D2APH2003 **(2 Pages)** **Name.....**
Reg.No.....

SECOND SEMESTER M.Sc. DEGREE EXAMINATION, APRIL 2021
PHYSICS
FPHY2C07: STATISTICAL MECHANICS

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

Part A: Short answer questions. *All* questions can be answered. Each carries *one* weightage (Ceiling 6 weightage).

1. State and explain the postulate of equal apriori probability.
2. Establish the relationship $S = -k\sum_r P_r ln P_r$,where S is entropy and P_r is probability.
3. How is density matrix defined in quantum mechanical micro canonical and canonical ensembles?
4. A closed system has three non degenerate energy levels 0, *E* and *2E*. If the temperature of the system is T. Find the partition function of the system.
5. Write the condition for onset of Bose-Einstein condensation and hence write the expression for characteristic temperature (T_c)
6. Briefly explain micro canonical, canonical and grand canonical ensembles.
7. Draw the variation of specific heat capacity of an ideal Fermi gas with temperature.
8. State Louville's theorem. Show that density function of a system in a micro canonical ensemble is a constant.

Part B: Essay questions. *All* questions can be answered. Each carries *six* weightage (Ceiling 12 weightage).

9. Explain Gibb's paradox. Explain how it is resolved and hence obtain the Sackur-Tetrode equation for Entropy.
10. Discuss the thermodynamic behavior of an ideal Bose gas.
11. Outline the quantum mechanical ensemble theory. Find the equation of motion of density matrix and expectation value of a physical quantity.
12. Explain the equilibrium between a system and heat reservoir. Discuss the physical significance of various statistical quantities in canonical ensemble.

Part C: Problems. *All* questions can be answered. Each carries *four* weightage (Ceiling 12 weightage).

13. Explain macro state and micro state. A system has three energy levels 0, E and 2E.The total energy of the system is 4E and it contains 5 particles. Find the number of microstates.
14. Show that the volume occupied by a single microstate of a one dimensional harmonic oscillator is ***h (****Planck's constant****).***
15. Obtain the grand partition function of classical ideal gas and show that its average internal energy is $\frac{3}{2}NkT$.
16. Obtain the density matrix of an electron in a magnetic field.
17. Show that, at low temperatures the specific heat of a solid obeys Debye T^3 law.
18. Briefly explain Pauli paramagnetism.
19. 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 $4.29A^0$. Calculate the Fermi energy of electron gas in sodium.