B.Sc. Part I (Pass Course)

1. PHYSICS

Scheme: Max. Marks: 100

Min. Pass Marks : 36

Part I	3 hrs duration	Max. Marks 33	Min. Pass marks 12
Part II	3 hrs duration	Max. Marks 33	Min. Pass marks 12
Part III	3 hrs duration	Max. Marks 33	Min. Pass marks 12
Practical	5 hrs duration	Max. Marks 50	Min. Pass marks 18

Paper-I : Mechanics & Oscillations

Work Load: 2 hrs. Lecture/week

Examination Duration: 3 Hrs.

Scheme of Examination: First question will be of nine marks comprising of six parts of short answer type with answer not exceeding half a page. Remaining four questions will be set with one from each of the units and will be of six marks each. Second to fifth question will have two parts namely (A) and (B) each carrying 3 marks. Part (A) of the second to fifth question shall be compulsory and Part (B) of these questions will have internal choice.

Unit – I: Physical Law and Frame of Reference

(a) Inertial and non-inertial frames, Transformation of displacement, velocity, acceleration between different frames of reference involving translation. Galilean transformation and invariance of Newton's laws.

(b) Coriolis Force: Transformation of displacement, velocity and acceleration between rotating frame, Pseudo forces, Coriolis force, Motion relative to earth, Focult's pendulum.

(c) Conservative Forces: Introduction about conservative and non-conservative forces, Rectilinear motion under conservative forces, Discussion of potential energy curve and motion of a particle.

Unit – II: Centre of Mass

Introduction about Centre of Mass, Centre of Mass Frame: Collision of two particles in one and two dimensions (elastic and inelastic), Slowing down of neutrons in a moderator, Motion of a system with varying mass, Angular momentum concept, conservation and charge particle scattering by a nucleus.

Rigid body

Equation of a motion of a rotating body, Inertial coefficient, Case of J not parallel to ω Kinetic energy of rotation and idea of principal axes, Precessional motion of a spinning top.

Unit – III: **Motion under Central Forces**

Introduction about Central Forces, Motion under central forces, Gravitational interaction, Inertia and gravitational mass, General solution under gravitational interaction, Kepler's Laws, Discussion of trajectories, Cases of elliptical and circular orbits.

Damped Harmonic Oscillations

Introduction about oscillations in a potential well, Damped force and motion under damping, damped Simple Harmonic Oscillator, Power dissipation, Anharmonic oscillator and simple pendulum as an example.

Unit – IV: **Driven Harmonic Oscillations**

Driven harmonic oscillator with damping, Frequency response, Phase relation, Quality factor, Resonance, Series and parallel of LCR circuit, Electromechanical system-Ballistic Galvanometer.

Coupled Oscillations

Equation of motion of two coupled Simple Harmonic Oscillators, Normal modes, motion in mixed modes, Transient behavior. Dynamics of a number of oscillators with neighbor interactions.

Text books:

- Mechanics (SIF) Charles Kinel
- Introduction to Classical mechanics. TMH
- The Physics of Waves & Oscillation. Bajaj
- H. Goldstein, Classical mechanics.
- L.N. Hand, J.D. Finch. Analytical mechanics (Cambridge, 1998)
- L. Landau, E. Lifshitz. Mechanics

Paper-II (Electromagnetism)

Work Load: 2 hrs. Lecture/week
Examination Duration: 3 Hrs.

Scheme of Examination: First question will be of nine marks comprising of six parts of short answer type with answer not exceeding half a page. Remaining four questions will be set with one from each of the units and will be of six marks each. Second to fifth question will have two parts namely (A) and (B) each carrying 3 marks. Part (A) of the second to fifth question shall be compulsory and Part (B) of these questions will have internal choice.

Unit – I: **Scalar and Vector Fields**

Concept of Field, Scalar and Vector Fields, Gradient of scalar field, Physical significance and formalism of Gradient, Divergence and Curl of a vector field Cartesian co-ordinates system, Problems based on Gradient, Divergence and curl operators, Concepts of Solid angle, Gauss divergence and Stoke's theorem, Gauss law from inverse square law. Differential form of Gauss law.

Electric field and potential energy

Invariance of Charge, Potential energy of a system of (i) Discrete N-charges (ii) Continuous charge distribution. Energy required to build a uniformly charged sphere, classical radius of the electron, Electric field due to a short electric dipole, Interaction of electric dipole with external uniform and non-uniform electric field, potential due to a uniformly charged spherical shell.

Poisson and Laplace equations in Cartesian coordinates and their applications to solve the problems of electrostatics.

Electric field measured in moving frames, Electric field of a point charge moving with constant velocity.

Unit – II: **Electric field in matter**

Multipole expansion, definition of moments of charge distribution, Dielectrics, Induced dipole moments, polar non polar molecules, Free and bound charges, Polarization, Atomic polarizability, electric displacement vector, electric susceptibility, electric constant, relation between them.

