Course Code	Course Title	L	T	P	C
BPHY404L	Statistical Mechanics	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Study the basic assumptions of kinetic theory of gases and to derive various needed physical parameters of gases.
2. Understand the basic laws of thermodynamics.
3. Express thermodynamic functions for classical and quantum systems in terms of partition function.
4. Apply Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics to various particle systems.

Course Outcomes

1. Get exposure to thermodynamic variables that determine the properties of the state of the system.
2. Understand and derive measurable physical parameters of gases.
3. Understand phase space, microstates, macrostates, entropy and their connections with statistical mechanics.
4. Be familiarized in-depth about statistical distribution and have basic ideas about Maxwell-Boltzmann, Bose-Einstein and Fermi Dirac Statistics and their applications.

Module:1	Thermodynamics	4 hours

Concepts of thermal equilibrium - Temperature, energy, work and other functions of state - Ideal gas - Reversible and Irreversible process - Exact differential

Module:2	Kinetic theory of Gases	6 hours

Introduction - Basic assumptions of kinetic theory - Pressure exerted by gas - Kinetic interpretation of temperature - Classical theory of heat capacities - Distribution of molecular velocities in a perfect gas

Module:3	Laws of Thermodynamics	9 hours

Introduction - Zeroth law and concept of temperature - Origin of the first law - Internal energy - Various interactions - The first law - Applications of first law - The second law - Entropy - Enthalpy - Gibb's free energy - Kelvin and Planck statement - Heat engines - Carnot cycle - Carnot theorem - Thermodynamic temperature - Irreversibility and unavailable energy

Module:4	Classical Statistical Mechanics	8 hours

Macrostate and Microstate - Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic probability - Maxwell-Boltzmann Distribution Law – Canonical ensemble and Partition function - Thermodynamic functions of an ideal gas - Classical entropy expression - Gibbs paradox - Law of equipartition of energy

Module:5	Theory of Radiation	6 hours

Introduction to Black body radiation - Kirchhoff's law - Stefan-Boltzmann law - Wien's Displacement law - Rayleigh-Jean's Law - Planck's quantum hypothesis - Average energy of oscillator and its classical limit

Module:6	Bose-Einstein Statistics	5 hours

B-E distribution law - Thermodynamic functions of a strongly degenerate Bose gas -

Bose Einstein condensation - Properties of liquid He (qualitative description) - Classical limit of BE statistics		
Module:7	**Fermi Dirac Statistics**	**5 hours**
Fermi-Dirac Distribution Law - Thermodynamic functions of a strongly degenerate Fermi Gas - Fermi Energy - Electron gas in a metal - Specific heat of metals - Classical limit of FD statistics		
Module:8	**Contemporary Issues**	**2 hours**
Guest lecture from industry and R & D organisations		
	Total Lecture hours:	**45 hours**

Text Book(s)

1. F. Reif, Fundamentals of Statistical and Thermal Physics, 2010, Tata McGraw Hill.
2. Enrico Fermi, Thermodynamics, 2012, Dover.

Reference Books

1. Robert Floyd Sekerka, Thermal Physics: Thermodynamics and Statistical Mechanics for Scientists and Engineers, 2015, 1st Edition, Elsevier, Holland.
2. R.H. Swendsen, An Introduction to Statistical Mechanics & Thermodynamics, 2012, Oxford Univ. Press
3. F.W. Sears and G.L. Salinger, Thermodynamics, Kinetic theory & Statistical thermodynamics, 2013 Reprint, Narosa Publishers, India.

Mode of Evaluation: CAT, Written Assignment, Quiz and FAT

Recommended by Board of Studies	20-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023