M-25

Semester I

Core Course **Mechanics** **PHB-11C**

Unit I: Fundamentals of Dynamics

Newton's Laws of motion, dynamics of a system of particles, centre of mass, conservation of momentum, impulse, variable mass system. Work-energy theorem, potential energy, conservative and non-conservative forces, force as gradient of potential energy. Particle collisions, centre of mass and laboratory frame. Inertial frames and non-inertial frames, uniformly accelerated system,

Unit II: Rotational Dynamics

Angular momentum of a system of particles, torque and conservation of angular momentum, rotation about a fixed axis, moment of inertia tensor: its calculation for regular bodies, kinetic energy of rotation; physics in rotating coordinate system, centrifugal and Coriolis forces.

Unit III: Gravitation

Newton's law of gravitation, inertial and gravitational mass, potential energy due to spherical shell and solid sphere, angular momentum conservation Kepler's laws.

Unit IV: Special Theory of Relativity I

Michelson Morley experiment, Lorentz transformations, simultaneity and order of events, Lorentz contraction and time dilation, velocity addition theorem.

Reference Books:

1. An introduction to mechanics : Kleppner & Kolenkow.
2. Feynman Lectures-Volume I,
3. Problems in Physics : Irodov
4. Special Theory of Relativity : Resnick
5. Newtonian Mechanics : A.P.French,
6. Mechanics : Berkeley Physics Course.

Semester I

Core Course **Electronics** **PHB-12C**

Unit I: Circuits Analysis

Kirchhoffs Laws, Mesh and Node Analysis of Circuits. Networks, Equivalent Star (T) and delta Networks. Star to Delta and Delta to Star Conversion. Network Theorems, Superposition theorem, Thevenin Theorem, Norton theorem.

Unit II: Semiconductor Diodes

Introduction, P and N Type Semiconductors. Energy Level Diagram. PN junction Diodes and its characteristics. Static and Dynamic Resistance. PN junction Rectifier Diode, Half-wave Rectifier, Full-wave Rectifiers its Ripple Factor and Efficiency. Idea of Filters. Zener diode,,Photo diode, varactor diode, LED.

Unit III: Transistors and Amplifiers

N-P-N and P-N-P Transistors, Characteristics of CB, CE and CC configurations. Active, Cutoff, and Saturation Regions. Load line and Q- point. Amplifiers and their classification, Class A, B, and C Amplifiers. Ideal amplifier, Voltage gain, current gain, Power gain, Input resistance, output resistance, load line.

Unit IV: Operational Amplifier

Principle of Operational Amplifier, Properties of ideal OPAMP, Open-loop and closed loop gain, Frequency response, CMMR, Slew rate, Virtual ground, Applications of operational Amplifiers : inverting, non-inverting, adder, subtractor, integrator, differentiator.

Reference Books:

1. Basic Electronics : D C Tayal,.
2. Principles of Electronics : V. K. Mehta.
3. Electronic Devices and Circuit : Robert Boylestad, Louis Nashelsky,
4. Basic Electronics and Linear Circuits : N. N. Bhargava, D. C. KulShreshtha.

Semester I

Choice Based Elective **Digital Electronics** **PHB-11E**

Unit I: Number system and codes

Introduction to decimal, binary, octal, hexadecimal number system, Inter conversion of binary, decimal, BCD, Octal and hex., BCD codes, Excess-3, grey codes. Simple binary arithmetic, binary addition, binary subtraction, 1`s and 2`s compliment of a binary number.

Unit II: Logic Gates

OR, AND, NOT NAND, XOR, NOR and XNOR gates, symbols and truth tables. NAND & NOR gates as universal gates, Logic families: DTL, TTL, RTL, ECL, DCTL, CMOS Logic and their merits and demerits.

Unit III: Boolean algebra

De Morgan's Theorems. Boolean laws. Simplification of logic circuit using Boolean algebra. Fundamental products. Minterms and Maxterms. Conversion of a truth table into an equivalent circuit by (1) SOP (2) POS method. Algebraic simplification, k-Maps, pairs, quads and octets, Karnaugh simplifications, Don't care conditions,

Unit IV: Adder, Flip-flop, Registers and Counters

Binary Adders (Half Adder, Full adder). Flip flops: RS Latches, Level clocking (Clocked SR flip flop), D latch, Edge triggered JK Flip Flop, JK Master Slave flip flop, T type Flip Flop. Registers-Shift Registers, synchronous & Asynchronous counters, Applications of Counters.