Electric potential and electric field due to a uniformly polarized sphere (i) outside the sphere (ii) at the surface of the sphere (iii) inside the sphere, Electric field due to a dielectric sphere placed in a uniform electric field (a) outside the sphere (b) inside the sphere, electric field due to a charge placed in dielectric medium and Gauss law, Clausius-Mossotti relation in dielectrics.

Unit – III: **Magnetostatics and magnetic field in matter**

Lorentz force, properties of magnetic field, Ampere's law, field due to a current carrying solid conducting cylinder (a) outside (b) at the surface and (ii) inside the cylinder. Ampere's law in differential form, Introduction of Magnetic Vector potential, Poisson's equation for vector potential, Deduction of Biot-Savart law using Magnetic Vector potentials, Differential form of Ampere's law.

Atomic magnet, Gyromagnetic ratio, bohr-magneton, Larmor frequency, induced magnetic moment and dia-magnetism, spin magnetic moment, para and ferro-magnetism, Intensity of Magnetization, Magnetic permeability and Susceptibility, free and bound current densities, Magnetic field due to a uniformly magnetized material and Non-uniformly magnetized material.

Unit – IV: **Maxwell's Equations and Electromagnetic waves**

Displacement current, Maxwell's Equation, Electromagnetic waves, Electromagnetic waves in an Isotropic medium, Properties of electromagnetic waves, Energy density of Electromagnetic waves, Pointing vector, Radiation pressure of free space, Electromagnetic waves in Dispersive medium, Spectrum of Electromagnetic waves.

References:

1. Electricity & Magnetism, A.S. Mahajan & Abbas A. Rangwala, Tata McGraw-Hill

2. Introduction to Electrodynamics, David J. Griffith, Prentice Hall
3. Berkeley Physics Course, Vol. II
4. Fundamental University Physics Vol II: Fields and Waves; M. Alonso and E.J. Finn: Addison-Wesley Publishing Company.

Paper - III : OPTICS

Work Load: 2 hrs. Lecture/week
Examination Duration: 3 Hrs.

Scheme of Examination: First question will be of nine marks comprising of six parts of short answer type with answer not exceeding half a page. Remaining four questions will be set with one from each of the units and will be of six marks each. Second to fifth question will have two parts namely (A) and (B) each carrying 3 marks. Part (A) of the second to fifth question shall be compulsory and Part (B) of these questions will have internal choice.

Unit – 1. Interference

Concept of Spatial and Temporal Coherence, coherence length, coherence time, Definition and propagation of a wave front Huygen's principle of secondary wavelets, Young's Double slit experiment. Types of interference, interference by division of wavefronts: Fresnel's Biprism, Measurement of wavelength λ and thickness of a thin transparent sheet, Interference by division of amplitude: Interference in thin films of constant thickness in transmitted and reflected waves. Interference produced by a wedge shaped film, Newton's rings, Determination of wavelength λ and refractive index μ by Newton's Rings: fringes of equal inclination (Haidinger fringes) and equal thickness (Fizeau fringes), Michelson's Interferometer, shape of fringes, Measurement of wavelength, difference between two spectral lines and thickness of a thin transparent sheet.

Unit – 2. Diffraction

Fresnel's diffraction, Half period zones, Fresnel's diffraction at a circular aperture, straight edge and a rectangular slit, Zone plate, Multiple foci of zone plate, comparison, between zone plate and convex lens, Fraunhofer diffraction by single slit and a circular aperture, Fraunhofer diffraction by N parallel slits with two slits as a special case, Missing order, Plane diffraction grating and its use in determining wavelength, Dispersion by a grating, Rayleigh's criterion of resolution, Resolving power of a Telescope and a Grating.

Unit – 3. Polarization

Polarization (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically Polarized light. Production of Plane polarized light (i) by reflection (ii) by refraction (iii) by double refraction and (iv) by dichroism (Polaroid), Identification of polarized light, hygiene theory of double refraction, Production of circularly and Elliptically Polarized light, Quarter wave and half wave plates, Analysis of polarized light, Optical activity, Laws of optical Activity, Fresnel's explanation of optical activity, Experimental verification of Fresnel's theory. Specific rotation. Polarimeter, Types of Polarimeter (i) Laurent's half shade polarimeter and (ii) biquartz polarimeter.

Unit – 4. Quantum Optics & Photonics

(i) **Laser:** Spontaneous and stimulated emission, Einstein's A & B coefficients, Energy density of radiation as a result of stimulated emission and absorption, population inversion, Methods of optical pumping, energy level schemes, He-Ne, Ruby, CO_2 lasers.

(ii) **Holography:** Basic concepts of Holographics, Principle of holography, Theory, construction and reconstruction of image, application of holography.

(iii) **Fiber Optics:** Introduction of Optical Fiber, Necessity of Cladding, Optical fiber system, optical fiber cable, Total internal Reflection, Explanation of Propagation of light through an optical fiber.

References:

1. Optics by Brij Lal & Subramanium, S. Chand.
2. Optics by D.P. Khandelwal.
3. Principles of optics by B.K. Mathur.
4. Introduction to Modern Optics by A.K. Ghatak.
5. An introduction to Modern Optics by G.R. Fowles.
6. Essentials of Lasers by Allen.

