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

CLASS: MSC **SEMESTER : II**
BRANCH: CHEMISTRY **SESSION : SP/2025**

SUBJECT: CH411 EQUILIBRIUM, NON-EQUILIBRIUM & STATISTICAL THERMODYNAMICS

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.**

			CO	BL
Q.1(a)	Define the 1st law of thermodynamics. Show that $\left(\frac{dU}{dV}\right)_T = 0 \; ; \; \left(\frac{dU}{dT}\right)_V = C_V dT$	[5]	1	2
Q.1(b)	Show graphically, that isothermal reversible expansion work is larger than the isothermal irreversible expansion work.	[5]	1	2
Q.2(a)	What is Carnot cycle? Determine the work produced, heat absorbed, change in internal energy and efficiency of Carnot engine.	[5]	2	2
Q.2(b)	Define the Kelvin-Planck statement of the 2nd law of thermodynamics. Prove the Clausius inequality.	[5]	2	2
Q.3(a)	Derive the Maxwell-Boltzmann distribution formula.	[5]	3	2
Q.3(b)	Obtain the form for the average vibrational energy using quantum theory.	[5]	3	2
Q.4(a)	Discuss the effect of nuclear spin statistics on the rotational partition function.	[5]	4	2
Q.4(b)	Obtain the equilibrium constant for the dissociation of $I_2 \rightarrow$ 2 I in terms of related partition functions.	[5]	4	2
Q.5(a)	Derive the general thermodynamic condition for chemical equilibrium.	[5]	5	2
Q.5(b)	Express the Onsager reciprocal relationship related to non-equilibrium phenomena? Derive the expression related to the entropy production due to heat flow and show that it complies with the Onsager relationship.	[5]	5	2

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