PG Even Semester Examination, May 2025

PHYSICS

(4th Semester)

Course No.: PHYCC-651

(Statistical Mechanics)

Full Marks: 70

Pass Marks: 28

Time: 3 hours

The figures in the right margin indicate full marks for the question.
Answer any five questions selecting one from each unit.

UNIT-I

1. (a) Define phase space and density of points in phase space. Explain whether two phase orbits can intersect each other. 4

   (b) Prove the Liouville's theorem in classical statistical distribution. 4

   (c) Describe briefly (i) free energy, (ii) internal energy, (iii) enthalpy 6

2. (a) State and explain all the laws of thermodynamics. 8

   (b) State and prove Boltzmann's entropy relation. 6

UNIT-II

3. (a) Find an expression for entropy for a classical system of non-interacting

particles and hence derive the equation of state. 5+4=9

(b) Show that one can obtain Sackur Tetrode equation for Boltzmann gas. 5

4. (a) Explain the meaning of ensemble. Show equivalence of various ensembles. 2+4=6

(b) State and prove (i) Virial and (ii) Equiparation theorem. 4+4=8

UNIT-III

5. (a) An electron with intrinsic spin $\frac{1}{2}\hbar\hat{\sigma}$ and magnetic moment μ_B is placed in an external magnetic field. Find expectation value of σ_Z. 7

(b) If $\hat{\rho}$ is the density operator and $\hat{H}$ is the Hamiltorian of a system, then show that $i\hbar\dot{\hat{\rho}} = [\hat{H},\hat{\rho}]$. 7

6. (a) What are the inadequacies of classical statistical mechanics? Define in brief the quantum mechanical ensemble theory. 3+3=6

(b) Derive the expression of Bose Einstein distribution law and find the density matrix for Grand cannocal esemble. 4+4=8

UNIT-IV

7. Dicuss the phenomenon of Bose— Einstein condensation. Show that it is a first order phase transition. 5+9=14

8. (a) What are the properties of liquid Helium. 6

(b) Explain the ideal Bose gas model for liquid Helium. 8

UNIT-V

9. Derive the expression for specific heat of an ideal Fermi gas at finite temperature and hence show that at ground state $\rho_0=n^{5/3}$. 6+8=14

10. Describe Ising model in one dimension. 14

*****