Practical

Work Load: Four hours laboratory work per week
Examination Duration: Four hours
Minimum Experiments: Total sixteen taking eight from each section.

The college are free to set new experiments of equivalent standard. This should be intimated and approved by the Convener, Board of Studies before the start of academic session. It is binding on the college to have experimental set up of at least sixteen experiments listed below (8 from each section). In case number of experiments performed by the student is less than sixteen, his marks shall be scaled down in final examination on pro rate basis. laboratory examination paper will be set by the external examiner by making pairs of experiments taking one from each section out of sixteen or more experiments available at the center. Different combinations shall be given for different batch.

Section A

1. To study the variation of power transfer by two different loads by a DC source and to verify maximum power transfer theorem.
2. To study the variation of charge and current in an RC circuit with a different time constant (using a DC source).
3. To study the behavior of an RC circuit with varying resistance and capacitance using AC mains as a power source and also to determine the impedance and phase relations.
4. To study the rise and decay of current in an LR circuit with a source of constant emf.

5. To study the voltage and current behavior of an LR circuit with an AC power source. Also determine power factor, impedance and phase relations.
6. To study the characteristics of a semiconductor junction diode and determine forward and reverse resistances.
7. To study the magnetic field along the axis of a current carrying circular coil. Plot the necessary graph and hence find the radius of the circular coil.
8. To determine the specific resistance of a material and determine the difference between two small resistance using Carey Foster's Bridge.
9. To convert a galvanometer into an ammeter of a given range.
10. To convert a galvanometer into a voltmeter of a given range.

Section B

1. To study the random decay and determine the decay constant using the statistical board.
2. Using compound pendulum study the variation of time period with amplitude in large angle oscillations.
3. To study the damping using compound pendulum.
4. Study the excitation of normal modes and measure frequency splitting using two coupled oscillators.
5. To study the frequency of energy transfer as a function of coupling strength using coupled oscillators.
6. To study the viscous fluid damping of a compound pendulum and determining damping coefficient and Q of the oscillator.
7. To study the electromagnetic damping of a compound pendulum and to find the variation of damping coefficients with the assistance of a conducting lamina.
8. To find J by Callender and Barnes Method.
9. To determine Young's modulus by bending of beam.
10. To determine Y, σ and η by Searl's method.
11. To ensure Curie temperature of Monel alloy.
12. To determine modulus of rigidity of a wire using Maxwell's needle.
13. Study of normal modes of a coupled pendulum system. Study of oscillations in mixed modes and find the period of energy exchange between the two oscillators.
14. To study variation of surface tension with temperature using Jaeger's method.
15. To study the specific-rotation of sugar solution by polarimeter.

B.Sc. Part II (Pass Course)

1. PHYSICS

Scheme: Max. Marks: 100

Min. Pass Marks : 36

Part I	3 hrs duration	Max. Marks 33	Min. Pass marks 12
Part II	3 hrs duration	Max. Marks 33	Min. Pass marks 12
Part III	3 hrs duration	Max. Marks 33	Min. Pass marks 12
Practical	5 hrs duration	Max. Marks 50	Min. Pass marks 18

Paper-I : Thermodynamics and Statistical Physics

Work Load: 2 hrs. Lecture/week

Examination Duration: 3 Hrs.

Scheme of Examination: First question will be of nine marks comprising of six parts of short answer type with answer not exceeding half a page. Remaining four questions will be set with one from each of the units and will be of six marks each. Second to fifth question will have two parts namely (A) and (B) each carrying 3 marks. Part (A) of the second to fifth question shall be compulsory and Part (B) of these questions will have internal choice.

Unit – 1

Thermal and adiabatic interactions: Thermal interaction: Zeroth law of thermodynamics; System in thermal contact with a heat reservoir (canonical distribution); Energy fluctuations; Entropy of a system in a heat bath; Helmholtz free energy: Adiabatic interaction and enthalpy; General interaction and first law of thermodynamics; Infinitesimal general interaction' Gibb's free energy. Phase transitions; Clausius Clapeyron equation; Vapour pressure curve: Heat engine and efficiency of engine. Carnpt's Cycle; Thermodynamics scale as an absolute scale; Maxwell relations and their applications.

Unit – 2

Production of low temperatures and applications: Joule Thomson expansion and J T coefficients for ideal as well as Van Der Waals gas, porous plug experiment, temperature inversion. Regenerative cooling, Cooling by adiabatic expansion and demagnetization; Liquid Helium. He I and He II, superfluidity, Refrigeration through Helium dilution; Quest for absolute zero, Nernst heat theorem.

The distribution of molecular velocities: Distribution law of molecular velocities, most probable, average and r.m.s. velocities: Energy distribution function: effusion and molecular beam. Experimental verification of the Maxwell velocity distribution; The principle of equipartition of energy

Transport phenomena: Mean free path, distribution of free paths, coefficients of viscosity, thermal conductivity, diffusion and their interaction.

