ARSD College, University of Delhi

Model Course Handout/Lesson Plan

Course Name : B.Sc Physics(H)

Credit : 06 (Theory-04, Practical-02)

Semester	**Course code& Title**
VIth	**Statistical Mechanics/ 32221602**
Teacher	Bhupendra Singh
Session	**2021-22**

Course Objective

The Statistical Mechanics deals with the derivation of the macroscopic parameters (internal energy, pressure, specific heat etc.) of a physical system consisting of large number of particles (solid, liquid or gas) from knowledge of the underlying microscopic behavior of atoms and molecules that comprises it. The main objective of this course work is to introduce the techniques of Statistical Mechanics which has applications in various fields including Astrophysics, Semiconductors, Plasma Physics, Bio-Physics etc. and in many other directions.

Lecture Hours	**Course Content**	**References**
	Unit 1 : BASIC ELEMENTS OF STATISTICAL MECHANICS	
1-2	Introduction to Statistical Mechanics, Phase Space, Entropy and Thermodynamic Probability	
3-4	Foundations of statistical mechanics, Postulates, Classical Entropy Expression	
5-6	Microscopic and macroscopic behavior	

7-8	Contact between statistics and thermodynamics, Boltzmann formula	Pathria R.K., Statistical Mechanics, 2ndEdition, Elsevier, 2000 K. Huang, Statistical Mechanics, Wiley, 2nd edition, 1987.
9-10	Maxwell-Boltzmann Distribution Law,Introduction to Partition function	
11-12	Partition function of an ideal monatomic gas	
13-14	Partition function of a diatomic molecule, Partition function and its relation to thermodynamic quantities	
15-16	Gibbs Paradox,	
17-18	Entropy of mixing and Gibb's paradox-Sackur -Tetrode equation	
19-20	The semi-classical perfect gas, Thermodynamic Functions of an Ideal Gas	
21-22	Specific heat of solids, Law of Equipartition of Energy (with proof	
23-24	Saha's ionization formula. Thermodynamic Functions of a Finite Level System, Negative Temperature.	
Unit II : Bose-Einstein Statistics		
25-26	B-E Distribution law,	Pathria R.K., Statistical Mechanics, 2ndEdition, Elsevier, 2000 K. Huang, Statistical Mechanics, Wiley, 2nd edition, 1987.
27-28	Thermodynamic functions of a strongly degenerate Bose Gas	
29-30	, Bose Einstein condensation, properties of liquid He (qualitative description),	
31-32	Radiation as a photon gas and Thermodynamic functions of photon gas.	
33-34	Bose derivation of Planck's law.--	
35-36	application	

	Unit-III-- **Fermi-Dirac Statistics**	Fundamentals of statistical and Thermal Physics Federick Reif (Mc Graw Hill)
37-38	Fermi-Dirac Distribution Law-	
39-40	Thermodynamic functions of a Completely	
41-42	thermodynamics function ofstrongly degenerate Fermi Gas,	
43-44	Fermi Energy Electron gas in a Metal,	
45-46	Specific Heat of Metals, Relativistic Fermi gas,.	
47-48	White Dwarf Stars, Chandrasekhar Mass Limit	
Cycle Test – I,		
Unit : IV- Theory of Radiation		
49	Introduction about Radiation	Pathria R.K., Statistical Mechanics, 2ndEdition, Elsevier, 2000 K. Huang, Statistical Mechanics, Wiley, 2nd edition, 1987.
50	Properties of Thermal Radiation and Radiation Pressure. Blackbody Radiation and its spectral distribution	
51-52	. Blackbody Radiation and its spectral distribution	
53-54	Kirchhoff law. Stefan-Boltzmann law and its Thermodynamic proof	
55	Wien's Displacement law. Wien's Distribution Law	
56	Rayleigh- Jean's Law.	
57	Planck's Quantum Postulates. Planck's Law of black body	
58	Blackbody Radiation Deduction of Wien's Distribution Law	
59	Rayleigh-Jeans Law,	
60	Stefan -Boltzmann Law and Wien's Displacement law from Planck's law	

Course Learning Outcomes By the end of the course,

students will be able to:

- Understand the concepts of microstate, macrostate , ensemble, phase space, thermodynamic probability and partition function.
- Understand the use of Thermodynamic probability and Partition function for calculation of thermodynamic variables. Difference between the classical and quantum statistics
- Understand the combinatoric studies of particles with their distinguishably or indistinguishably nature and conditions which lead to the three different distribution laws e.g. Maxwell-Boltzmann distribution, Bose-Einstein distribution and Fermi-Dirac distribution laws of particles and their derivation.
- Comprehend and articulate the connection as well as dichotomy between classical statistical mechanics and quantum statistical mechanics.
- Learn to apply the classical statistical mechanics to derive the law of equipartition of energy and specific heat.

- Understand the Gibbs paradox, equipartition of energy and concept of negative temperature in two level system.
- Learn to derive classical radiation laws of black body radiation. Wiens law, Rayleigh, Jeans law, ultraviolet catastrophe. Saha ionization formula.
- Learn to calculate the macroscopic properties of degenerate photon gas using BE distribution law, understand Bose-Einstein condensation law and liquid Helium. Bose derivation of Plank's law
- Understand the concept of Fermi energy and Fermi level, calculate the macroscopic properties of completely and strongly degenerate Fermi gas, electronic contribution to