free path.

Transport phenomenon-viscosity, conductivity and diffusion, Brownian motion, Langevin and Einstein's theories and experimental determination of Avogadro's number.

Rectilinear flow of heat in a metal rod conductivity of periodic flow method. Relation between thermal and electrical conductivities Van der Waal equation of state.

**GROUP - B : Thermodynamics**

Zeroth law of thermodynamics, Definition of temperature, first and second law of thermodynamics, Carnot's engine and Carnot's theorem, Absolute scale of temperature, Clausius inequality entropy, Energy changes in reversible and irreversible processes, Enthalpy, Helmholtz and Gibb's function, Gibb's Helmholtz equations, Maxwell's equations and its

application to simple physical problems.

Thermodynamics description of phase transition Chemical potential, Latent heat of transition, Clapeyron equation, Ehrenfest scheme of phase transition.

Joule Thompson effect, Liquefaction of gasses with special reference to hydrogen and helium, Production and measurement of low temperature.

Black body radiation, Kirchoff's law, Stefan's law, Wiens law, Planck's law and its experimental verification.

Einstein and Debye theories of specific heats of solids.

### **PRACTICAL PAPERS.**

1. 'g' by Kater's Pendulum
2. Young Modulus by Flexure of beam.
3. Elastic constants by Searle's method
4. Rigidity modulus by (i) Barton's apparatus (ii) Maxwell's model
5. Moment of inertia by - Fly-wheel.
6. Surface tension by Jagger's method
7. Surface tension by method of Ripples
8. Surface tension of Soap solutions by bubble method.
9. Viscosity of water by capillary flow method
10. Viscosity of air by Rankine's method.
11. Viscosity by Stokes method.
12. Laws of transverse Vibration by Sonometer.
13. Frequency of tuning fork by Melde's experiment.
14. Velocity of ultrasonic wave in a liquid.
15. Specific heat of liquid by cooling method.
16. Thermal conductivity of Ebonite by Lee's Disc Method.
17. 'J' by Joules calorimeter.

## B. Sc. Part - II:- PHYSICS (HONOURS)

### PAPER-III(Theory)

#### **GROUP-A:Optics**

Fermat's Principle, mirror and lens formulae, Cardinal points of a thick lens and thick lens formula.

Interferencephenomenabydivisionofwavefrontanddivisionofamplitude,MichelsonInterferometer,Fabry-PerotInterferometer, LGplate,EchelonGrating.

Diffraction - Fresnel's & Fraunhofer's diffraction, Half period zones, Zone plate, Fresnel's diffraction at straight edge and single narrow wire, Fraunhofer's diffraction at slits and circular aperture, Plane diffraction grating, Concave grating and mounting, Resolving power of prism, telescope and microscope, Cornu's spiral and its use in diffraction problems.

Production of plane, circularly and elliptically polarized light, Nicol's prism Quarter wave plate, Babinet's compensator, Analysis of elliptically polarized light, Rotatory polarization and polarimeter, Principle of Laser action, Ruby Laser, He-Ne Laser.

#### **GROUP-B:ElectromagneticTheory**

Maxwell's field equations, Poynting vector, electro-magnetic momentum, Maxwell's stress tensor, Pressure of radiation, Plane electromagnetic waves, Reflection and total Internal reflections of polarized light, Double refraction in crystal, Theory of Dispersion, Optical properties of metals and dispersion in metals, Scattering by free and bound charges.

### PAPER-IV (Theory)

#### **GROUP-A: Electrostatics & Magnetism**

Boundary conditions at the surface of separation of two dielectrics and refraction of lines of forces.

Scalar potentials in Electrostatics, The potential of a system of charges, Dipole and Quadrupole moment, Energy stored in an electrostatic field, Poisson's and Laplace's equation in Cartesian, Polar and cylindrical co-ordinates and their solutions for simple geometries, Dielectric polarization, Relation between  $D$ ,  $E$  &  $P$ .

Properties of ferromagnetic materials, Magnetic Hysteresis curve method for obtaining B-H curve, Energy loss per cycle, Magnetic circuit and application to electromagnet & Measurement of Magnetic flux density (B) by (a) B. G. and Search coil (b) Grassot fluxmeter, Energy stored in a magnetic field, Measurement of susceptibility of liquid by Quinke's method, Langevin's and Weiss theories of dia, para and ferromagnetism.