Unit – 3

Classical Statistics: Validity of Classical approximation. Phase space, micro and macro states. Thermodynamics probability, relation between entropy and thermodynamic probability. Monatomic ideal gas: Barometric equation; Specific heat capacity of diatomic gas; Heat capacity of solids.

Unit – 4

Quantum Statistics: Black body radiation and failure of classical statistics. Postulates quantum statistics, indistinguishability, wave function and exchange degeneracy, a priori-probability; Bose-Einstein statistics and its distribution function' Planck distribution function and radiation formula; Fermi-Dirac statistics and its distribution function. contact potential, thermionic emission; Specific heat anomaly of metals; Nuclear spin statistics (para and ortho-hydrogen).

References:

1. Berkeley Series, Vol. V, Statistical Physics
2. Reif – Thermodynamics and Statistical Physics.
3. Lokanathan and Khandelwal – Thermodynamics and Statistical Physics
4. Sears – Thermodynamics, Kinetic Theory of Gases and Statistical Physics
5. Kittle – Thermal Physics

Paper-II : Mathematical Physics and Special Theory of Relativity

Work Load: 2 hrs. Lecture/week

Examination Duration: 3 Hrs.

Scheme of Examination: First question will be of nine marks comprising of six parts of short answer type with answer not exceeding half a page. Remaining four questions will be set with one from each of the units and will be of six marks each. Second to fifth question will have two parts namely (A) and (B) each carrying 3 marks. Part (A) of the second to fifth question shall be compulsory and Part (B) of these questions will have internal choice.

Unit – 1

Orthogonal Curvilinear coordinate system. Scale factors, expression for gradient, divergence and curl and their applications to Cartesian, circular, cylindrical and spherical polar coordinate.
Coordinate transformation and Jacobian. Transformation of Covariant, Contravariant and Mixed Tensors. Addition, Multiplication and Contraction of Tensors. Metric tensor and its use in transformation of tensors.
Dirac Delta Function and its properties.

Unit – 2

Lorentz transformation, Length Contraction, Time Dilation, Mass variation, rotation in space-time like and space like vector, world line, macro-causality.

Four vector formulation, energy momentum four vector, relativistic equation of motion, invariance of rest mass, orthogonality of four force and four velocity. Lorentz force as an example of four force, transformation of four frequency vector, longitudinal and transverse Doppler's effect.

Transformation between laboratory and center of mass system, four momentum conservation, kinematics of decay products of unstable particles and reaction thresholds: Pair production, inelastic collision of two particles, Compton effect.

Unit – 3

(a) Transformation of electric and magnetic fields between two inertial frames. Electric field measured in moving frames. Electric field of a point charge moving with constant velocity.

(b) The second order linear differential equation with variable coefficient and singular points, series solution method and its application to the Hermite's. Legendre's and Laguerre's differential equations; Basic properties like orthogonality, recurrence relation, graphical representation and generating function of Hermite, Lagendre, Leguerre and Associated Legendre functions (simple applications).

Unit – 4

Techniques of separation of variables and its application to following boundary value problems. (i) Laplace equation in three dimensional Cartesian coordinate system-line charge between two earthed parallel plates. (ii) Helmholtz equation in circular cylindrical coordinates-cylindrical resonant cavity, (iii) Wave equation in spherical polar coordinates the vibrations of a circular membrane, (iv) Diffusion equation in two dimensional Cartesian coordinate system, heat conduction in thin rectangular plate, (v) Laplace equation in spherical coordinate system- electric potential around a spherical surface.

References:

Paper-III : Electronics and Solid State Devices

Work Load: 2 hrs. Lecture/week

Examination Duration: 3 Hrs.

Scheme of Examination: First question will be of nine marks comprising of six parts of short answer type with answer not exceeding half a page. Remaining four questions will be set with one from each of the units and will be of six marks each. Second to fifth question will have two parts namely (A) and (B) each carrying 3 marks. Part (A) of the second to fifth question shall be compulsory and Part (B) of these questions will have internal choice.

Unit – 1: Circuit analysis and PN junctions

Circuit analysis: Networks-some important definitions, loop and nodal equations based on DC and AC circuits (Kirchhoff's Laws).
Four terminal network: Ampere-volt conventions, open, close and hybrid parameters of any four terminal network; Input, Output and mutual impedance for an active four terminal network.
Various circuit theorems: Superposition, Thevenin, Norton, reciprocity, compensation, maximum power transfer and Miller theorems. **PN junction:** Charge densities in N and P materials; Conduction by drift and diffusion of charge carriers, PN diode equation; capacitance effects.

Unit – 2: Rectifiers and transistors

Rectifiers: Basic idea of Half-wave, full wave and bridge rectifier: calculation of ripple factor, efficiency and regulation; Filters: series inductor, shunt capacitor, L section and π section filters.
Voltage regulation: Voltage regulation and voltage stabilization by Zener diode, voltage multiplier.
Transistors: Notations and volt-ampere characteristics for bipolar junction transistor; Concept of load line and operating point, Hybrid parameters. CB, CE, CC configurations; Junction field effect transistor (JFET) and metal oxide semiconductor field effect transistor (MOSFET), Circuit symbols, biasing and volt-ampere characteristics, source follower operation of FET as variable voltage resistor.

