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

(ii) **Questions : 9** **Sub. Code : 3710**

**Exam. Code : 0473**

**M.Sc. Physics 2nd Semester**

**(2042)**

# STATISTICAL MECHANICS

**Paper–PHY-8022**

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

**Note :**—Attempt **five** questions in all, including Question No. IX (Unit–V) which is compulsory by selecting **one** question each from Unit–I to Unit–IV.

## UNIT–I

I. (a) State and prove Virial and Equipartition theorem. 8

(b) Discuss classical ideal gas in Micro Canonical Ensemble and derive its thermodynamics. 8

II. (a) Define ensemble and discuss its various types. 4

(b) What is Gibb's Paradox, hence derive expression for Sackur-tetrode equation ? 12

## UNIT–II

III. (a) Derive expression for probability for G.C.E. and grand partition function and hence describe thermodynamics of Grand Canonical Ensemble (G.C.E.) 8

(b) Discuss Ideal gas in quantum mechanical ensembles. 8

IV. (a) Define Quantum states and phase space. Derive expression for statistics of occupation numbers. 8

(b) Show that expression

$$S = \frac{U - A}{T} = KT\left(\frac{\partial q}{\partial t}\right)_{z,y} - KN\,\ell nZ + Kq$$

for entropy of a system in a grand canonical ensemble can also be written as $S = K\left[\frac{\partial}{\partial T}(Tq)\right]_{u,v}$. 8

## UNIT–III

V. (a) Discuss the thermodynamics of Bose ideal gas in detail and discuss phenomena of Bose-Einstein condensation. 12

(b) Draw variation of fugacity (z) of an ideal Bose gas as a function of $\left(V/\lambda^3\right)$. 4

VI. (a) Derive the grand partition function of Photon gas. 8

(b) Discuss Pauli paramagnetism in an ideal fermi gas. 8

## UNIT–IV

VII. (a) Define phase transitions and explain Ising and Heisenberg models. 8

(b) Describe the Einstein-Smoulichowski theory of Brownian motion and hence show that any conclusion drawn from Smoulichowski approach are the same as the ones drawn from Einstein approach. 8

VIII. (a) Derive the relationship between density fluctuations and spatial correlations in any fluid system. 6

(b) Derive Fokker-Plank equation and hence derive expression of diffusion equation. 10

## UNIT–V

IX. (a) Define phase space.

(b) What is intensive and extensive property ?

(c) Define q-potential and fugacity (z).

(d) Define ensemble and its types.

(e) Define partition function.

(f) Define Liouville's theorem.

(g) What is Fermi gas and Bose gas ?

(h) Making use of the fact the entropy S(N, V, E) of a thermodynamic system is an extensive quantity, show that $N\left(\frac{\partial S}{\partial N}\right)_{V,E} + V\left(\frac{\partial S}{\partial V}\right)_{N,E} + E\left(\frac{\partial S}{\partial E}\right)_{N,V} = S.$

2×8=16