#### **GROUP-B:Current electricity**

Thermodynamic treatment of Seebeck, Peltier and Thomson effect and their applications, Self inductance and Mutual inductance, Growth and decay of current in circuits containing  $L$ ,  $C$  and  $R$ . Simple applications of these circuits, Moving coil galvanometer, aperiodic and ballistic galvanometers. A.C. and A.C. Circuits: Use of vectors and complex number in A.C. circuit theory, Series and parallel resonant circuit, Power in A.C. circuits, Wattmeter, A.C. Bridges (i) De-

Sauty's bridge(ii) Anderson bridge(iii) Carey Foster bridge, Three phase A.C. Systems, Mutually coupled circuits, Rotating magnetic fields polyphase and single phase induction motors. The transformer equipment circuit and vector diagram, Iron and Copper losses in transformer.

### **GROUP-C: Modern Physics**

Measurement of charge by Millikan's method and specific charge of an electron by Thompson's method, Natural radioactivity, Rutherford Soddy's theory of radioactive decay, Geiger Muller counters, Discovery of Neutron Isotopes, Artificial Radioactivity, Elementary idea about nucleus and its structure, Nuclear fission Reactors, Aston's mass spectrograph, Cyclotron and Betatron.

Photoelectric emission, Einstein Photoelectric equation, Photo conductive and Photo-Voltaic cells.

Compton effect, Bragg's law and determination of X-ray wave length, Cathode ray Oscilloscope and its uses in amplitude frequency and phase measurement, Solid state rectifier and one stage R. C. amplifier.

Primary and secondary Cosmic rays, Principal components of cosmic rays, Altitude and latitude variation of Cosmic ray, intensity, E. W. Asymmetry, Cosmic ray showers, outline of cascade origin of cosmic rays.

## **B.Sc Part – II (Physics Hons)**

### **Practical Papers**

Time : 6 Hours

Full Marks : 50

The course shall include the following experiments :

1. Refractive index by spectrometer.
2. Wavelength by Newton's ring.
3. Wavelength by plane transmission grating.
4. Magnifying power of microscope.
5. Magnifying power of telescope.
6. Resolving power of telescope.
7. Dip by Dip Circle.
8. Measurement of low and high resistance.
9. Temperature variation of electrical resistance.
10. Characteristics of semiconductor diodes.
11. Wavelength of diode LASER by plane transmission grating.
12. Determination of wavelength by Fresnel's Biprism.

**B. Sc. Part - III:- PHYSICS (HONOURS)****PHYSICSPAPER-V****GROUP:A****METHODSOFMATHEMATICALPHYSICS**

Curvilinear co-ordinates, Cartesian, spherical-Polar and cylindrical co-ordinates. Orthogonal transformations of co-ordinates, scalar and vector fields, divergence and curl, line, surface and volume integrals. Theorem of Gauss, Stoke and Green, Tensor and its elementary properties.

Partial differential equations and its solution by separation of variables, Laplace equation and its solution, Wave equation and its solution, Poisson's equation and its solution.

Function of a complex variable, Cauchy-Rieman equations, Zeroes and poles, Taylor and Lorentz theorems, Cauchy's integral theorem, residue theorem, Integration of complex functions .

**GROUP: B****CLASSICALMECHANICS**

Hamilton's principle and Euler-Lagrange's equation, Principle of least actionconservation theorems and symmetry properties, Application of Hamiltonian dynamics to simple problems-Charged particle in an electromagnetic field (non-relativistic cases), Laws of motion, Moment of Inertia and products of Inertia, Eulerian angles, Euler's equation of motion of a rigid body, Gyroscopic motion, Motion of symmetrical top, Canonical transformation, Examples of Canonical transformations, Contact transformations, Hamilton-Jacobi equation, Action angle variations.

**GROUP:C****QUANTUM MECHANICS**

Inadequacy of classical mechanics, Dual nature of matter and radiation, De Broglie'srelation, Concept of state, Correspondence Principle, Postulates of quantum mechanics, Eigen functions and Eigen values of Hamilton Operators, uncertainly relations.

Schrodinger wave equation and its physical meaning, its application to problems of free particle, Transmission of particle through potential step, one dimensional Square· and well, particle in a box, Linear harmonic oscillator, Rigid rotator, Hydrogen atom.

Commutation rules of orbital angular momentum, their Eigen function and Eigen values, Spin hall angular momentum, Pauli's spin matrices, Pauli's Spinors, Symmetric and anti-symmetric wave function, Pauli's exclusive principle.