Unit – 3: Transistor biasing and amplifiers

Transistor biasing: Need of bias and stability of Q point, stability factors and various types of bias circuits for thermal bias stability: fixed bias, collector to base feedback bias and four resistor bias.
Amplifiers: Analysis of transistor amplifiers using hybrid parameters and its gain-frequency response; basic idea of Cascade amplifiers, direct coupled and R-C coupled amplifiers; **Amplifier with feedback:** Concept of feedback, positive and negative feedback, voltage and current feedback circuits. Advantages of negative feedback: Stabilization of gain, effect of negative feedback on output and input resistance, reduction of nonlinear distortion, effect on gain - frequency response.

Unit – 4: Oscillators and Logic Circuits

Oscillators: Criteria for self excited and self sustained oscillations, circuit requirement for buildup of oscillation; Basic transistor oscillator circuit and its analysis: Colpitts and Hartley oscillators, RC Oscillators.
Logic circuits: Logic fundamentals: AND, OR, NOT, NOR, NAND, XOR gates, Boolean algebra, De Morgan's theorem, positive and negative logic, logic gates circuit realization using DTL and TTL logic, simplification of Boolean expressions.

References:

1. John D. Ryder, Electronic Fundamentals and Applications, Prentice Hall of India Pvt. Ltd., New Delhi.
2. John D. Ryder, Engineering Electronics, McGraw Hill Book Company, New Delhi.

3. Jacob Millman and Christos C Halkias, Integrated Electronics. Analog and Digital Circuits and systems: McGraw-Hill Ltd. (1972)
4. Albert Paul Malvino, Digital Computer Electronics, Tata McGraw-Hill publication Co. Ltd., New Delhi (1983)
5. Kumar & Gupta, Hand book of Electronics.
6. G.K. Mithal, Hand Book of Electronics.
7. G.K. Mithal, Electronics Devices and Applications.
8. R.P. Jain, Digital Electronics.

PRACTICAL

Teaching : 4 hrs/week
Practical One - Paper 5 hrs duration
Min Pass Marks : 18 Max. Marks : 50
Note : Total number of experiments to be performed by the students during the session should be 16 selecting any 8 from each section.

Section - A

1. Study of dependence of velocity of wave propagation on line parameter using torsional wave apparatus.
2. Study of variation of reflection coefficient of nature of termination using torsional wave apparatus.
3. Using platinum resistance thermometer find the melting point of a given substance.
4. Using Newton's rings method find out the wavelength of a monochromatic source and find the refractive index of liquid.
5. Using Michelson's interferometer find out the wavelength of given monochromatic source (Sodium light).
6. To determine dispersive power of prism.
7. To determine the wavelength of sodium light using grating.
8. To determine the wavelength of sodium light using Biprism.
9. Determine the thermodynamic constant $\gamma = C_p/C_v$ using Clement's & Desormes method.
10. To determine the thermal conductivity of a bad conductor by Lee's method.
11. Determination of ballistic constant of a ballistic galvanometer.
12. Study of variation of total thermal radiation with temperature.

Section - B

1. Plot thermo emf versus temperature graph and find the neutral temperature. (Use sand bath)
2. Study of power supply using two diodes/bridge rectifier with various filter circuits.
3. Study of half wave rectifier using single diode and application of L and π section filters.
4. To study the characteristics of a given transistor PNP/NPN (common emitter, common base and common collector configurations).

5. Determination of band gap using a junction diode.
6. Determination of power factor (cosθ) of a given coil using CRO.
7. Study of single stage transistor audio amplifier (variation of gain with frequency).
8. To determine e/m by Thomson's method.
9. Determination of velocity of sound in air by standing wave method using speaker, microphone and CRO.
10. Measurement of inductance of a coil by Anderson's bridge.
11. Measurement of capacitance and dielectric constant of a liquid and gang condenser by de-Sauty bridge.

B.Sc. Part III (Pass Course)

1. PHYSICS

Scheme: Max. Marks: 100

Min. Pass Marks : 36

Part I	3 hrs duration	Max. Marks 33	Min. Pass marks 12
Part II	3 hrs duration	Max. Marks 33	Min. Pass marks 12
Part III	3 hrs duration	Max. Marks 33	Min. Pass marks 12
Practical	5 hrs duration	Max. Marks 50	Min. Pass marks 18

Paper-I : Quantum Mechanics and Spectroscopy

Work Load: 2 hrs. Lecture/week

Scheme of Examination: First question will be of nine marks comprising of six parts of short answer type with answer not exceeding half a page. Remaining four questions will be set with one from each of the units and will be of six marks each. Second to fifth question will have two parts namely (A) and (B) each carrying 3 marks. Part (A) of the second to fifth question shall be compulsory and Part (B) of these questions will have internal choice.

