Reg. No ..... Name **24P2043**

M.Sc. DEGREE END SEMESTER EXAMINATION - MARCH 2024

SEMESTER 2 - PHYSICS

COURSE : **21P2PHYT08 - STATISTICAL MECHANICS**

(For Regular 2023 Admission and Improvement/Supplementary 2022/2021 Admissions)

Duration : Three Hours Max. Weights: 30

PART A

Answer any 8 questions **Weight: 1**

1.	Define the term *Phase*?	(U, CO 4)
2.	State the fundamental formula that connects the microscopic and macroscopic in Statistical mechanics.	(U)
3.	Write down the partition function in terms of Quantum statistics in the case of a canonical ensemble.	(U)
4.	What are the major importance of using Density matrix in Quantum statistics? What is its equivalent term in classical statistics?	(U)
5.	Write down Clapeyron equation and evaluate the slope of the coexistence curve in Phase diagram when latent heat associated with the phase transition is zero.	(U)
6.	Write down the unnormalized two particle wavefunction, in terms of the single particle wavefunction, that satisfies Fermi particle symmetry requirement.	(U)
7.	Plot the fermi distribution function for electron at absolute zero when spin is not considered.	(U)
8.	Differentiate between microstates and macrostates in Statistical mechanics.	(U, CO 1)
9.	What is the difference between Grand Canonical and microcanonical ensemble?	(U, CO 2)
10.	What does the term “Thermodynamic limit” in Statistical mechanics convey to you?	(U, CO 1)

(1 x 8 = 8)

PART B

Answer any 6 questions **Weights: 2**

11.	Determine whether the electron gas in copper at room temperature is degenerate or non-degenerate. Concentration of electron in Copper is $8.5 \times 10^{28}\ m^{-3}$.	(A)
12.	Derive the canonical density matrix for a free particle in a box, in the coordinate representation.	(A)
13.	If N particles are distributed in 2 energy levels E1 and E2. Calculate the number of particles in each energy level at a finite temperature.	(A)
14.	Discuss the Boltzmann limit of Bose and Fermi gases in terms of the mean occupation number.	(U)
15.	Obtain the expression for Entropy and pressure from the Partition function.	(A)
16.	Discuss the microcanonical ensemble in Quantum mechanics.	(A)

17. Discuss the condition for equilibrium when 2 systems are brought in mechanical contact. (U)

18. Under microcanonical ensemble concept, discuss 1D Harmonic Oscillator in Phase space and arrive an expression for energy at temperature (T). (U)

(2 x 6 = 12)

PART C

Answer any 2 questions **Weights: 5**

19. Derive the Liouville's theorem. (R)

20. Treat BE and FD statistics for ideal gas using Grand Canonical ensemble and arrive at the quantum distribution functions associated with each of them. (U)

21. Obtain the general expression for Energy of an ideal gas in the distinguishable limit and arrive an expression at the high temperature limit. (An)

22. Show that for a N identical and indistinguishable non interacting non-localized particles (ideal classical gas)under Grand canonical treatment shows PV=NkT relationship. (A)

(5 x 2 = 10)

OBE: Questions to Course Outcome Mapping

CO	Course Outcome Description	CL	Questions	Total Wt.
CO 1	Understand the concepts of Statistical Mechanics, Phase Space idea, Microcanonical and Canonical Ensemble	U	8, 10	2
CO 2	Understand Grand Canonical and Introduction to Quantum Statistics and to apply to simple problems.	U	9	1
CO 4	Understand the basics of phases and phase transitions	U	1	1

Cognitive Level (CL): Cr - CREATE; E - EVALUATE; An - ANALYZE; A - APPLY; U - UNDERSTAND; R - REMEMBER;