YMCA UNIVERSITY OF SCIENCE & TECHNOLOGY, FARIDABAD
M.Sc. PHYSICS 3rd SEMESTER (UNDER CBS)
STATISTICAL MECHANICS (PHY-302)

Time: 3 Hours **Max. Marks: 60**

Note: 1. ***It is compulsory to answer the questions of Part -1. Limit your answers within 20-40 word in this part.***
2. ***Answer any four questions from Part -2 in detail.***
3. ***Different parts of the same question are to be attempted adjacent to each other.***

PART -1

Q1 (a) Define the term partition function. (2)
(b) What is the difference between statistical and thermodynamic entropy? (2)
(c) Show that the entropy at absolute zero in a canonical ensemble can be expressed as $S=k \log g_0$ where g_0 is the statistical weight of the ground state. (2)

(d) What is phase space in statistical mechanics? (2)
(e) State the principle of equipartition of energy. (2)
(f) Explain exchange symmetry of wave functions. (2)
(g) Define a priori probability. (2)
(h) Differentiate between classical and quantum statistics. (2)
(i) Show that for a large assembly the most probable state corresponds to one of mean value of energy (2)
(j) What do understand by density matrix? (2)

PART -2

Q2 Define Bose Einstein gas. Find the expression for energy and pressure of this gas. Also prove that the temperature at which the Bose Einstein condensation begins depends upon the density of the gas. (10).

Q3 (a) Derive the expressions for energy and pressure of an ideal Fermi Dirac gas. (5)

(b) Show that for an assembly of N molecules of an ideal gas at absolute temperature T, the number of molecules in energy range ε and ε + dε is given by (5)

$$n(\varepsilon)d\varepsilon = 2\pi N\left(\frac{1}{\pi kT}\right)^{3/2} \varepsilon^{1/2} e^{-\varepsilon/kT} d\varepsilon$$

where the symbols have their usual meanings.

Q4 (a) What is a Grand Canonical Ensemble? Derive the partition function and thermodynamic functions for Grand canonical ensemble. (5)

(b) What do you understand by Gibbs Paradox? How was it explained? (5)

Q5 (a) Show that the Maxwellian distribution function is given by (5)

$$f(v) = \left(\frac{m}{2\pi kT}\right)^{3/2} \frac{e^{-mv^2}}{2kT}$$

(b) Write a short note on linear harmonic and anharmonic oscillators. (5)

Q6 (a) Explain in detail the Landau's theory of liquid Helium II and hence the concept of quantum liquid. (5)

(b) What are some peculiar properties of Liquid Helium II? Explain (5)

Q7 Write short note on: (5x2)

(a) Mayer Cluster expansion

(b) Ising Model