**PHYSICSPAPER-VI****GROUP:A****STATISTICS PHYSICS**

Fundamental assumption of statistical mechanics, Probability distribution and entropy, Partition function and its conversion to thermodynamic functions, Sackur-Tetrode equation and Gibb's paradox, Elements of ensemble theory and Liouville's theorem, Canonical ensemble and thermodynamics, Energy fluctuations in the canonical ensemble, Density and energy fluctuation in the grand canonical ensemble. Simple application of ensemble theories to perfect gas.

Boltzmann distribution, Fermi-Dirac distribution. Bose-Einstein distribution and their simple applications, Radial distribution function and its relation to thermodynamic functions, A brief introduction to first and second order phase transformation, Critical exponent. Ising model in zeroth approximation, Introduction to Fluctuations. The probability of thermodynamic fluctuation.

**GROUP: B****ELECTRONICS**

Thermionics-Richardson's equation and its experimental verification, Child-Langmuir equation, Schottky Effect. Semiconductor Devices, p-n junction and Zener diodes, BJT and FET transistor, Opto-electrical devices, photo-devices, LOR Photovoltaic cell, photo transistor.

**CIRCUIT THEORY**

Coupled LCR circuits, Superposition theorem, Thevenin and Reciprocity theorems : Maximum power transfer theorem, One port and two port networks (Only h-parameter), T and pi equivalence of two port network. Ladder network and constant K filters (low, high and band pass), Attenuators.

**SOLID STATE ELECTRONIC CIRCUITS**

Equivalent circuit of BJT and FET, Half-wave and Full-wave rectifiers. Power supply with specific reference to smoothing circuits and voltages stabilization by cold cathode valve and Zener diode. A. F. amplifiers (R.C. coupled amplifier) Feedback amplifiers, Push-pull power amplifier, Simple circuits for LC oscillation, Hartley and Colpitt's Oscillator, R.C. Coupled Oscillator, Astable Multivibrator, Principle of amplitude modulation, amplitude modulator, average and envelope detection, Radio receivers, Super heterodyne receivers, Simple idea of transmitter (with block diagram), CRO and its applications, Logic circuits, AND, OR, NAND, NOR operation with the help of simple logic gates.

Types of computers and three basic components, Input and Out-put devices, Concept of hardware and software, BITS and BYTES, Computer programming of some simple mathematical problems, Mathematical problems in BASIC and FORTRAN Languages.

**PHYSICSPAPER-VII****GROUP:A****PLASMAANDCLASSICAL ELECTRODYNAMICS**

Microscopic and macroscopic properties of Plasma, Plasma oscillations, Debye's potential, Wave propagation in isotropic plasma, Ionospheric reflection, Pinch effect. Alfvén wave, Saha's theory of ionization.

Retarded and advanced potential, Field due to an oscillating current element, Oscillating dipole, Liénard-Wiechert potentials, Potential and field due to uniformly moving charge.

Covariance of Maxwell equations under Lorentz transformation, Transformation of equations electromagnetic fields.

**GROUP:B****SOLIDSTATEPHYSICS**

Elements of crystallography, Bravais lattice, Miller indices, Seven crystal system, Simple crystal structure of NaCl, CaCl<sub>2</sub> and diamond.

Interaction of X-rays, Neutrons and electrons with matter, Diffraction of X-rays from a perfect crystal, Bragg's law, Reciprocal lattice, Ewald construction and Brillouin zones.

Crystal binding-ionic, metallic, covalent and Vanderwall's, Vanderwall's -London interaction and cohesive energy of inert gas crystals. Madelung energy and Madelung constant.

Free electron theory of metals, Heat capacity of electron gas, Electrical conductivity of metals, Boltzmann-Transport equation, Sommerfeld theory of electrical conductivity, Band theory of solid, Bloch's Theorem, Kronig-Penny model, Distinction between metal, semiconductor and Insulator, Intrinsic and Extrinsic semiconductors, p-n junction rectifier, Transistors, Hall-Effect.

**GROUP:C****PHYSICS OF ATOMS, MOLECULES AND NUCLEI**

Origin of atomic spectra, Bohr's theory and Bohr-Sommerfeld theory of hydrogen atom, spectra of alkali, alkaline and earth metals, Selection-rules, Excitation potential, Fine Structure, Stern Gerlach Experiment, Vector model of atom, Zeeman Effect and Paschen Back effect of single valence atom, Moseley's Law, Origin of X-ray spectra.