Reference Books:

1. Digital Electronics : Gothman
2. Digital Principals & Applications : Malvino & Leach
4. Digital Computer Electronics : A.P.Malvino
5. Analog and Digital Electronics : Peter.H.Beards.
6. Integrated Electronics : Millman & Halkias

Semester I

Physics Practical **Lab I** **PHB-11L**

Mechanics & Oscillation

List of Experiments :

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine **g** using simple pendulum.
3. To study the Motion of Spring and calculate Spring constant by static and dynamic method.(4)
4. To determine the Moment of Inertia of a Flywheel. (4)
5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method). (2)
6. To determine the Young's Modulus of a rod by bending by Optical Lever Method. (1)
7. To determine the value of g using Bar Pendulum. (4)
8. To determine the value of g using Kater's Pendulum. (4)
9. To determine surface tension of a fluid by capillary rise method. (3)
10. To determine the coefficient of viscosity of a liquid by Stoke's law. (3)
11. To determine the surface tension of a liquid by Jaeger's method.(2)
12. To determine the modulus of rigidity of material of a wire by Maxwell's needle. (1)

Semester II

Core Course **Thermal Physics** **PHB-21C**

Unit I: Kinetic theory of gases

Derivation of Maxwell's law of distribution of velocities and its experimental verification. Mean free path. Transport phenomena, viscosity.

Unit II: Ideal and Real gases

Equation of state for ideal gas, internal energy, specific heat, entropy, deviation from ideal gas, Andrew's experiment, Van der Waal's equation, critical constants and law of corresponding states, Joule-Thompson effect.

Unit III: Thermodynamics

Zeroth, First and second laws. Reversible and irreversible processes. Carnot's theorem. Clausius inequality. Absolute scale of temperature. Entropy. Thermodynamic Relations and their applications.

Unit IV: Thermodynamic Functions

Maxwell's relations and their applications. Change of phase. Equilibrium between a liquid and its vapour. Clausius–Clapeyron equation. Triple point with examples from physics. Second order phase transitions.

Reference Books:

1. A Text book of heat: M. N Saha and B.N Srivastava
2. Heat and Thermodynamics: Zemansky, Richard Dittman .
3. Thermal Physics : Garg, Bansal and Ghosh .
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Sears &Salinger.

Semester II

Core Course **Oscillation and Waves** **PHB-22C**

Unit I: Harmonic Oscillations

Simple harmonic oscillator, Examples in one Degree of Freedom: Simple pendulum, Mass-Spring system, Torsional Pendulum, Compound pendulum, Linearity and Superposition Principle. Oscillations having same frequency and different frequencies, Superposition of two mutually perpendicular oscillations. Lissajous Figures.

Unit II: Damped and Forced Oscillations

Free Damped Oscillations, Transient and Steady States, Amplitude, Phase, Resonance, Sharpness of Resonance, Power Dissipation and Quality Factor.

Unit III: Vibrations in Continuous Systems

Transverse vibrations of stretched strings. Normal modes of stretched strings. Pluck and struck strings. Longitudinal vibrations in air and other continuous medium. Newton's formula for Velocity of Sound. Laplace's correction.

Unit IV: Wave Motion

Wave Equation. Solutions of wave equation. Wave front. Plane and Spherical Waves. Longitudinal and Transverse Waves. Phase and Group Velocities. Energy Transport in a wave. Intensity of Wave. Standing waves in a string, reflection at fixed and free ends. Melde's experiment. Longitudinal Standing Waves in Open and Closed Pipes.

Reference Books:

1. Vibrations and Waves : A. P. French.
2. The Physics of Waves and Oscillations : N.K. Bajaj
3. An Introduction to Mechanics : Kleppner and Kolenkow
4. Waves: Berkley Physics Course : Franks Crawford

Semester II

Physics Practical **Lab II** **PHB-21L**

Electronics (Analog) & Thermal Physics

List of Experiments :

1. To study V-I characteristics of PN junction diode (4)
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator. (4)
3. To study the characteristics of a Bipolar Junction Transistor in CE configuration. (4)
4. To study growth and decay of charge on a condenser in RC circuit. (4)
5. To study Half wave and Full wave rectifier and find their ripple factor with various filters. (4)
6. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee's disc method. (2)
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier. (2)
8. To verify the network theorems. (2)
9. To determine Stefan's constant (2)
10. To determine the frequency of the mains with Melde's experiment.(3)

Semester II

Choice Based Elective **Development of Modern Physics** **PHB-21E**

Unit I: Radiation

Black body radiation, Planck radiation formula, Photoclcctric cffect, X- rays, Compton Scattering, X-ray diffraction,

Unit II: Wave nature of particles

Matter wave hypothesis of de Broglie, wave packets, phase and group velocities, Born's interpretation of the wave function, Diffraction of particles Davisson and Germer's experiment, G.P.Thomson's experiment, uncertainty principle.