Unit – I : Evolution of quantum physics

1. Difficulties of classical mechanics to explain the black-body emission spectrum, specific heat of solids. Planck quanta concept and radiation law, Photoelectric effect and Einstein's explanations. Compton effect, De-Broglie hypothesis, diffraction and interference experiments of particle (Davisson-Germer experiment).

2. Uncertainty principle: position and momentum, angle and angular momentum, energy and time. Application of uncertainty principle: (i) Ground state energy of hydrogen atom, (ii) ground state energy of a simple harmonic oscillator, (iii) Natural width of spectral lines, (iv) Non-existence of electrons in the nucleus.
3. Operators linear operators, product of two operators, commuting and non-commuting operators, simultaneous eigenfunctions and eigenvalues, orthogonal wavefunctions, Hermitian operators, their eigenvalues, Hermitian adjoint operators. eigenvalues and eigenfunctions; expectation values of operators: position, momentum, energy; Ehrenfest theorem and complementarity, Concept of group and phase velocity, wave packet, Gaussian wave packet, bra-ket notation.

Unit – II : Schrödinger wave equation and its solutions

1. Schrödinger wave equation: general equation of wave propagation. propagation of matter waves, time dependent and time-independent Schrödinger equation, wavefunction representation (ψ), physical meaning of ψ, properties and conditions on ψ, postulates of wave mechanics, operators, observable and measurements; probability current density.
2. Time independent Schrödinger equation, stationary state solution, one dimensional problem, particle in one dimensional box, eigenfunctions and eigenvalues, discrete energy levels, generalization into three dimensions and degeneracy of energy levels, concept of a potential well and barrier, step potential, penetration through rectangular barrier, reflection and transmission coefficients, barriers with special shapes (graphical representation), quantum mechanical tunneling (alpha decay).

Unit – III : Schrödinger equation solutions in special cases

1. Symmetric square well potential, reflection and transmission coefficients, resonant scattering; Bound state problems; particle in one dimensional infinite potential well and finite depth potential well, energy eigenvalues and eigenfunctions, transcendental equation and its solution; Simple harmonic oscillator, Schrödinger equation for simple harmonic oscillator and its solution, eigenfunction, eigenvalues, zero point energy, quantum and classical probability density, parity, symmetric and antisymmetric wave functions with graphical representation.
2. Schrödinger equation in spherical coordinates, Schrödinger equation for one electron atom in spherical coordinates, separation into radial and angular variables, solution of radial equation and angular equation, qualitative discussion of spherical harmonics, series solution and energy eigenvalues, stationary state wavefunction. Wave-functions of H-atom for ground and first excited states, average radius of H-atom, Bohr correspondence principle, orbital angular momentum and its quantization, commutation relation, eigenvalues and eigenfunctions.

Unit – IV : H-atom, Atomic and Molecular spectroscopy

1. Energy level derivation for H-atom, quantum features of hydrogen spectra and hydrogen like spectra, Stern-Gerlach experiment, electron spin, spin magnetic moment, spin-orbit coupling, qualitative explanation of fine structure, Franck-Hertz experiment, Zeeman effect, normal Zeeman splitting, Qualitative understanding about Stark effect.
2. Absorption and emission spectroscopy, its block diagram, brief explanation about the function of each element and its limitations; single beam spectrophotometer.

3. Molecular spectroscopy: concept of rigid rotator, rotational energy levels, rotational spectra, selection rules, intensity of spectral lines, isotopic effect, Vibrational energy levels, vibrational spectra, selection rules, isotropic effect, effect of anharmonicity in vibrational spectra, vibrational-rotational spectra of CO and HCI molecules.

Reference books:

1. David J. Griffiths, Introduction to Quantum Mechanics, 2nd edition.
2. R. Shankar, Principles of Quantum Mechanics, 2nd edition.
3. Arthur Beiser, Perspective of modern Physics, 6th edition.
4. AK Ghatak and S Lokanathan, Quantum Mechanics: Theory and applications.
5. HS Mani, GK Mehta, Introduction to modern Physics.
6. C.N. Banwell and E.M. McCash, Fundamental of Molecular Spectroscopy, 4th edition.
7. H.E. White, Introduction to atomic physics.

Paper- II : Nuclear and Particle Physics

Work Load: 2 hrs. Lecture/week

Scheme of Examination: First question will be of nine marks comprising of six parts of short answer type with answer not exceeding half a page. Remaining four questions will be set with one from each of the units and will be of six marks each. Second to fifth question will have two parts namely (A) and (B) each carrying 3 marks. Part (A) of the second to fifth question shall be compulsory and Part (B) of these questions will have internal choice.

Unit – 1

Properties of Nucleus: Discovery of Nucleus, Rutherford Scattering, Constituents of the Nucleus, Mass, Charge, Size, Nuclear Density, Charge Distribution, Hotstadier's experiment. Nuclear Angular momentum, Nuclear Magnetic Dipole Moment, Electric Quadrupole moment, Spin, Isospin, Wave Mechanical Properties: Parity and Statistics, Classification of Nuclei, Mass Defect and Binding Energy, Packing Fraction, Mass Spectrograph.

