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

(ii) **Questions : 9** **Sub. Code : 3 2 3 6**

Exam. Code : 4 7 4

M.Sc. III[rd] Semester

1125

PHYSICS

Paper : Phy-7002 : Statistics Mechanics

Time Allowed : 3 Hours] **[Maximum Marks : 60**

Note :– Attempt **five** questions in all, selecting **one** each from Units I-IV. Q. 9. Unit V is compulsory. All questions carry equal marks.

UNIT–I

1. (a) Using the corrected entropy formula work out the entropy of mixing for two different gases and thus show that actually there is no Gibbs paradox. 7

   (b) For extreme relativistic gas show that $\gamma = 4/3$. 5

2. (a) State and prove Liouville's theorem. Discuss its consequences. How do they lead to the description of a microcanonical and a canonical ensemble ? 7

   (b) Two systems A and B, of identical composition are brought together and allowed to exchange energy and particles, keeping volumes constant. Show that minimum value of the quantity (dE_A / dN_A) is $\frac{\mu_A T_B - \mu_B T_A}{T_B - T_A}$. 5

UNIT–II

3. Evaluate partition function of ideal gas in quantum mechanical ensemble. Generalise it for different ensembles. 12

4. (a) Analyse the problem of solid-vapour equilibrium using grand partition function. 6

   (b) Evaluate the quantity $p_\varepsilon(n)$, probability that there are n particles in the state of energy ε. Comment on this quantity for F.D. and B.E. statistics. 6

UNIT–III

5. (a) Define the mean thermal wavelength of a particle. Why is it known as 'wavelength' ? Discuss the phenomenon of Bose-Einstein condensation. 7

   (b) Show that for Fermi gas at finite but low temperature C_v is proportional to T. 5

6. (a) Show that in the limit $T \to 0$, Fermi gas follows third law of thermodynamics. 6

   (b) Set up the equation of state for an ideal Fermi gas. 6

UNIT–IV

7. (a) Find the approximate value of long range order parameter and thus deduce heat capacity and entropy of a system of up and down spins. 6

(b) Given that $p_n(m) = \frac{n!}{\left\{\frac{(n+m)}{2}\right\}!\left\{\frac{(n-m)}{2}\right\}!}\left(\frac{1}{2}\right)^n$, show that the given equation may be written in the Gaussian form. 6

8. (a) Evaluate mean square fluctuations in energy with T and V as independent variables and compare your result with canonical and grand canonical ensemble. 6

(b) Evaluate specific heat of a system of ½ spins (Using model) at $T \leq T_c$ approaching from below T_c and thus account for the discontinuity at $T = T_c$. 6

UNIT–V

9. (a) Assuming that S and Ω of a physical system are related through the arbitrary functional form $S = f(\Omega)$, show that the additive character of S and the multiplicative nature of Ω necessarily require that the function $f(\Omega)$ be of the form $S = k \ln \Omega$.

(b) For classical ideal gas show that $PV^{5/3}$ = Constant.

(c) Is $\ln Q_N(V, T)$ an extensive or intensive property of the system ? Justify.

(d) Compare graphically the specific heats of a classical ideal gas, an ideal Bose gas and an ideal Fermi gas as a function of temperature.

(e) Find the partition function of a system of N classical harmonic oscillators.

(f) How does mean square fluctuation of intensive and extensive quantity vary with size of the system ? Give examples.

6×2=12