Rotational vibrational spectra of diatomic molecules, Rotation, vibration and electronic bands, Introduction of NMR, ESR Laser spectroscopy .

General properties of nuclear mass, charge, spin, static magnetic moment, size and stability, Nuclear models, Liquid drop model and mass formulae. The Shell model, Classical theory of Rutherford scattering.

**PHYSICSPAPER-VIIIA**

**The courses shall include the following experiments:**

1. Junction diode and Zener diode characteristic
2. BJT characteristic.
3. FET characteristic
4. Static characteristic of tetrode.
5. Verification of Child-Langmuir law.
6. Frequency response of R-C amplifier.
7. Effect of negative feedback in R-C amplifier.
8. Properties of Hartley oscillator.
9. Study of a plane modulated amplifier.
10. Frequency study of a tuned R-F amplifier.
11. Study of load characteristic of a rectifier.
12. Multi-vibrator and study of its waveforms.
13. Study of logic gates {AND, OR, NAND, NOR}.

**PHYSICSPAPER-VIIIB**

**The courses shall include the following experiments:**

1. Verification of Brewster's law.
2. Verification of Fresnel's laws of reflection and refraction of polarized light.
3. Analysis of elliptical polarized light.
4. Inductance by Anderson bridge.
5. Mutual inductance by Carey-Foster bridge.
6. Frequency characteristic of low pass filter.
7.  $e/m$  by Braun's tube.
8.  $e/m$  by Helical method.
9. Measurement of Hall coefficient.
10. Band gap of semiconductor.
11. Planck's constant by photo-cell method.
12. Copper loss and iron loss of a transformer.
13. Insertion loss variation load of the T-section of an attenuator.



**B. Sc. Part-IPHYSICS (General and Subsidiary Course)****Paper-1 (Theory)**

The course shall consist of one theory paper (Paper-1 of 70 marks). The pass marks will be 21 and the examination will be of 3 hours duration in this paper. There will be also one practical paper (Paper-1 of 30 marks). The pass marks will be 12 and examination will be of 5 hours duration-in this paper.

The following be the detailed course.

**Time: 3 Hours]**

**PAPER-I (Theory)**

**[Full Marks: 70**

(12 question to be set, 6 to be answered, atleast 2 from group-A, one from group-B and atleast 3 from Group-C)

**GROUP-A: Relativity, Mechanics, Properties of Matter****4 Questions**

Galilean Transformation, Inertial frame of reference, Michelson Morley experiment Lorentz-fitzgerald contraction, Einstein postulates, Lorentz transformation and its consequences, Length contraction and time dilation, Addition of velocities, Relativistic Doppler effect for propagation of light waves, variation of mass with velocity, Mass energy Relation.

Inertial and Non-inertial frames of references, Coriolis's and centrifugal forces and their simple application, Motion in central field, Kepler's laws, Generalised co-ordinates, Constraints (Holonomic and Non-Holonomic), Lagrangian equation of motion and their simple applications.

Elasticity and elastic constraints, Relation between elastic constants, Bending of beams and cantilevers, Torsion of Cylinder and rigidity modulus by flat spiral spring.

Surface tension and surface energy, Ripples and gravity waves, Surface tension by the method of ripples, Effect of temperature and pressure on surface tension.

Perfect fluids, equation of continuity, Euler's equation for perfect fluid, Bernoulli's equation.

Viscosity of liquids, critical velocity, Poiseuille's formulae with correction, Flow of compressible fluid through a narrow tube, Viscosity of gases, Rankine's method. Effect of temperature and pressure on viscosity.

**GROUP-B: Waves and Acoustics : 4 Questions**

Differential equation of wave, Equation of Progressive waves, Stationary waves, Compression waves in fluids and in extended solids.

Free Damped and forced oscillations Fourier analysis Vibration of strings Intensity and loudness of sound and their measurements, Accounts of buildings, Ultrasonic

**GROUP-C: Thermal Physics : 5 Questions**

Maxwell's law of distribution of velocities and its experimental verification. Degrees of freedom and equipartition of energy, Mean free path and its experimental determination. Perfect Gas equation and Vander Waal's Equation of State. Laws of Thermodynamics, Absolute scale of temperature, Carnot's Theorem and Carnot's cycle Entropy and its calculation in simple cases, Thermodynamic Relations and their application to simple physical problem, Claussius-Claperyon equation, Joule Thomson effect Liquefaction of Gases with special reference to Helium, Super fluidity in liquid Helium.