Nuclear Forces: Properties of Nuclear Forces, Yukawa Meson Theory, Nuclear Potential.

Nuclear Models: Segre Chart, Liquid Drop Model, Semi Empirical Mass Formula, Condition of Stability, Fermi Gas Model, Evidence for Nuclear Shell Structure, Nuclear Magic Numbers and Basic Assumptions of the Shell Model.

Unit – 2

Radioactive Decays: Alpha Decay- Basis of α-Decay Processes, Theory of β-Emission Spectrum, Gamow Factor, Geiger Nuttal Law, Range of Alpha Particles, Beta Decay- Energy kinematics for β-Decay, β-Decay Spectrum, Positron Emission, Electron Capture, Pauli's Neutrino Hypothesis. Gamma Decay- Gamma Ray Emission and Kinematics, Internal Conversion, Applications of Radioactivity.

Nuclear Fission and Fusion: Nuclear Fission, Spontaneous Fission and Potential Barrier, its Explanation by Liquid Drop model, Chain reaction, Controlled chain reaction, Four Factor Formula, Nuclear Reactors, Classification of Nuclear Reactor, uncontrolled Chain Reaction, Nuclear Fusion, Energy released in nuclear Fusion, Fusion in stars.

Nuclear Reactions: Types of Reactions, Conservation laws, Kinematics of Reactions, Q-Value, Threshold Energy, Reaction Rate, Reaction Cross-Section.

Unit – 3

Interaction of Nuclear Radiation with Matter: Energy Loss by Heavy Charged Particles in Matter, Interaction of Electrons with Matter, Range of Charged Particle, Bremsstrahlung, Cherenkov Radiation, Gamma Ray Interaction With Matter.

Radiation Detectors: Gas filled detector, Avalanche, Geiger Discharge, Ionization Chamber, Proportional Counter, Geiger Muller Counter, Current mode and Pulse Mode Operation of Detector.

Particle Accelerators: Ion source, Van-de-Graaff Accelerator (Tandem Accelerator), Linear Accelerator, Cyclotron, Synchrocyclotron, Betatron, Proton Synchrotron

Unit – 4

Elementary Particles: Necessity of high energy to discover elementary constituents, historical introduction to discovery of elementary particles (electron, positron, neutrions, strange mesons, charm quark, intermediate vector boson, bottom quark, top quark and Higgs boson) Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc), elementary particles included in the standard model.

Fundamental Interactions : Four types of fundamental forces, Symmetries and Conservation Laws, Discrete symmetries C, P and T invariance, Application of symmetry arguments to particle reactions, Parity non-conservation in weak interaction CP violation.

Quark Model: Flavor symmetries, Gellmann-Nishijima formula, the eightfold way, Quark model, Octet Diagram for Mesons and Baryons, Concept of Quark model, the November Revolution, Baryon Decuplet, Color Quantum Number and Gluons.

Suggested Books:

1. Nuclear and Particle Physics, W.E. Burcham and M Jobs, Addison Wesley Longman Inc.
2. Nuclear and Particle Physics, Brian R Martin, John Wiley & Sons.
3. Introduction to Nuclear and Particle Physics, Das and Ferbel, World Scientific.
4. Elements of Nuclear Physics, Walter E. Meyerhof, McGraw-Hill Book Company.
5. Introductory Nuclear Physics, Kenneth S. Krane, John Wiley & Sons.
6. Introduction to Elementary Particles, David J. Griffiths, John Wiley & Sons)
7. Radiation Detection and Measurement G.F. Knoll (John Wiley & Sons)
8. Introduction to Nuclear and Particle Physics, V.K. Mittal, R.C. Verma, S.C. Gupta, PHI
9. Concepts of Modern Physics, A. Beiser, McGraw-Hill Book Company.

Paper- III : Solid State Physics

Work Load: 2 hrs. Lecture/week

Scheme of Examination: First question will be of nine marks comprising of six parts of short answer type with answer not exceeding half a page. Remaining four questions will be set with one from each of the units and will be of six marks each. Second to fifth question will have two parts namely (A) and (B) each carrying 3 marks. Part (A) of the second to fifth question shall be compulsory and Part (B) of these questions will have internal choice.

Unit – 1

Bonding in Solids and Crystal structure:

Force between atoms, Ionic bonds, Covalent and metallic bonds, Vander waals and Hydrogen bonding, Periodicity in lattices, Basis, lattice point and space lattice, Translation vectors, unit and primitive cell, Crystal systems, Packing fractions for Simple Cubic (SC), Body Centred Cubic (BCC), Face Centred Cubic (FCC) and Hexagonal lattice structures, Bravais space lattices.

