Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

Course: Statistical Mechanics **Semester: VI**
Program: B. Sc (Honors) Physics **Time : 03 hrs.**
Course Code: PHYS 3004 **Max. Marks: 100**

Instructions: Draw a neat and clean diagram wherever it is needed.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Deduce the Wien's Law from the Planck's law of Blackbody radiation.	**4**	**CO1**
Q.2	Determine the wavelength corresponding to the maximum emissivity of a blackbody at a temperature equal to 300K. Take the Wien's constant equal to 2898 μm K.	**4**	**CO2**
Q.3	Define the following terms (a) Phase space (b) Macro and Micro states (c) Ensemble and types of ensemble	**4**	**CO1**
Q.4	Discuss the variation of the fermi probability function, $f(\epsilon)$ with energy, ϵ at different temperatures.	**4**	**CO1**
Q.5	Three distinguishable particle have to be accommodated in four available states. Find the number of ways in which this can be done if the particles obey M-B statistics.	**4**	**CO1**

SECTION B
(4Qx10M= 40 Marks)

Q.6	Consider a system of N particles and a phase space consisting of only two states with energies 0 and, ϵ. Calculate the partition function and the internal energy.	**10**	**CO2**
Q.7	Consider the system of N elements with two non-degenerate energy levels ϵ_1 and ϵ_2 where ϵ_2 is the excited state. Apply the classical approach to show that the heat capacity at constant volume, C_V is given by $C_V = N k_B \left(\frac{\Theta}{T}\right)^2 \frac{e^{\frac{\Theta}{T}}}{\left(1+e^{\frac{\Theta}{T}}\right)^2}$ where, $\Theta = \frac{\epsilon}{k_B}$ is called characteristic temperature.	**10**	**CO3**
Q.8	Apply Bose-Einstein statistics to photon gas and derive the Planck's law for the spectral distribution of energy in black body radiation.	**10**	**CO3**
Q.9	Calculate the number of modes in a chamber of volume $1 m^3$ in the frequency range 0.6×10^{14} Hz to 0.61×10^{14} Hz.	**10**	**CO2**

SECTION-C (2Qx20M=40 Marks)			
Q.10	Derive Sackur Tetrod equation for the entropy of an ideal gas. How does it resolve the Gibb's paradox?	**20**	**CO4**
	OR		
	Consider the non-relativistic electron gas with electron density, n. Demonstrate that the total internal energy of a non-relativistic fermion system is greater than that predicted classically. Mention the reason behind it.	**20**	
Q.11	(a) Explain the Bose-Einstein condensation. How does it differ from ordinary condensation? Obtain an expression for the critical temperature at which this phenomenon sets in.	**10**	**CO2**
	(b) Show that the distribution function of the Bosons for the most probable macrostate is given by $n_s = \frac{g_s}{e^{\alpha+\beta\epsilon_s} - 1}$ where $\alpha \wedge \beta$ are the Lagrange multipliers.	**10**	**CO3**