B. Sc.- Semester I

MECHANICS AND WAVE MOTION

(4 CREDITS) **PAPER I** **(40 LECTURES)**

Unit I

Inertial and non-inertial reference frames, radial and transverse components of velocity and acceleration using polar coordinates, Newton's laws of motion. Dynamics of particle in rectilinear and circular motion, Conservative and Non-Conservative forces, conservation of energy, linear momentum, and angular momentum. Collision in one and two dimensions, cross section.

Unit II

Rotational energy and rotational inertia for simple bodies (ring, disk, rod, solid and hollow sphere, cylinder, rectangular lamina). The combined translational and rotational motion of a rigid body on horizontal and inclined planes. Simple treatment of the motion of a top. Relations between elastic constants, bending of beam and torsion of cylinder.

Unit III

Central forces, Two body central force problem, Reduced mass and its equation of motion, Centre of mass motion, Newton's law of gravitation; Gravitational binding energy, Equivalence of inertial and gravitational mass, Gravitational field and potential at a point inside and outside a hollow and solid sphere. Kepler's laws, motion of planets and satellites, geo-stationary satellites.

Unit IV

Differential equation of Simple Harmonic Motion (SHM) and its solution, use of complex notation, damped and forced oscillations, Quality factor. Composition of simple harmonic motion, Lissajous figures.

Differential equation of wave motion, plane progressive waves in fluid media, reflection of waves, phase change on reflection, Principle of superposition of waves, stationary waves, pressure and energy distribution, phase and group velocity.

B. Sc.- Semester I

CIRCUIT FUNDAMENTALS AND BASIC ELECTRONICS

(4 CREDITS) **PAPER II** **(40 LECTURES)**

Unit I

Growth and decay of current through inductive resistances (LR circuit), charging and discharging of capacitor through resistance (CR circuit) and inductive resistance (LCR circuit) , time constant, Measurement of high resistance by leakage method.

Alternating current in RLC circuits, method of imaginaries, complex impedance, phase diagrams, Q factor, series and parallel resonant circuits, theory of coupled circuits, Transformers, Reflected Impedance and impedance matching, Maximum power transfer theorem. AC bridges: Maxwell, Schering and Wien.

Unit II

Semiconductors: Covalent bonding, Energy bands, Forbidden energy gap, Intrinsic and extrinsic semiconductors, p-type and n-type semiconductors. Formation of the pn junction. Depletion layer, Field and potential at the depletion layer. Unbiased diode, Forward and Reverse biased diodes, Current conduction in a pn junction, majority and minority carriers. Characteristic curves. Static (DC) and Dynamic (AC) resistance.Diode as a rectifier, Half wave, Full wave and Bridge rectifier. Rectification Efficiency and Ripple factor. Zener and Avalanche breakdown. Zener diode as a voltage regulator. Filter Circuits: Choke input filter, Capacitor input filter, L and π type filters; DC Power supply, Bipolar transistors: PNP and NPN transistors, their characteristic curves in common base, common emitter and common collector configurations, Active, Cut-off and Saturation regions, DC alpha and DC beta and relationship between them.

Unit III

Transistor biasing: Need for biasing, Transistor biasing circuits: Base Bias, Emitter Bias, Voltage Divider Bias. Transistor leakage currents, thermal runaway, transistor stabilization, swamping, Stability factor. Load line, DC and AC load line, Operating point. DC and AC equivalent circuits. Low frequency transistor models, small signal amplifiers, Common Base, Common Emitter, Common Collector amplifier, Current and Voltage gain, RC coupled amplifier, Qualitative treatment, Study of frequency response of RC coupled amplifier.

Unit IV

Feedback in amplifiers: Positive and Negative feedback, Input and Output Impedance of Negative feedback voltage amplifiers. Transistor as an oscillator, Tank circuit, Barkhausen criterion, General discussion and theory of Hartley oscillator. Elements of transmission and reception, Basic principle of amplitude modulation and demodulation, principle and design of linear multimeters and their applications, Cathode ray Oscilloscope and its simple applications.