Crystallography and Diffraction:

Direction, planes and miller indices in a crystal lattice, Reciprocal lattice and its significance, Conversion of SC and FCC structures in reciprocal lattice frame, Concept of Crystalline, polycrystalline and amorphous materials, X-ray diffraction by solids: Laue and Braggs equation, Study of crystals by X-rays: FWHM, Sherrer formula and Lattice Constants (for simple cubic structure), Electron and Neutron diffraction (qualitative).

Unit – 2

Band theory of solids:

Formation of bands, Periodic potential and Bloch Theorem, Number of states in the bands. Kroning Penny model, Brilliuon zones, Crystal momentum and physical origin of effective mass, Negative Effective Mass and Holes, Energy dispersion relations: weak and tight binding.

Semiconductors:

Energy band Structures in Insulators, Conductors, Semiconductors, Concept of Direct and Indirect band gap in semiconductors, Generation and recombination of charge carriers, Mobility of current carriers, hall Effect in semiconductors: Hall coefficient, Mobility, Charge carrier concentration, Conductivity and Hall angle.

Unit – 3

Thermal properties of Materials:

Elastic waves, Phonon, Phonon dispersion relations in monoatomic and diatomic linear lattice Lattice heat capacity, Classical theory of specific heat, Dulong-Petit's law, Einstein and Debye's theories of specific heat of solids and limitations of these models, concept of Thermoelectric Power.

Electrical properties of Materials:
Drude-Lorentz theory, Sommerfeld's Model, Thermal conductivity, Electrical conductivity, Widemann-Franz relation, Thermionic Emission, Escape of electrons from metals, Hall Effect in Metals, Density of states.

Unit – 4

Magnetic properties of Materials:
Classification of Magnetic Materials, Origin of Atomic Magnetism, Classical Langevin Theory of dia and Paramagnetic Domains, Quantum theory of Paramagnetism, Curie's law, Weiss's Theory of Ferromagnetism, Concept of Domain Wall, Magnetostriction, Heisenberg's Exchange Interaction, Relation between Exchange Integral and Weiss Constant.

Superconductivity:
Experimental features of superconductivity: Critical Temperature, Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect, idea of BCS theory (No derivation); Cooper Pair and Coherence length. Josephson Effect (No derivation)

Reference Books:

1. Introduction to Solid State Physics — Charles Kittel (Wiley Publication)
2. Elementary Solid state Physics — M. Ali Omar (Pearson Education)
3. Elements of X-ray diffraction — B.D. Cullity (Prentice Hall)

PRACTICAL

Teaching : 4 hrs/week
Practical One - Paper 5 hrs duration
Min Pass Marks : 18 Max. Marks : 50
Note : Total number of experiments to be performed by the students during the session should be 16 selecting any 8 from each section.

Section - A

1. Determination of Planck's constant by photocell (retarding potential method using optical filters, preferably five wave length).
2. Determination of Planck's constant using solar cell.
3. Determination of Stefan's constant (Black body method)
4. Study of the temperature dependence of resistance of a semiconductor (four probe method).
5. Study of Iodine spectrum with the help of grating and spectrometer and ordinary bulb light.
6. Study of characteristics of a GM counter and verification of inverse square law for the same strength of a radioactive source.
7. Study of β-absorption in Al foil using GM Counter.

8. To find the magnetic susceptibility of a paramagnetic solution using Quincke's method. Also find the ionic molecular susceptibility of the ion and magnetic moment of the ion in terms of Bohr magneton.
9. Determination of coefficient of rigidity as a function of temperature using torsional oscillator (resonance method).
10. Study of polarization by reflection from a glass plate with the help of nicol's prism and photocell and verification of Brewster law and law of Malus.
11. e/m measurement by helical Method.
12. Measurement of magnetic field using ballistic galvanometers and search coil. Study of variation of magnetic field of an electromagnet with current.
13. Measurement of electric charge by Millikan's oil drop method.

Section - B

1. Study of a R-C transmission line at 50 Hz.
2. Study of a L-C transmission line
   (i) at fixed frequency.
   (ii) at variable frequency.
3. Study of resonance in an LCR circuit (using air core inductance and damping by metal plate).
   (i) at fixed frequency by varying C, and
   (ii) by varying frequency.
4. Study of the characteristics of junction diode & Zener diode.
5. Study of
   (i) Recovery time of junction diode and point contact diode.
   (ii) Recovery time as a function of frequency of operation and switching current.
6. To design Zener regulated power supply and study the regulation with various loads.
7. To study the characteristics of a field effect transistor (FET) and design/study amplifier of finite gain (10).
8. To study the frequency response of a transistor amplifier and obtain the input and output impedance of the amplifier.
9. To design and study of an R-C phase shift oscillator and measure output impedance (frequency response with change of component of R and C).
10. To study a voltage multiplier circuit to generate high voltage D.C. from A.C.
11. Using discrete components, study OR, AND, NOT logic gates, compared with TTL integrated circuits (I.C.'s).
12. Application of operational amplifier (OP-AMP) as : Minimum two of the following exercises– (a) Buffer (for accurate voltage measurement) (b) inverting amplifier (c) Non inverting amplifier (d) Summing amplifier.