

DEPARTMENT OF SCIENCES, IV SEMESTER M.Sc. (Physics) END SEMESTER EXAMINATIONS, APRIL 2019

THERMODYNAMICS AND STATISTICAL PHYSICS [PHY 5202] (REVISED CREDIT SYSTEM-2017)

 Time: 3 Hours
 Date: 24/04/2019
 MAX. MARKS: 50

Note: (i) Answer ALL questions

(ii) Draw diagrams, and write equations wherever necessary

1.

- a) Derive the Gibbs-Duhem relation in the entropy representation and discuss its significance.
- b) Prove that:

$$C_P = C_V + \frac{TV\alpha^2}{\kappa}$$

where, α is the coefficient of thermal expansion and κ is the isothermal compressibility.

(3 + 4 = 07 Marks)

2.

- a) State and prove Liouville's theorem. Explain its physical significance.
- b) Compare the three ensembles used in statistical mechanics.

(7 + 3 = 10 Marks)

3.

- a) Derive the canonical partition function $Q_N(V,T)$ of a classical ideal gas and hence obtain expressions for Helmholtz free energy (A) and pressure (P).
- b) Derive rotational and vibrational partition functions of a diatomic molecule.

(5 + 5 = 10 Marks)

4. Derive the grand canonical partition function for a system of N one-dimensional quantum harmonic oscillators and obtain the pressure of the system.

(05 Marks)

5.

- a) Discuss Bose-Einstein condensation. Obtain an expression for specific heat of a Bose gas and discuss its variation with temperature.
- b) The Fermi energy of copper is 7.05 eV. (i) What is the average energy of a conduction electron in copper? (ii) At what temperature would the average translational energy of molecules in an ideal gas be equal to the energy calculated in part (i)?

(7 + 3 = 10 Marks)

6.

- a) Explain the one dimensional Ising model. Does Ising model exhibit ferromagnetic phase transition?
- b) Prove that in the canonical ensemble formalism, the relative energy fluctuation $\frac{\Delta E}{E} \rightarrow 0$ as $N \rightarrow \infty$.

(5 + 3 = 08 Marks)