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.

Suggested books:

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).