Unit III: Atomic Structure

Rutherford scattering, Atomic model. Atomic spectra, energy levels, Bohr theory, quantum numbers, Franck-Hertz experiment.

Unit IV: Nuclei and particles

Nuclear composition, binding energy, Nuclear fission and fusion, Classification of fundamental forces, Nuclear forces and Elementary particles. Qualitative introduction to standard models of Particle physics and Cosmology.

Reference Books:

1. A. Beiser : Concepts of Modern Physics
2. H. H. Mani and G. K. Mehta : Modern Physics
3. Max Born : Atomic Physics
4. Urey and Ruark : Atoms and Quanta

Semester III

Core Course **Electricity & Magnetism I** **PHB-31C**

Unit I: Vector Calculus

Scalars and vectors, dot and cross products. Gradient of a scalar field, divergence and curl of vector field. Line, surface and volume integrals involving vector fields. Gauss' , Green's and Stokes' theorems.

Unit II: Electrostatics

Coulomb's law, Calculation of electric field for simple distributions of charges. Electrostatic potential, Gauss' law and its applications. Capacitors, electrostatic field energy. Method of images. Poisson and Laplace's equations.

Unit III: Magneto-statics

Magnetic induction B. Lorentz force, Biot-Savart law. Ampere's law. Fields due to a straight wire and a circular current loop. Magnetic dipole. Circular current and solenoid.

Unit IV: Faraday's law

Electromagnetic induction: Integral and differential forms. Induced electric field and emf. Mutual and self-inductance. Transformers. Magnetic field energy.

Reference Books:

1. Introduction to Electrodynamics : D.J. Griffiths
2. Electricity and Magnetism : A.S. Mahajan and A.A. Rangwala
3. Electricity and Magnetism : Berkeley Physics Course ed. E.M. Purcell
4. Physics (Vol. 2) : Halliday and Resnick
5. Feynman Lectures in Physics (Vol II)

Semester III

Core Course **Optics** **PHB-32C**

Unit I: Interference :

Coherent sources, Young's Double slit experiment, Division of wave front. Fresnel's bi-prism. Division of amplitude. Interference in thin films. Newton's rings. Michelson's interferometer.

Unit II: Diffraction :

Fraunhofer diffraction at single, double and N slits. Fresnel diffraction at a straight edge and circular aperture. Cornu-spiral. Half-period zones. Zone plate. Diffraction grating.

Unit III: Polarization :

Plane, circular and elliptical polarization of light. Double refraction. Nicol prisms. Wave plates. Optical activity.

Unit IV: Miscellaneous Topics :

Fermat's principle of geometrical optics. Huygen's principle. Resolving power of optical in- strunents and diffraction grating. Principle of lasers and holography.

Reference Books:

1. Optics : A. K.Ghatak
2. Fundamentals of Optics : Jenkins and White
3. Principles of Optics : Max Born andf Emil Wolf
4. Optics : Eugene Hecht

Semester III

Core Course **Mathematical Physics I** **PHB-33C**

Unit I: Matrices and Linear Vector Space :

Matrix algebra; Different types of matrices; Quotient space; Inner Product; Abstract Systems; Binary Operations; Groups; Fields; Vector Spaces; Subspaces; Linear Independence and Dependence; Basis; Dimensions; Change of basis; Homomorphism, Isomorphism, Linear and Non-singular Transformations.

Unit II: Vector Calculus :

Vector algebra; Fields; Directional derivatives; normal derivative; Gradient; Divergence; Curl; Laplacian, Vector identities, Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Notion of infinitesimal line, surface, volume elements; Line, surface, volume integrals of vector fields. Flux of a vector field, Gauss theorem, Green's theorem and Stokes Theorems, Orthogonal curvilinear coordinates; Calculation of divergence, gradient, curl and Laplacian in spherical polar and cylindrical coordinates. Multiple Integrals, Jacobian.

