BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION MO/2023)

CLASS: B.TECH. **SEMESTER : III**
BRANCH: CHEMICAL ENGINEERING **SESSION : MO/2023**

SUBJECT: CL201 THERMODYNAMICS

TIME: 02 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. **The question paper contains 5 questions each of 5 marks and total 25 marks.**
2. **Attempt all questions.**
3. **The missing data, if any, may be assumed suitably.**
4. **Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

			CO	BL
Q.1(a)	Define State function and Path function	[2]	CO201.1	1
Q.1(b)	Two kilograms of CO_2 gas is contained in a piston–cylinder assembly at a pressure of 6.5 bar and a temperature of 300 K. The piston has a mass of 5000 kg and a surface area of 1 m^2. The friction of the piston on the walls is significant and cannot be ignored. The atmospheric pressure is 1.01325 x 10^5 Pa. The latch holding the piston is suddenly removed and the gas is allowed to expand. The expansion is arrested when the volume is double the original volume. Assume ideal gas behavior. Determine the work appearing in the surroundings. Will it be the same as the work done by the gas?	[3]	CO201.2	5
Q.2(a)	Prove that $ds = \left(C_v/T\right)dT + \left(\frac{\partial P}{\partial T}\right)_V dV$	[2]	CO201.2	5
Q.2(b)	Derive Clausius Clapeyron equation from Clapeyron equation. Mention the assumptions.	[3]	CO201.2	3
Q.3(a)	Define Joule Thomson co-efficient. Plot inversion temperature graph and explain.	[2]	CO201.1	1
Q.3(b)	A hot steel rod is cooled down to 46.52 ^{0}C by quenching in 150 kg of oil (C_p= 2.5 kJ/kg/K) whose initial temperature is 25^{0}C. If thermal equilibrium is reached, estimate (i) change in entropy of oil (ii) estimate entropy change of steel rod, if total entropy is 9.80 kJ/K. Write opinion on the obtained values	[3]	CO201.3	5
Q.4(a)	Steam with initial pressure of 10,000 kPa, internal energy of 3211 kJ and enthalpy of 3375 kJ enters a throttle valve and expands to 33.68 times its initial volume. Evaluate initial volume, final volume and final pressure of steam after throttling process. Let final internal energy be 3209 kJ	[2]	CO201.2	5
Q.4(b)	$\Delta U = \int \left(\frac{RT}{V-b} - P\right) dV$ Based on this relation determine change in internal energy of propane gas when it expands from 0.001 m^3/mol to 0.04 m^3/mol using Van Der Waal's EOS. Let a = 9.4 x 10^6 J.m^3 / mol^2	[3]	CO201.3	5
Q.5(a)	Demonstrate $\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$	[2]	CO201.1	2
Q.5(b)	Explain Carnot cycle	[3]	CO201.1	2

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