(i) Printed Pages : 3 Roll No. ....

(ii) Questions : 9

Sub. Code : | 3 | 7 | 1 | 0 |

Exam. Code : | 0 | 4 | 7 | 3 |

M.Sc. Physics 2nd Semester

(2054)

STATISTICAL MECHANICS

Paper : PHY-8022

Time Allowed : Three Hours] **[Maximum Marks : 80**

Note :— Attempt **five** questions in all, selecting **one** question each from Units I to IV. Unit-V is compulsory to attempt.

UNIT—I

1. (a) What is phase space of a classical system ? Define density function. State and prove Liouville's theorem. What is its importance ? 8

   (b) Discuss Gibbs Paradox. How is it resolved ? 8

2. (a) Derive a relation to show that the volume of phase-space per Eigen state for a 1-Dimensional harmonic oscillator is asymptotically equivalent to Planck's constant. 8

   (b) State the law of Equipartition of energy. 8

UNIT—II

3. (a) Define a canonical ensemble and its partition function. Explain energy fluctuations in canonical ensembles. 8

(b) What is grand canonical Ensembles ? Write partition function for the grand canonical ensembles. Use it to calculate the thermodynamical quantities-Entropy, internal energy and chemical potential per particle of a monoatomic perfect gas. 8

4. (a) Discuss the energy fluctuations in Grand canonical ensemble and show that it is more than its corresponding value in a canonical ensemble. 8

(b) Derive an expression for the entropy of a system in Grand canonical ensemble and show that $S = k\sigma$. 8

UNIT—III

5. (a) Derive the equation of state for an ideal Bose gas. Determine the conditions for the appearance of Bose-Einstein condensation. 8

(b) Define Fermi energy. Calculate zero point energy of Fermi gas and show that it is purely due to a quantum effect. 8

6. (a) Discuss the thermodynamic behaviour of an ideal Bose gas. 8

(b) Define the mean thermal wave length of a particle and show that in the limit of $T \rightarrow 0$, Fermi gas follows the third law of thermodynamics. 8

UNIT—IV

7. (a) Discuss the Einstien Smoluchowski theory of Brownian particles initially concentrated at the origin diffuses out as the time progresses. 8

   (b) Discuss the Ising and Heisenberg Model of interaction energy of Lattice. 8

8. (a) Describe the 1st order and 2nd order phase Transition. Compare these by giving example of each. 8

   (b) What do you mean by fluctuations ? Explain with example. Hence find an expression for the probability of fluctuations of particle in two halves of a box from most probable distribution. 8

UNIT—V

9. (a) What is a classical ideal gas ?

   (b) Define degeneracy discriminant. Calculate its value for Hydrogen gas.

   (c) Define critical opalescence. What are the conditions leading to it ?

   (d) In the context of white dwarf star, what is Chandrashekhar limit and how it is related to the mass of the Sun ?

   (e) What is thermodynamic limit ? Explain its importance.

   (f) Establish equivalence of canonical and grand canonical ensembles.

   (g) Obtain Virial theorem using the law of equipartition of energy.

   (h) Discuss that the chemical potential of an ideal Bose gas is always negative. $8\times2=16$