Unit III: Probability

Basic concepts: Sample space and probability, Permutation, combination, average and standard deviation; Binomial and Poisson distribution, Continuous random variable, Normal distribution

Unit IV: Complex Analysis :

Review of complex number; Graphical representation; Euler's formula; De-Moivre's theorem; Roots of complex numbers; Functions of complex variables; Multiple Valued Functions; Power Series; Analyticity; Cauchy-Riemann conditions; Singular functions; Poles, branch points, singularities; Simply and multiply connected region; Cauchy integral theorem; Cauchy integral formula; Cauchy's inequality; Derivative as integral; Morera's Theorem; Liouville's Theorem; Taylor and Laurent series; Residues; Contour Integration.

Reference Books:

1. Vector Analysis : Schaum Series
2. Advanced Engineering Mathematics : Kreyzig
3. Linear Algebra : Schaum Series
4. Complex Variable : Spiegel
5. Linear Vector Spaces : M. C. Jain

Semester III

Physics Practical **Lab III** **PHb-31L**

Optics

List of Experiments :

1. Focal length of two lenses by Nodal Slide method and verification of Newton's formula. (1)
2. To determine wavelength of Na source using plane diffraction grating (2)
3. Determination of refractive Index and dispersive power of a prism using spectrometer. (2)
4. Determination of wavelength of LASER using plane transmission diffraction grating. (2)
5. Determination of wavelength of sodium light by Newton's Rings method. (4)
6. Determination of specific rotation of sugar solution by Laurent's Half-Shade Polarimeter(4)
7. Verification of Hartman's dispersion formula. (1)
8. To determine wavelength of spectral lines of Hg source using plane diffraction grating. (2)
9. To determine dispersive power and resolving power of a plane diffraction grating.(1)
10. To determine the wavelength of Sodium light by using Fresnel's Biprsm (1)

Semester III

Ability Enhancement Course **Instruments & Measurements** **PHB-31A**

Unit I: Basic Measurement Concepts :

Measurement systems – Static and dynamic characteristics – units and standards of Measurements, Error: different types, source of error, error analysis.

Unit II: Electrical Measurements :

DC measurements: dc voltmeter, ohmmeter, ammeter (analog and digital), And AC measurements: ac voltmeter, ammeter, wattmeter, energy meter (analog and digital). Digital multimeter, Digital frequency meter, ac bridges.

Unit III: Oscillators and Electronic Display:

Essentials of oscillators: Barkhauson criterion, RC phase shift oscillator, Wein Bridge oscillator, Hartley oscillator. The Cathode Ray Oscilloscope (CRO): Block diagram of a General Purpose Oscilloscope and its basic operation, Applications: Measurement of Time, Period and Frequency Types of CRO's: dual trace oscilloscope, digital storage oscilloscope. Signal generators, Function generators - RF signal generator.

Unit IV: Vacuum Systems & Gauges :

Fundamentals: Gas Flow Mechanisms, Concept of Throughput and pumping Speed. Different types of pump: Rotary and Diffusion Pump. Measurement of vacuum: gauges-pirani gauge, penning gauge.

Reference Books:

1. Electrical Measurements & Electronic Measurements : A.K. Sawhney
2. Modern electronic Instrumentation and measurement techniques : Helfrick Cooper
3. Electronic test instruments: analog and digital measurements: R. A. Witte
4. Instrumentation, devices and systems : Rangan, Sarma and Mani
5. Electronic Instrumentation : H. S. Kalsi .

Semester IV

Core Course **Electricity & Magnetism II** **PHB-41C**

Unit I: Current and circuits

Current density, steady and non-steady currents and continuity equation, rise and decay of currents in LR and CR circuits, Complex impedance and reactance, frequency response. Series and parallel circuits, resonance, Q factor, Power dissipation and power factor.

Unit II: Electrostatic fields in matter

Dielectrics, polarization and the electric displacement vector D. Susceptibility, permittivity, dielectric constant. Energy in dielectric systems, forces on Dielectrics, Clausius-Mossotti equation, Polar molecules. The Langevin formula.

Unit III: Magnetic fields in matter

Magnetization. Dia, para and ferromagnetism. The field of a magnetized object. Bound currents. Ampere's law in magnetized medium. Magnetic field intensity vector H. Magnetic susceptibility and permeability. Ferromagnetism. Energy loss in Hysteresis and the B-H curve.

Unit IV: Boundary value problems

Poisson's equation, Laplace's equation, boundary conditions, uniqueness theorem. Method of images, Different image problems; Boundary value problems with linear dielectric materials and linear magnetic materials.

