D2APH2103 **(2 Pages)** **Name.....**
Reg.No.....

SECOND SEMESTER M.Sc. DEGREE EXAMINATION, APRIL 2022
(Regular/Improvement/Supplementary)

PHYSICS
FPHY2C07: STATISTICAL MECHANICS

Time: 3 Hours **Maximum Weightage: 30**

Part A: Short answer questions. Answer *all* questions. Each carries 1 weightage.

1. Explain the importance of Boltzman's formula for entropy ($S=k \ln \Omega$).
2. A closed system has two non degenerate energy levels E and $2E$ .If the temperature of the system is T. Find the partition function of the system.
3. Explain the postulate of random a priori phases.
4. Draw the variation of pressure of an ideal Bose gas with temperature.
5. A particle of unit mass is executing simple harmonic motion. Determine its trajectory in phase space.
6. Explain equipartition theorem.
7. State Louville's theorem. Show that density function of a system in a microcanonical ensemble is a constant.
8. Write the expression for Fermi energy and explain the terms.

(8 × 1 = 8 weightage)

Part B: Essay questions. Answer any *two* questions. Each carries 5 weightage.

9. Discuss a system of harmonic oscillator in canonical ensemble. Obtain the expressions for Helmholtz free energy, chemical potential, entropy and average energy by classical and quantum treatment.
10. Explain Gibb's paradox. Explain how it is resolved and hence obtain the Sackur-Tetrode equation for Entropy.
11. Explain Bose-Einstein condensation. Discuss the thermodynamic behavior of normal phase and condensed phase.
12. Explain the quantum mechanical ensemble theory. Find the equation of motion of density matrix and expectation value of a physical quantity.

(2 × 5 = 10 weightage)

(P.T.O.)

Part C: Problems. Answer any *four* questions. Each carries 3 weightage.

13. Show that the partition function of a classical ideal gas is $Q_N(V,T) = \frac{1}{N!}\left[\frac{V}{h^3}(2\pi mkT)^{3/2}\right]^N$.
14. Discuss density and energy fluctuations in grand canonical ensemble.
15. Show that the pressure of black body radiation is equal to one third of its energy density.
16. Briefly explain Landau diamagnetism.
17. The number of conduction electrons per atom in sodium is 1, the number of atoms per unit cell is 2 and the lattice constant is $4.29A^0$. Show that the Fermi energy of electron gas in sodium is 3.14eV.
18. Obtain the density matrix of an electron in a magnetic field.
19. Three distinguishable particles have total energy 9. But the particles are restricted to energy levels 0 to 4. Calculate number of macrostates and microstates.

(4 × 3 = 12 weightage)