Kirchoff's laws and black-body radiation, Stefan Boltzmann Law-its equation and experimental verification.

**Time: 6 Hours]****PAPER-I (Theory)****[Full Marks: 30****The courses shall include the following experiments:**

1. Determination of 'g' by Bar pendulum.
2. Determination of Youngs modulus by Flexure of beam.
3. Rigidity modulus by (i) statical method (ii) dynamical method.
4. Moment of inertia by inertia table and M.I. of Flywheel.
5. Surface tension by jagger's method.
6. Viscosity of liquid by capillary flow method.
7. Viscosity by Stoke's method.
8. Determination of 'gamma' by constant pressure thermometer.
9. Specific heat of liquid by method of cooling.
10. Thermal conductivity of copper.
11. Thermal conductivity of ebonite by Lee's disc method.
12. 'J' by Joules calorimeter.
13. Frequency of tuning forks by Melde's experiment.

## B. Sc. Part-IIPHYSICS (General and Subsidiary Course)

The course shall consist of one theory paper (Paper II theory) of 70 marks. The pass marks will be 21 and the examination will be of 3 Hours duration in this paper. There will be also one practical paper (paper II practical) of 30 marks. The pass marks will be 12 and the examination will be 6 hours duration in this paper.

The following will be the detailed course : .

**Time: 3 Hours]**

**PAPER-II**

**[Full Marks: 70**

12 questions to be set; 6 to be answered, one from Group A, 3 from Group B and 2 From Group C.

### GROUP-A

#### Electrostatics and Magnetism 2 (1+ 1) Questions

Boundary conditions at the surface of operation of two dielectrics, Electric dipoles, Dipole Moment, Dielectric polarisation, Electrical Image-problem involving infinite conducting plane and thin conducting spherical shell only.

Magnetic shell, Langevin's and Weiss theory of dia, para and Ferro Magnetism, Curie law Production and measurement of strong magnetic fields Magnetic circuit and Electromagnets.

### GROUP-B

#### Current electricity, Modern Physics

**(6 Questions)**

Thermodynamic treatment of Seebeck, Peltier and Thomson effects and their application, Moving coil Galvanometer, a periodic and ballistic galvanometers, Growth and decay of currents in electric circuit. Oscillatory discharge of condenser.

**AC and DC circuits:** Use of Vectors and complex quantities in Ac. Circuit theory (LR, CR, AND LCR, circuits) De Sauty's bridge, Anderson bridge, Carey Foster's bridge.

Measurement of charge by Milliken's method and specific charge of an electron by Thompson method, Natural radioactivity, Rutherford Soddy's Theory of radio active decay, Geiger-Muller counter, Discovery of Neutron Isotope, Artificial radioactivity. Elementary ideas about nucleus and structure, Nuclear fission Reactors, Aston's mass spectrograph.

Photoelectric emission, Einstein's photoelectric equation, Photo-conductive and photo-voltaic cells.

Compton effect, Bragg's law and determination of X ray's wave length.

Cathode ray oscilloscope and its uses in amplitude, frequency and phase measurements, Solid state rectifier. One stage R-C amplifier, Principle of amplitude modulation and demodulation, Radio receiver through block diagram.

**GROUP-C****OPTICS****(4 Questions)**

Fermat's principle, Newton's ring. Michelson's interferometer, Fresnel's diffraction at straight edge, Fraunhofer's diffraction, single slit, double slit, plane transmission, grating Resolving power of microscope and telescope, Polarization, production of plane, circularly and elliptically polarised lights, Nicol's prism, Quarter waveplate, Half wave plate, polarimeter, Babinet's compensator.

Bohr's theory of hydrogen spectra, principle of laser action, Ruby laser. Maxwell equations, Equation of plane electromagnetic waves and its solution,

**PRACTICAL****Time: 6 Hours]****PAPER-II****[Full Marks: 30**

The course shall include following experiments:

1. Refractive index by Spectrometer.
2. Wavelength by Newton's ring.
3. Wavelength by plane transmission grating.
4. Magnifying Power of microscope.
5. Magnifying power of telescope.
6. Resolving power of telescope.
7. Dip by (i) Dip circle (ii) Earth's inductor.
8. Figure of merit of moving Galvanometer.
9. Measurements of low and high resistance.
10. Temperature variation of electrical resistance.
11. Characteristics of valve and semiconductor diodes.