Reference Books:

1. Introduction to Electrodynamics : D.J. Griffiths
2. Electricity and Magnetism : A.S. Mahajan and A.A. Rangwala
3. Electricity and Magnetism : Berkeley Physics Course ed. E.M. Purcell
4. Physics (Vol. 2) : Halliday and Resnick

Semester IV

Core Course **Quantum Mechanics** **PHB-42C**

Unit I: The Schrodinger equation

Schrodinger Equation. Conservation of Probability. Probability current density. Expectation values. Ehrenfest theorem. Time independent Schrodinger equation. Stationary States. Eigen function and eigenvalues.

Unit II: One dimensional problems

Particle in potential well - infinite square well and finite square wells. Potential barrier problems - step potential and rectangular potential. The harmonic oscillator problem.

Unit III: Operators and matrices

Hilbert space. Orthonormal bases. Linear operators. Dirac notation. Operators. Eigenvalues and eigenfunction of operators. Observables. Commutators. Generalised Uncertainty relations.

Unit IV: The three-dimensional problem

Spherically symmetric potential. Angular momentum operator and its eigenvalues. Commutation Relations. Spin of the electron. Hydrogen atom and the degeneracy of energy levels.

Reference

1. Concepts in Modern Physics: Beiser
2. Quantum Mechanics: Zettili
3. Quantum Mechanics: Griffiths
4. A text book on Quantum Mechanics : M.C.Jain

Semester IV

Core Course **Mathematical Physics II** **PHB-43C**

Unit I: Dirac Delta Function, Fourier Series and Transform:

Properties and representation of Dirac delta function in 1D, 2D, 3D; integral representation; Fourier series: Periodic functions; Dirichlet Conditions; Fourier coefficients; complex form, Expansion of arbitrary period function, non-periodic function, even and odd functions; Half range expansions; Summing of infinite series; Parseval Identity; Fourier Integral theorem, Fourier Transform, Representation of Dirac delta function as a Fourier Integral, Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem, Properties and Applications

Unit II: Differential Equations :

PDE's and ODE's; Separation of variables in different coordinates system; Normal form of FODE; Integrating factors; First and Second order linear differential equations; Superposition, Uniqueness, Wronskian; General solutions of homogeneous and inhomogeneous cases; Second order linear differential equation with constant coefficient; Central force problem;

Unit III: Special Functions:

Laplace's equation in Cartesian and spherical coordinates; Legendre's differential equation; series solution, orthogonality, recurrence and orthogonality relations; Expansions in Legendre polynomials; Laplace's equation in cylinderical coordinates; Bessel's differential equation; generating functions, recurrence relations etc; Expansions in Bessel's functions and examples; Some other PDE's of physics: Heat, wave and Schrodinger equations.

Unit IV: Tensors

Transformation properties of vectors, covariant and contra-variant vectors; Tensors: Definition, algebraic properties; Numerical tensors (Kronecker delta and Levi-Civita symbols), metric tensor, index raising, lowering, contraction; Electromagnetic field tensor; Covariant differential; Affine connection; Covariant derivative; metric connection; Riemann curvature tensor, Bianchiidentity; Ricci tensor; Einstein equation and curvature tensor.

Reference Books:

1. Mathematical Methods for Physicists: Arfken and Weber
2. Advanced Engineering Mathematics : Erwin Kreyszig
3. Fourier Analysis : M.R. Spiegel.
4. Differential Equations : G. Simmons.
5. Mathematical methods for Scientists & Engineers : D.A. McQuarrie.

Semester IV

Physics Practical **Lab IV** **PHB-41L**

Electricity & Magnetism

List of Experiments:

1. Determination of E.C.E. of copper using a Copper Voltameter and checking the accuracy of ammeter. (2)
2. Determination of Self Inductance of a coil using Anderson's Bridge. (3)
3. Determination Self Inductance of a coil by Owen's Bridge. (2)
4. Study of LCR circuit and determination of impedence. (3)
5. Determination of magnetic field by Helmholtz coil. (2)
6. To draw the B-H curve for the iron and to determine the energy loss due to hysterisis.(2)
7. To determine the temperature coefficient of resistance by Platinum Resistance Thermometer (PRT). (2)
8. Conversion of a moving coil galvanometer into an ammeter and voltmeter.(3)
9. To determine the dielectric constants for solids.(1)
10. Study of the Wien bridge oscillator and determine the frequency of the oscillator. (2)

Semester IV

Choice Based Elective **Properties of Matter** **PHB-41E**

Unit I: Elasticity

Hooke's law, Relation between elastic constants, Torsion of a cylinder, Bending moment, Cantilever, Beam supported at both ends, Beams clamped at both ends, Reciprocity theorem, Elastic energy in different types of deformation, Rigidity modulus.