B. Sc.- Semester II

OPTICS

(4 CREDITS) **PAPER I** **(40 LECTURES)**

Unit I

Interference of two beams of light, Conditions for interference, Spatial and temporal coherence, classification of interference, Division of Wavefront: Fresnel's Biprism, Lloyd's Mirror. Division of amplitude: Newton's rings, Michelson's Interferometer, Fringes of equal inclination, Fringes of equal thickness, Interference involving multiple reflections, Stokes' treatment, interference in transmitted light, Fabry-Perot interferometer, Edser- Butler interferometer.

Unit II

Fresnel and Fraunhofer Diffraction, Diffraction by a single and double slits. Derivation of equation for intensity, comparison of single-slit and double slit patterns, distinction between interference and diffraction, missing orders. Diffraction grating, formation of spectra by a grating, principal maxima, difference between spectra of prism and grating, production of ruled grating.

Unit III

Rayleigh's criterion of resolution, Resolving power of Grating, Resolving power of a telescope, Fresnel's half period zones, the straight edge, diffraction at a narrow wire, Zone plate. Polarization, polarization by reflection, polarizing angle, Brewster's law, Law of Malus, Polarization by dichroic crystals, birefringence, anisotropic crystals, Nicol prism, Retardation plates, Babinet compensator, Analysis of polarized light.

Unit IV

Optical activity and Fresnel's explanation, Half shade and Biquartz polarimeters, Jones matrix, matrix representation of plane polarized waves, matrices for polarizers, retardation plates and rotators; Sources of light: Incoherent (Sodium, Neon,Mercury) and coherent (Laser-simple treatment).

B. Sc.- Semester II

PRACTICALS

(4 CREDITS) **PAPER II**

1. Modulus of rigidity by statical method.
2. Young’s modulus of material of a beam by flexure method.
3. Wavelength of sodium light by Newton’s rings.
4. Surface Tension of water by capillary rise method.
5. Resolving power of a Telescope.
6. Specific rotation of an optically active substance by Polarimeter.
7. Diameter of a wire by diffraction.
8. Dispersive power of a prism.
9. Verification of Brewster’s law.
10. Frequency of A.C. mains using a Sonometer.
11. ‘g’ by Compound Pendulum.

B.Sc. - Semester III

ELECTRICITY AND MAGNETISM

(4 CREDITS) **PAPER-I** **(40 LECTURES)**

Unit I

Electrostatics: Electric Field and Lines, Electric Field **E** due to a Ring of Charge. Electric Flux; Gauss's law, Gauss's law in Differential form. Applications of Gauss's Law : **E** due to (1) an Infinite Line of Charge, (2) a Charged Cylindrical Conductor, (3) an Infinite Sheet of Charge and Two Parallel Charged Sheets, (4) a Charged Spherical Shell, (5) a Charged Conducting Sphere, (6) a Uniformly Charged Sphere, (7) Two Charged Concentric Spherical Shells and (8) a Charged Conductor. Force on the Surface of a Charged Conductor and Electrostatic Energy in the Medium surrounding a Charged Conductor. Electric Potential: Line Integral of Electric Field. Electric Potential Difference and Electric Potential V (Line integral). Conservative Nature of Electrostatic Field. Relation between **E** and V. Electrostatic Potential Energy of a System of Charges. Potential and Electric Field of (1) a Dipole, (2) Quadrupole (3) a Charged Wire and (4) a Charged Disc. Force and Torque on a Dipole. Conductors in an Electrostatic Field. Description of a System of Charged Conductors. An Isolated Conductor and Capacitance. Electrostatic Energy of (1) a Point Charge, (2) a System of Point Charges, (3) a Uniform Sphere, (4) a Capacitor.

