BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: IMSc **SEMESTER : VI**
BRANCH: PHYSICS **SESSION : SP/2023**

SUBJECT: PH316 STATISTICAL MECHANICS

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	A system is in contact with its surrounding environment at temperature T. Derive an expression for the probability of the system being in a particular microstate ε_r.	[5]	1	2
Q.1(b)	What is a partition function? Show that the mean energy of a system in canonical ensemble is given by $-\partial \ln Z/\partial \beta$.	[2+3]	1	3
Q.2(a)	Prove that the power of a black body radiation varies as the fourth power of temperature. Given: the pressure exerted by the radiation is $p=mnc^2/3$.	[5]	2	3
Q.2(b)	Briefly explain Wien's Displacement Law. If the temperature of outer space is 2.7 K, find the wavelength of the cosmic microwave background radiation.	[2+3]	2	2
Q.3(a)	If radiation is quantized in units of hv, derive an expression for the mean energy per radiation mode.	[5]	3	2
Q.3(b)	What is the classical value of mean energy per radiation mode? Show that the Planck's expression converges to the classical value in the limit $h\nu \ll k_B T$.	[2+3]	3	2
Q.4(a)	Discuss the number of states obtained when two particles are distributed into three states, when the particles are (a) classical, (b) fermionic, and (c) bosonic.	[5]	4	2
Q.4(b)	Derive an expression for the mean ocupancy of a state for bosonic particles.	[5]	4	3
Q.5(a)	Sketch a diagram of the Fermi distribution at different temperatures. Briefly explain how the Fermi energy level is related to the chemical potential of the Fermi gas.	[3+2]	5	2
Q.5(b)	The mean energy of a Fermi gas is given by the expression $E = \frac{3}{5} N\varepsilon_F \left[1 + \frac{5\pi^2}{12}\left(\frac{T}{T_F}\right)^2 + \cdots\right]$. Find the expressions for the (a) C_V and (b) pressure.	[5]	5	3

::::::25/04/2023::::::M