Unit II: Surface Tension

Surface Tension and Surface energy, Surface Tension determination by Jaeger's & Quincke's Methods, Angle of contact, Variation of surface tension with temperature, Excess of pressure over a curved surface, Shape of liquid drops, Application to spherical and cylindrical drops and bubbles.

Unit III: Viscosity

Streamlined and turbulent motion, Reynolds number, Poiseuille's formula, Determination of coefficient of viscosity, capillary flow method, Stoke's formula, viscosity of highly viscous liquids, Variation of viscosity of a liquid with temperature

Unit IV: Fluid Mechanics

Streamlines and flowlines - Equation of continuity- Euler's equation of motion- Bernoulli's theorem and its applications - Newtonian and non-Newtonian fluid

Reference Books:

1. General properties of Matter : Newman and Searle
2. Properties of Matter : Newman and Searle
3. Treatise on General Properties of matter : Newman and Searle

Semester V

Core Course **Electro Magnetic Theory** **PHB-51C**

Unit I: Electromagnetic Field Equations

Electromagnetic Units, Displacement current, Continuity Equation, Maxwell's Equations in vacuum and in media, Boundary conditions, Electromagnetic potentials, Conservation of energy.

Unit II: Multipole expansion and Radiation

Multipole Expansion of potentials. Radiation, Electric dipole field and radiation, Magnetic dipole radiation, Radiation from an arbitrary source.

Unit III: Propagation of Electromagnetic waves

Electromagnetic waves in vacuum and non conducting medium, Propagation in linear media, reflection and refraction at a plane interface, Brewster's angle, total internal reflection. EM waves in conductors, absorption and dispersion.

Unit IV: Waveguides

Cylindrical cavities and Waveguides, Wave guides, Modes in Rectangular wave guides, Energy flow and attenuation in Waveguides

Reference Books:

1. Introduction to Electrodynamics : D.J. Griffiths
2. Foundations of Electromagnetic Theory : Reitz, Millford and Christy
3. Classical Electrodynamics : J.D.Jackson
4. Introduction to Electromagnetic Field and Waves : Corson and Lorrain

Semester V

Core Course **Atomic & Molecular Physics** **PHB-52C**

Unit I: Introduction

Brief review of early models of atomic structure. Rutherford scattering, Limitation of Bohr-Sommerfeld theory. Frank & Hertz experiment. Addition of angular momenta.

Unit II: Atomic structure

Pauli's Exclusion Principle; Symmetric & Antisymmetric Wave Functions; Periodic table; Fine structure; Spin-orbit coupling; Vector model; L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms.

Unit III: Interaction with Electromagnetic field

Spin angular momentum; Larmors Theorem; Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman effect; Normal and Anomalous Zeeman Effect; Paschen Beck effect; Stark effect

Unit IV: Molecular Spectra

Rotational Energy levels, Selection rules and pure rotational spectra; Vibrational energy levels, selection rules and vibration spectra; Rotation-vibration energy levels, selection rules and spectra. Determination of internuclear distance. Raman Effect, Stoke's and Anti-Stoke's Lines.

Reference Books:

1. Concepts of Modern Physics : Arthur Beiser .
2. Introduction to Atomic Spectroscopy : H.E. White.
3. Modern Physics : Mani and Mehta
4. Physics of Atoms and Molecules : Bransden and Joachain.
5. Molecular Spectroscopy : C.N. Banwell.

Semester V

Core Course **Solid State Physics I** **PHB-53C**

Unit I: Crystal Structure Defects

Crystalline state of solids, Lattice Translation Vector, Unit cell, Wigner- Seitz cell, Number of lattice point per unit cell, packing fraction, Bravais lattice, Miller indices, Interplaner spacing, Symmetry elements, types of lattices Brillouin zone, reciprocal lattice. Point defects-Frenkel and Schottky vacancies, Line defects-Edge and screw dislocations, Planer defects, Stacking faults

Unit II: X-rays and Atomic Bonding

X-Rays: Continuous and characteristic X-rays spectra, Absorption of X-rays, Diffraction of X-rays, Bragg's law, Laue's equations, Powder method. Atomic Bonding: Interatomic forces and classification of solids, Bond dissociation Energy, Cohesive Energy of ionic crystal, Types of Bonds; Ionic bond, Covalent bond, Metallic Bonding, Van der Waals Bonding

Unit III: Elementary Lattice Dynamics

Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic molecules chains, Acoustical and Optical Phonons, Qualitative Description of the Phonon spectrum in solids, Dulong and Petit law, Einstein and Debye theories of specific heat of solids, Debye T3 law.