Unit -II

Magnetism: Magnetostatics: Magnetic Effect of Currents, Magnetic Field **B**. Magnetic Force between Current Elements and Definition of **B.** Magnetic Flux. Biot-Savart's Law : **B** due to (1) a Straight Current Carrying Conductor, (2) Current Loop and (3) Solenoid. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital law (Integral and Differential Forms): B due to (1) a Solenoid and (2) a Toroid. Properties of **B.** Curl and Divergence of **B**. Vector Potential. Forces on an Isolated Moving Charge. Magnetic Force on a Current Carrying Wire. Torque on a Current Loop in a Uniform Magnetic Field. Magnetic Properties of Matter: Gauss's law of magnetism (Integral and Differential Forms). Magnetization current. Relative Permeability of a Material. Magnetic Susceptibility. Magnetization Vector (**M**). Magnetic Intensity (**H**). Relation between **B**, **M** and **H**. Stored Magnetic Energy in Matter. Magnetic Circuit. B-H Curve and Energy Loss in Hysteresis.

Unit –III

Electromagnetic Induction: Faraday's laws of Electromagnetic Induction, Lenz's Law, Self and Mutual Inductance, L of Single Coil, M of Two Coils. Energy Stored in Magnetic Field. Skin effect. Motion of Electron in Changing Magnetic field , Betatron , Magnetic Energy in Field , Induced Magnetic Field (Time Varying Electric Field), Displacement current.

Ballistic Galvanometer: Potential Energy of a Current Loop. Ballistic Galvanometer: Current and Charge sensitivity. Electromagnetic Damping. Logarithmic Damping.

Unit –IV

Dielectrics: Electric Field in Matter. Dielectric Constant. Parallel Plate Capacitor with a Dielectric. Polarization, Polarization Charges and Polarization Vector. Electric Susceptibility. Gauss's law in

Dielectrics. Displacement Vector **D**. Relations between the three Electric Vectors. Capacitors filled with Dielectrics. Electrostatic equation with dielectrics, Field , Force and Energy in Dielectrics.

Maxwell`s equations and Electromagnetic wave propagation: Equation of Continuity of Current, Displacement Current, Maxwell's Equations, Poynting vector, Energy Density in Electromagnetic Field, Electromagnetic Wave Propagation through Vacuum and Isotropic Dielectric Medium, Transverse nature of EM Waves.

Suggested Books:

1. Electricity and Magnetism By Edward M. Purcell (McGraw-Hill Education, 1986)
2. Fundamentals of Electricity and Magnetism By Arthur F. Kip (McGraw-Hill, 1968)
3. Electricity and Magnetism by J.H.Fewkes & John Yarwood. Vol. I (Oxford Univ. Press, 1991).
4. Electricity and Magnetism. By D C Tayal (Himalaya Publishing House,1988).
5. David J. Griffiths, Introduction to Electrodynamics, 3rd Edn, (Benjamin Cummings,1998).

B.Sc. - Semester III

PRACTICALS

(4 CREDITS) **PAPER-II** **(40 LECTURES)**

1. To study the time constant in a C.R. Circuit.
2. To study the solid state common power supply.
3. To determine the field along the axis of Helmholtz coil.
4. To measure magnetic field using a ballistic galvanometer.
5. To determine the capacity of condensor by absolute method.
6. To determine the coefficient of mutual induction between two coils.
7. To determine high resistance by leakage method.
8. To study the characteristics of junction and Zener diodes.
9. To Study the Characteristics of p-n-p transistor.
10. To measure ‘L’ & ‘C’ by A.C. bridge

B.Sc. - Semester IV

THERMAL PHYSICS AND ELEMENTARY STATISTICAL MECHANICS

(4 CREDITS) **PAPER-I** **(40 LECTURES)**

Unit I

Thermodynamics: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_p & C_v, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot 's cycle & theorem, Entropy changes in reversible & irreversible processes. Clausius Inequality, entropy and unavailable energy, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for (C_P– C_V), CP/CV, TdS equations.

