Semester –II

BRANCH	Subject Title	Subject Code
B.Sc. (Physics – Minor/GE)	THERMODYNAMICS AND STATISTICAL PHYSICS	PYM2/PY-121

Course Learning Outcomes (CLO)

1. The course would enable the students to understand the basic Physics of heat and temperature in relation to energy, work, radiation and matter.
2. The students are expected to learn that "how laws of thermodynamics are used in a heat engine to transform heat into work".
3. This course will also develop an understanding of the various concepts of statistics and the methods to apply them in thermodynamics.
4. Students will understand the importance of studying statistical mechanics with the behavior of particles under classical and quantum conditions.

CONTENT

Unit - 1

Historical background & Laws of thermodynamics

1. Historical background:

1.1.A brief historical background of thermodynamics and statistical Physics in the context of India and Indian culture, Contribution of S. N. Bose in statistical Physics.

2. Laws of thermodynamics:

2.1.Thermodynamical system and thermodynamical coordinates, Thermal equilibrium, Zeroth law of thermodynamics, The concept of path function and point function, Work done by and on the system.

2.2.First law of thermodynamics, Internal energy as a state function, Reversible and irreversible change, Heat engine and its efficiency, Carnot's cycle, Carnot's engine and its efficiency, Camot's theorem, Otto engine, Otto cycle, diesel engine.

2.3.Second law of thermodynamics, Statement of Kelvin- Plank and Clapeyron, Absolute scale of temperature: Zero of absolute scale, Size of degree, Identity of a perfect gas scale and absolute scale.

Unit - 2

Entropy

1. Concept of entropy, Clausius theorem, Entropy as a point function, Change in entropy in reversible and irreversible processes.
2. Change in entropy of an ideal gas, Change in entropy when two liquids at different temperatures are mixed (or two bodies at different temperatures are kept in contact).
3. Principle of increase of Entropy, Change in entropy of the universe in an irreversible process, Disorder and heat death of universe.
4. Physical significance of Entropy, Temperature - entropy (T-S) diagram, third law of thermodynamics.

Unit - 3

Thermodynamic potentials and kinetic theory of gases

1. Thermodynamic potential and its application:

1.1.Thermodynamic potentials, Thermal equilibrium, Internal energy, Helmholtz free energy, Enthalpy and Gibbs free energy.

1.2.Derivation of Maxwell's relations from thermodynamic potentials, Gibbs Helmholtz equation, Thermodynamic energy equation for ideal and van der Waal gas.

1.3.TdS equation, Derivation of expressions for Cp-Cy and their special cases for ideal and van der Waal gases, derivation of the expression Es/E Cp / Cv.

1.4.Clausius Clapeyron latent heat equation, Temperature change in adiabatic process, Principle of refrigeration, Joule Thomson effect, Cooling by adiabatic demagnetization, Production and measurement of very low temperatures.

2. Kinetic theory of gases:

2.1.Behavior of a real gas and its deviation from an ideal gas, Virial equation, Andrews experiment on CO2 gas.

2.2.Critical constant, continuity of the liquid and gaseous state, Vapour and gas state, Boyle temperature, van der Waals equation for real gas, Values of critical constants, Law of the corresponding state.

Unit - 4

Classical Statistics

1. Probability, Distribution of N particles in two identical boxes, Probability of occurrence of either event, probability of composite events, Weightage probability.

2. Probability distribution and its lnarrowing with the increase in number of particles, Expression for average properties, constraints, Accessible and non-accessible microstates.
3. Ensemble theory (Micro-canonical, Canonical and Grand- canonical), Macro and micro states with examples, Principle of equal a prior probability, Concept of phase space.
4. Boltzmann Canonical distribution law Application: average energy of one-dimensional harmonic oscillator,
5. Derivation of law of equipartition of energy from statistics, Equilibrium between two system in thermal contact and parameter, Statistical Interpretation of entropy and relation S=k logW.
6. Boltzmann partition function and derivation of expression for Internal energy, Helmholtz free energy, Enthalpy and Gibbs free energy.

Unit - 5

Quantum Statistics

1. Indistinguishability of particles and its consequences, Maxwell Boltzmann statistics (Classical statistics): Maxwell- Boltzmann distribution law of velocity and speed, Maxwell - Boltzmann statistics and its distribution law.
2. Quantum statistics: Bose-Einstein statistics and distribution law, Derivation of Planck's radiation law from B-E statistics, Rayleigh -Jeans law, Wein's displacement law and Stefan's law.
3. Fermi Dirac statistics and its distribution law, Explanation of free electron theory, Fermi level and Fermi energy.
4. Comparison between the Maxwell Boltzmann, Bose- Einstein and Fermi - Dirac statistics.

Topic PRACTICAL

1. Determination of the mechanical equivalent of heat by Callendar & Barne's method
2. Determination of efficiency of electrical Kettle with variable voltages
3. Determination of temperature coefficient of a resistance using platinum resistance thermometer.
4. Determination of electromotive force of a thermocouple
5. Determination of thermal conductivity of a bad conductor by Lee's disc method.
6. Verification of Newton's law of cooling
7. Determination of the ratio of specific heat of air by Clement- Desorme's method.
8. Determination of specific heat of a liquid with the help of Newton's law of cooling
9. Determination of the coefficient of thermal conductivity of a metal by Searl's method.
10. Determination of thermal conductivity of the rubber using calorimeter.
11. Determination calorimeter. of mechanical equivalent of heat (J) using Joule calorimeter.
12. Determination of Stefan's constant using thermocouple.
13. Study of statistical distribution and determination of standard deviation with the help of black and white dice.
14. Determination of the temperature coefficient of a resistance with the help of Carey-Foster bridge.
15 Determination of the critical constant of a gas/vapour.