Unit IV: Electrical Conductivity

Free electron theory, Sommerfeld model, Fermi level, Density of states, Electrical conductivity of metals and its temperature dependence, Weidemann-Franz law, Hall Effect.

Reference Books:

1. Introduction to Solid State Physics : Charles Kittle
2. Solid state physics : Rita John
3. Introduction to Solids : Azaroff L. V
4. Solid State Physics : N.W. Ashcroft and N.D. Mermin
5. Solid-state Physics : H. Ibach and H. Luth
6. Elements of Solid State Physics : J.P. Srivastava.

Semester V

Physics Practical **Lab V** **PHB-51L**

Modern Physics

List of Experiments :

1. Determination of Planck's constant by photocell and verify the radiation law. (2)
2. Determination of wavelength of Sodium light using Michelson's Interferometer (2)
3. Determination of the band gap of a semiconductor using four probe method. (2)
4. Determination of magnetic susceptiblity of $MnCl_2$ by Quinck's method (2)
5. Determination of Planck's constant by cut off method. (2)
6. e/m by Thomson's method. (2)
7. To determine the Hall coefficient of a semiconductor sample.(2)
8. To demonstrate the concept of quantisation of energy levels using Franck Hertz Experiment (1)
9. To determine the ionization potential of mercury (1)
10. To determine the Zeeman splitting with Mercury. (1)

Semester V

Choice Based Elective **Classical Mechanics** **PHB-51E**

Unit I: Lagrangian formulation

Generalised coordinates, constraints and degrees of freedom; D'Alembart's principle; Lagrange's equation for conservative systems and its application to simple cases

Unit II: Hamiltonian formulation

Calculus of Variation, Hamilton's principle, Definition of Hamiltonian; Generalised momentum; Cyclic coordinates and laws; Hamilton's equation and its application to simple cases.

Unit III: Special Theory of Relativity - II

Lorentz transformation; Four vectors; Example of common four-vectors; Relativistic dynamics: variation of mass with velocity; Energy momentum relationship; Space-time diagram; Space like, time-like and light like intervals; Light cone.

Unit IV: Central force problem

Motion under central force; Two body central force problem, reduction to the equivalent one body problem; Nature of orbits in an attractive inverse square field; Kepler's laws of planetary motion; Condition for stable circular orbit.

Reference Books:

1.Classical Mechanics: H. Goldstein.
2.Mechanics: L. D. Landau and E. M. Lifshitz
3.Introduction to Classical Mechanics: Takwale and Puranik.
4.Theoretical Mechanics: Murray Spiegel.

Semester VI

Core Course **Solid State Physics II** **PHB-61C**

Unit I: Elementary Band Theory of Solids

Bloch Theorem, Electron in periodic field: Kronig Penney model, Brillouin zones, Effective mass of electron, Origin of Band Gap, Insulator, semiconductor and metals. Intrinsic and Extrinsic Semiconductors, Carrier concentration, Fermi level and conductivity for Intrinsic and Extrinsic Semiconductors

Unit II: Magnetic Properties of Matter

Response of substance to magnetic fields, Dia, Para and Ferromagnetic materials, Absence of magnetic charge, Electric current in atoms, Electron spin and magnetic moment Measurement of the susceptibility of paramagnetic substances, Langevin's theory of diamagnetic and paramagnetic substances, Curie- Weiss Law, Theory of ferromagnetism.

Unit III: Dielectric Properties of Solids

Polarization and Susceptibility, The local field, Dielectric Constant and Polarizability, Clausius-Mossitti Equation, Sources of Polarizability (Electronic, Ionic, Dipolar Polari ability), Classical Theory of Electronic Polari ability, Frequency Dependence of Total Polarizability.

Unit IV: Superconductivity

Introduction and Historical Developments, Electrical Resistivity, Perfect Diamagnetism or Meissner Effect, Supercurrents and Penetration Depth, London Equations, Critical Field and Critical Temperature, Type I and Type II Superconductors, Thermodynamical properties, Flux Quantization, The Josephson Effects and Tunnelling, Idea of the BCS Theory, High Temperature Ceramic Superconductors.