Unit II

Kinetic Theory of Gases: RMS speed, Kinetic Interpretation of temperature, Degree of Freedom, Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic Gases. Mean free path, Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Derivation of Maxwell's law of distribution of velocities and its experimental verification.

Unit III

Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law. Solar Constant.

Unit IV

Statistical Mechanics: Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity -Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.

<u>Suggested books:</u>

1. Thermal Physics - S. Garg, R. Bansal and C. Ghosh (McGraw Hill Education 1993)
2. A Treatise on Heat - Meghnad Saha, and B.N. Srivastava (Indian Press 1969)
3. Thermodynamics - Enrico Fermi (Dover Publications, 2013)
4. Heat and Thermodynamics - M.W.Zemasky and R. Dittman (McGraw-Hill College 1996)
5. Thermodynamics, Kinetic theory & Statistical thermodynamics - F.W.Sears & G.L.Salinger (Pearson 1975)
6. Statistical and Thermal Physics - S.Loknathan and R.S.Gambhir (BPB Publications, Delhi)

B.Sc. - Semester IV

ELEMENTS OF MODERN PHYSICS

(4 CREDITS) **PAPER-II** **(40 LECTURES)**

Unit I

Inadequacies of classical mechanics, Photoelectric Effect, The Quantum Theory of Light, Continuous and characteristic X-ray, X-ray generation and uses, Compton effect, Gravitational Red Shift, de Broglie waves, de Broglie Wave Function and its Properties, Interpretation of wave function, de Broglie Wave Velocity, Complementary principle, Principle of superposition, Wave and Group Velocity, Motion of Wave Packets Davisson and Germer Experiment-Diffraction of Electrons, Wave-particle duality Experiment.

Unit II

Heisenberg's Uncertainty principle and its applications, Estimating minimum energy of a confined particle using uncertainty principle, Estimate of Hydrogen Ground State Energy; Wave Equation, Wave Equivalent of an unrestricted Particle, Time Dependent Schrödinger wave equation: Eigenvalues and Eigen Functions, Probability Current; Expectation values, Expectation Values of Energy and Momentum Operators, Ehrenfest theorem.

Unit III

Continuity of wave Function, Boundary Condition and Discrete Energy Levels, Steady State Schrödinger Equation, Application of Schrödinger Wave Equation for Particle in an infinitely Rigid Box: Energy and Momentum Quantization, Normalization, Quantum Dot as an example; One Dimensional Step Potential, Rectangular Barrier, Square Well Potential.

Unit IV

Bohr atomic model, de Broglie Waves and Stationary Orbits, Hydrogen Atom Spectrum, Atomic Excitation-Franck Hertz Experiment, Correspondence Principle, Sommerfeld Elliptic Orbits. Electron Angular Momentum, Space Quantization, Electron Spin and Spin Angular Momentum, Spin Magnetic Moment, Stern – Gerlach Experiment, Pauli's Exclusion Principle and Periodic Table. Fine structure, Spin Orbit Coupling, Spectral Notation for Atomic States, Total Angular Momentum, Vector Model, Coupling schemes (LS and jj) for two electron systems. Zeeman Effect for one Electron System.

Suggested Books:

1. Concepts of Modern Physics- Arthur Beiser (McGraw-Hill, 2009).
2. Modern Physics- John R. Taylor, Chris D. Zafiratos, Michael A.Dubson (PHI Learning2009).
3. Six Ideas that Shaped Physics: Particles Behave like Waves, Thomas A. Moore, (McGraw Hill, 2009).
4. Modern Physics - R.A. Serway, C.J. Moses, and C.A. Moyer (Third Edition, 2005, Cengage Learning
4. A Text book of Quantum Mechanics- P.M. Mathews & K. Venkatesan (2nd Ed., 2010, McGraw Hill).
5. Quantum Mechanics: Theory and Applications - Ajoy Ghatak, S. Lokanathan.(Macmillan Publishers India Limited).
6. Fundamentals of Modern Physics - R.M. Eisberg (Wiley, New York).
7. Introduction to Atomic Spectra -H.E. White,(McGraw-Hill, New York).

Annexure VI

Annexure VI

B. Sc. - Semester V

PHYSICS

ELECTRONICS

(4 CREDITS) **PAPER – I** **(48 LECTURES)**

Unit – I

Diodes: Junctions between metal and semiconductors; Semiconductor properties: P. N. junction, depletion layer, Diode equation, junction potential width of depletion layer (qualitative only), field and capacitance of depletion layer, Effect of temperature on Junction diode, AC and DC resistances, reverse breakdown of PN junction; Zener and Avalanche diodes; Tunnel diode; Point contact diode; Light emitting diodes (LEDs); Photodiodes, Thermistors.

Unit - II

Transistors: Transistor parameters, base width modulation, Emitter resistance, Collector conductance, Current and Voltage gain, Biasing formulae for transistors, Base bias, emitter bias and mixed type bias, Input and Output Characteristics of CB, CE and CC Configurations. Transistor circuit application at law frequencies, their AC and DC equivalent for three different modes of operation, large signal operation of transistors. Transistor Power amplifiers: Class A and B operation, maximum power output, effect of temperature, Distortion in amplifiers, cascading of stages, Frequency response, Negative and positive feedback in transistor amplifiers.

Unit- III

Field Effect Transistors: JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage Output Characteristics. MOSFET, types of MOSFETs, Circuit symbols, Working and Characteristic curves of Depletion type MOSFET (both N channel and P Channel) and Enhancement type MOSFET (both N channel and P channel). Complimentary MOS (CMOS)
Power Devices: Unijunction transistors (UJT), basic construction and working, Silicon controlled rectifier (SCR) construction, working and characteristics, Triac, Diac, IGBT, MESFET, operation and applications.

Unit- IV

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, octal and hexadecimal arithmetic (addition, subtraction and multiplication), representation of signed and unsigned numbers, Binary Coded Decimal codes. 14

Logic Gates and Boolean algebra: Introduction to Boolean Algebra and Boolean operators, Truth Tables of OR, AND, NOT, Basic postulates and fundamental theorems of Boolean algebra, Truth tables, construction and symbolic representation of XOR, XNOR, Universal (NOR and NAND) gates. Digital Logic families: Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, TTL and CMOS families and their comparison.

Reference books:

1. Semiconductor Devices: Kanaan Kano
2. Basic Electronic Devices and Circuits: R. Y. Borse
3. Electronic Devices and Circuits: S. Rama Reddy
4. Electronic Principles: A P Malvino
5. Digital Principles and Application: Leach & Malvino
6. Electronics: Fundamentals and Applications: D. Chattopadhyay & P.C. Rakshit

B.Sc. - Semester V

PHYSICS

NUCLEAR PHYSICS

(4 CREDITS) **PAPER – II** **(48 LECTURES)**

Unit - I

General Properties of Nucleus: Brief survey of general properties of the nucleus; Mass, Mass defect, Binding energy, Main features of binding energy versus mass number curve, N/Z plot, Nuclear charge and mass distribution, Size, Spin and Parity. Nuclear Magnetic dipole moment, Electric quadrupole moment and Nuclear shape.

Nuclear forces and two-nucleon system: Deuteron ground state and excited states. Nucleon-Nucleons scattering: Basic idea of scattering cross section, n-p and p-p scattering (qualitative only), Basic characteristics of Nuclear force, Elementary discussion on Yukawa's theory of nuclear force.

Unit - II

Nuclear Models: Need for nuclear models, Fermi gas model, Liquid drop model, Bethe-Weizsäcker mass formula, Single particle Shell model (only the level scheme in the context of reproduction of magic numbers). Collective model, Nuclear Vibrational and Rotational states. (qualitative)

Natural Radioactivity: Alpha decay and its energy spectrum, Q-value for alpha decay, Theory of alpha decay - Quantum tunnelling. Beta decay and its energy spectrum, Q-value for beta decay, Need for the neutrino, Fermi's theory of beta decay (qualitative), Non-conservation of Parity in beta decay (qualitative), Gamma decay, Selection rules for gamma transitions (no derivation).

Unit - III

Nuclear Reactions: Nuclear reactions and their conservation laws, Q value for nuclear reaction, Cross section of nuclear reactions, Theory of Fission, Nuclear fusion (qualitative), and nuclear reactors.

Accelerators and detectors: Van de Graff, Cyclotron and Synchrotron, Basic idea of Large Hadron Collider (LHC) and future Colliders, Interaction of charged particles and gamma rays with matter: Mechanism, Ionization formula, Stopping power and range, Radiation detectors: GM counter, Scintillation counter and Neutron detectors.

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Unit - IV

Elementary Particles: Basic interactions and their mediating quanta, Types of particles and their families, Basic concept of Feynman diagrams. Symmetries and Conservation Laws (Noether's theorem): Energy and Momentum, Angular momentum, Parity, Baryon number, Lepton number, Isospin, Strangeness, Hypercharge. Basic concept of Quark model, Origin of mass of elementary particles (B.E.H Field mechanism). (qualitative).

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Suggested books:

1. Introductory nuclear Physics: Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2. Introduction to the physics of nuclei & particles: R.A. Dunlap. (Thomson Asia, 2004).
3. Nuclear Physics: S.N. Ghoshal, S. Chand & Company Ltd.
4. Nuclear Physics an Introduction: S.B. Patel, New Age International (P) Limited.
5. Introduction to Elementary Particles: D. Griffith, John Wiley & Sons.
6. Quarks and Leptons: F. Halzen and A.D. Martin, Wiley India, New Delhi.
7. Basic ideas and concepts in Nuclear Physics - An Introductory Approach:K. Heyde (IOP- Institute of Physics Publishing, 2004).
8. Radiation detection and measurement: G.F. Knoll (John Wiley & Sons, 2000).

B.Sc.- Semester V

PHYSICS PRACTICALS

(4 CREDITS) PAPER III (48 LECTURES)

1. To study the characteristics of Field Effect Transistor
2. Study of FET as a Voltage Variable Resistor (VVR) and application of FET as a VVR in Voltage Controlled Attenuator (VCA)
3. To study the frequency response of RC coupled transistor amplifier
4. Study of IC amplifier
5. Study of Logic Gates
6. To determine the velocity of sound by CRO
7. To determine Stefan's constant
8. To study series and parallel LCR circuit
9. To study clipper and clamper circuits.

Suggested Books:

1. Advanced Practical Physics for students: B.L. Worsnop and H.T. Flint, 1971, Asia Publishing House.
2. A Text Book of Practical Physics: I. Prakash and Ramakrishna 11th edition, Kitab Mahal.
3. A Laboratory Manual of Physics for UG classes: D.P. Khandelwal, 1985, Vikas Publications.
4. Practical Physics: G.L. Squires, 2015, 4th edition, Cambridge University Press.

Annexure VII

Annexure VII

B.Sc. - Semester VI

PHYSICS

MATHEMATICAL METHODS AND NUMERICAL TECHNIQUES

(4 CREDITS) **PAPER – I** **(48 LECTURES)**

Unit-1

Complex numbers and their polar form, Properties of moduli and arguments, Regions in the complex plane, Continuity and differentiability of complex functions, Analytic (Regular) functions, The Cauchy - Reimann equations and its polar form, Laplace equation, Harmonic functions.

Unit-2

Initial and boundary value problems, Partial differential equation and variable separable method, Legendre's relation, Bessel function, Recurrence relations, Taylor and Laurent's series, Cauchy Integral formula.

Unit-3

Mean value theorem, physical application, Partial derivatives, Maxima and minima, Diffusion equation of heat flow- 1D, 2D, 3D, Fourier series, Convolution- Physical application, Fourier transform.

Unit-4

Numerical methods for solution of differential, partial differential and integral equations, Euler's method, Runge - Kutta method, Numerical Integration, Differentiation, Simpson's rule -1/3, 1/8, Newton Raphson method, Gauss quadratic formula.

Suggested books:

1 • Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
2 • Fourier Analysis: M.R. Spiegel, 2004, Tata McGraw-Hill.
3 • Mathematics for Physicists: Susan M. Lea, 2004, Thomson Brooks/Cole.
4 • An Introduction to Ordinary Differential Equations: E.A Coddington, 1961, PHI Learning
5 • Differential Equations: George F. Simmons, 2006, Tata McGraw-Hill.
6 • Essential Mathematical Methods: K.F. Riley and M.P. Hobson, 2011, Cambridge University Press
7 • Introduction to Numerical Analysis: S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.

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8 • Numerical Recipes in C++: The Art of Scientific Computing, W.H. Press et.al., 2nd Edn., 2013, Cambridge University Press.

9 • A first course in Numerical Methods: U.M. Ascher & C. Greif, 2012, PHI Learning.

10 • An Introduction to computational Physics:T.Pang,2nd Edn., 2006,CambridgeUniv. Press

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B. Sc. - Semester VI
PHYSICS
ELEMENTS OF RELATIVISTIC AND CLASSICAL MECHANICS

(4 CREDITS) **PAPER-II** **(48 LECTURES)**

Unit - I

Michelson-Morley experiment and its consequences. Notion of relativity of electric and magnetic effects and rejection of absolute motion, Einstein's postulates of special theory of relativity. Lorentz transformations; their orthogonality and homogeneity. Relativity of simultaneity, Lorentz contraction, Time dilation. Resolution of Twin Paradox, Relativistic Doppler effect, Relativistic addition of velocities and rapidities. Motion under a constant force. Variation of mass with velocity, zero rest mass particle.

Unit - II

Spacetime diagrams for frames in relative motion. Light cones. Four-interval, Time-like, space-like and light-like intervals. Invariance under Lorentz transformations, Difference between invariant and conserved quantities, Mass energy equivalence, Relation between energy and momentum, Four-momentum and its conservation. Basics of general theory of relativity. Equivalence principle. Basic concept of Schwarzschild metric, gravitational redshift, bending of light, gravitational waves.

Unit - III

Holonomic and non-holonomic constraints. Principle of virtual work, Lagrange's equations from D'Alembert's principle, Degrees of freedom, Generalized coordinates. Hamilton's principle and its role in Lagrangian formulation, Lagrangian of a relativistic free particle. Generalized momentum. Cyclic coordinates. Conservation laws and spacetime symmetries. Calculus of variation and its applications, brachistochrone problem. Hamiltonian formulation and Hamilton's equations of motion.

Unit - IV

Two-body central force problem. Reduced mass from Lagrangian, Derivation of orbits from first integrals of equations of motion, and from Hamilton-Jacobi equation, Classification of orbits—closed, open, bounded, unbounded motion. Importance of inverse square law force. Planetary orbits as circular hodographs, Isochronous potentials, Kepler's problem in velocity space, Inadequacy of Classical Mechanics, Virial theorem and its applications. Action-angle variables for one-dimensional periodic motion.

Reference books:

1. Introduction to Special Relativity : R. Resnick (Wiley-Eastern).
2. Spacetime Physics : E. Taylor and J. Wheeler (Freeman 1992).
3. Special Relativity: A.P. French (W W Norton).
4. Introducing Einstein's Relativity: Ray D'Inverno (Oxford 1992).
5. An introduction to Relativity: J.V.Narlikar (Cambridge Univ press)
6. Spacetime and Geometry: S. Carroll (Pearson 2018).
7. Classical Mechanics : H.Goldstein et al, (Prentice Hall/Narosa).
8. Introduction to Classical Mechanics (with problems and solutions): D.J. Morrin (Cambridge Univ Press, 2008).
9. Mechanics: L. D. Landau and E.M. Lifshitz (Elsevier)
10. Classical Mechanics : N. C. Rana and P.S. Joag (McGraw Hill, 2017).

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B.Sc. Semester VI

PHYSICS

SOLID STATE PHYSICS

(4 CREDITS) PAPER-III (48 LECTURES)

Unit –I

Crystal Structure: Lattice Translation Vectors and Lattice, Basis and Crystal Structure, Primitive and Unit Cells, Two and Three dimensional lattice types, Symmetry operations, Points groups and space groups, Miller indices, Simple crystal structures, NaCl, CsCl, Diamond, Cubic, ZnS and Hexagonal, Glasses.

Crystal Diffraction and Reciprocal Lattice: Incident Beam, Bragg's Law, Experimental Diffraction Method, Laue Method, Rotating-Crystal Method, Powder Method, Derivation of Scattered Wave Amplitude, Fourier Analysis, Reciprocal Lattice Vectors, Diffraction Conditions, Ewald Method, Brillouin Zones, Reciprocal Lattice to SC, BCC and FCC lattices, Fourier Analysis of the Basis and Atomic Form Factor.

Unit – II

Crystal Bindings: Crystal of Inert Gases, Van der Walls-London Interaction Repulsive Interaction, Equilibrium Lattice Constants, Cohesive Energy, Compressibility and Bulk Modulus of Ionic Crystal, Madelung Energy and Evaluation of Madelung Constant, Covalent Crystals, Metallic Bond, Hydrogen-Bonded Crystals, Atomic Radii.

Elementary Lattice Dynamics: Lattice Vibrations and Phonons, Linear Mono-and Diatomic Chains, Acoustic and Optical Phonons (Qualitative treatment only), Qualitative Description of Phonon in Solids, Dulong and Petit's Law, Einstein Theory of Specific Heat of solids.

Unit III

Electrical Properties of Materials: Free Electron Theory, Fermi Energy, Density of States, Heat Capacity of Electron Gas, Paramagnetic Susceptibility of Conduction Electrons, Hall Effect in Metals. Origin of Band Theory, Qualitative Idea of Bloch Theorem, Kronig-Penney Model, Number of Orbitals in a Band, Effective Mass of Electron, Concept of Holes, Band Gap, Energy Band Diagram and Classification of Solids.

Band Structure in Semiconductors, Direct and Indirect Band Gap, Intrinsic and Extrinsic Semiconductors, p and n-type Semiconductors, Conductivity and Hall Effect in Semi-Conductors (Qualitative Discussion Only).

Unit IV

Magnetic Properties of Matter: Origin of Magnetism, Dia-Para-Ferri-and Ferromagnetic materials, Classical Langvein theory of Dia-and paramagnetism, Curies's Law, Weiss theory of paramagnetism, Qualitative discussion of B-H Curve; Hysteresis and Energy Loss, Soft and Hard magnetic materials (06 Lectures).

Dielectric Properties of Materials: Classification of dielectrics, Electric Polarization, Local electric field at an atom, Depolarization field, Dielectric Constant, Electric Susceptibility, Polarizability, Langvin theory of polarization, Polar Solids, Ferroelectricity (Qualitative discussion only)

Referece Books:

1. Introduction to Solid State Physics: Charles Kittel
2. Solid State Physics: Adrianus J. Dekker
3. Solid State Physics: Ashcroft and Mermin
4. Introduction to Solids: Lenoid V. Azaroff