Reference Books:

1. Introduction to Solid State Physics : Charles Kittle
2. Solid state physics : Rita John
3. Introduction to Solids : Azaroff L. V
4. Solid State Physics : N.W. Ashcroft and N.D. Mermin
5. Solid-state Physics : H. Ibach and H. Luth
6. Elements of Solid State Physics : J.P. Srivastava.
7. Solid State Physics : M.A.Wahab

Semester VI

Core Course **Nuclear &Particle Physics** **PHB-62C**

Unit I: Radioactivity

Radioactive decay constant, half life and mean life. Radioactive transformations and equilibrium. Natural radioactive series. Alpha decay. Gamow's theory. Beta decay. Pauli's neutrino hypothesis. Electron capture process.

Unit II: Nuclear models and reactions

The liquid drop model of a nucleus. Weizsacker's semi-empirical mass formula. The shell model of a nucleus Nuclear reactions. Threshold energy. Energy production in stars by proton- proton and carbon cycle.

Unit III: Elementary Particles

Fundamental interactions in nature. Classification of elementary particles. Photons, leptons, mesons and baryons. Quantum numbers: isospin, strangeness, and charm. Quarks and confinement. Conservation laws.

Unit IV: Accelerators and Detectors

Need of accelerators. Cyclotron. Betatron and Linac. Detectors for charged particles. Working principle of Cloud chamber, Bubble chamber, Ionisation chamber. Proportional counter. G.M. Counter. Scintillation Counter.

Reference Book

1. Concepts of Modem Physics : A. Beiser
2. Nuclear Physics : I. Kaplan
3. Concepts of Nuclear Physics : Cohen
4. Introduction to the Physics of Nuclei and Particles : Dunlap
5. Introductory Nuclear Physics : Krane

Semester VI

Core Course **Statistical Mechanics** **PHB-63C**

Unit I: Foundations of Statistics

The macroscopic and the microscopic states, phase space, trajectories and density of states, Liouville's theorem, ensemble theory, the principle of maximum entropy, contact between statistical mechanics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox

Unit II: Ensemble Theory

Micro-canonical ensemble; Canonical Ensemble, partition function, calculation of statistical quantities, Energy fluctuations. Particle number fluctuation, Grand canonical ensemble, Entropy in grand canonical ensemble, thermodynamic potentials.

Unit III: Quantum Statistics

Statistics of indistinguishable particles, Maxwell-Boltzmann distribution, Need for quantum statistics, Postulates of quantum statistics, density matrix, statistics of ensembles.

Unit IV: Bose-Einstein and Fermi-Dirac Statistics

Bose-Einstein distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, Photons, Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal.

Reference Books:

1. Fundamentals of Statistical and Thermal Physics : F. Reif
2. Thermodynamics and an Introduction to Thermostatistics : H. B. Callen
3. Thermodynamics and Statistical Mechanics : Greiner, Neiser and Stocker

Semester VI

Skill Enhancement Course **Computational Methods in Physics** **PHB-61AL**

Unit I: Introduction

Introduction to operating system, Use of linux as an OS, Algorithm: definition, properties and development; Flowchart: Concept of flowchart, symbols, guidelines, types. Some examples.

Unit II: Scientific Programming and Logic

Introduction to FORTRAN, Basic elements of FORTRAN, I/O Statements (unformatted/formatted), Layout of Fortran Program, Format of writing Program and concept of coding; Logic (Sequential, Selection, Repetition), Branching Statements, Looping Statements, Jumping Statements Subscripted Variables, Functions and Subroutines.

Unit III: Visualization

Importance of visualization of computation and computational data, Introduction to Gnuplot; Basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

Unit IV: Hands on Exercise

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization .

Reference Books:

1. Introduction to Numerical Analysis : S.S. Sastry
2. Computer Programming in Fortran 77 : V. Rajaraman
3. Schaum's Outline of Theory and Problems of Programming with Fortran :S.Lipsdutz and A Poe.

Semester VI

Physics Practical **Lab VI** **PHB-61L**

Advanced Electronics

List of Experiments :

1. To design an inverting amplifier of given gain using Op-amp (741,351) and study thc frequency response
2. To design non-inverting amplifier of given gain using Op-amp (741,351) and study its frequency response
3. To design and study an Op-amp adder
4. To design and study the use of an op-amp as an Integrator / Differentiator.
5. To determine the frequency and duty cycle of an astable 555 timer.
6. To design an astable multivibrator of frequency 1 kHz using a 555 timer.
7. To design a monostable 555 multivibrator and measure the pulsewidth of its output.
8. To verify and design AND, OR, NOT and XOR gates using NAND gates.
9. To design a Half Adder and Full Adder circuit using IC.
10. To construct Flip-Flop circuits(RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs