BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION MO 2022)

CLASS: BTECH **SEMESTER: III**
BRANCH: CHEMICAL **SESSION: MO/2022**

SUBJECT: CL201 THERMODYNAMICS

TIME: 3 HOURS **FULL MARKS: 50**

INSTRUCTIONS:
1. The total marks of the questions are 25.
2. Candidates attempt for all 25 marks.
3. Before attempting the question paper, be sure that you have got the correct question paper.
4. The missing data, if any, may be assumed suitably.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a)	Differentiate between State and Path Functions with proper explanation	[2]	CO1,BL2
Q.1(b)	Elaborate Carnot cycle and find out its efficiency.	[3]	CO3,BL2
Q.1(c)	Hydrocarbon oil is to be cooled from 425 K to 340 K at a rate of 5000 kg/h in a parallel flow heat exchanger. Cooling water at a rate of 10,000 kg/h at 295 K is available. The mean specific heats of the oil and water are respectively 2.5 kJ/kg K and 4.2 kJ/kg K. (a) Determine the total change in entropy. Is the process reversible? (b) If a reversible Carnot engine is to be operated receiving the heat from the oil and rejecting the heat to the surroundings at 295 K, how much work would be available?	[5]	CO3,BL5
Q.2(a)	Translate the following basic equations into their corresponding Maxwell relations by derivation: (i) dU = TdS – PdV (ii) dH = TdS + VdP	[5]	CO1,BL2
Q.2(b)	Develop Clausius-Clapeyron equation by derivation mentioning the all assumptions	[5]	CO1,BL3
Q.3(a)	Demonstrate equation for Flash vaporization through derivation	[5]	CO4,BL2
Q.3(b)	A mixture contains 50% pentane (1), 30% hexane (2) and 20% cyclohexane (3) (all in mol-%), exists at T = 400 K. (i) Assume ideal liquid mixture and estimate Bubble point pressure and composition of the first vapor (ii) Assume ideal vapor mixture and estimate Dew point pressure Antoine constants of (1) A = 3.98 , B = 1064.84 , C = -41.14 (2) A = 4.0 , B = 1170.88 , C = - 48.83 (3) A = 3.93, B = 1182.77 , C = - 52.53	[5]	CO4,BL5
Q.4(a)	Develop relationship between chemical potential and phase equilibria	[5]	CO5,BL3
Q.4(b)	In a lab a 2000 cm^3 of antifreeze solution has to be prepared consisting 30 mol % methanol in water. What volumes of pure methanol & water has to be mixed to obtain this solution at 25 ^{0}C. Partial molar vol. of methanol & water in 30 mol % methanol solution, pure species molar volumes @ 25 ^{0}C are given below: $\overline{V}_1$ = 38.632 cm^3/mol ; V_1 = 40.727 cm^3/mol; $\overline{V}_2$ = 17.765 cm^3/mol; V_2 = 18.068 cm^3/mol. Write opinion on the obtained total volume	[5]	CO4,BL5
Q.5(a)	Discuss the effect of Pressure on Equilibrium Constant and on Equilibrium Composition.	[2]	CO1,BL6
Q.5(b)	Determine the number of degrees of freedom in a gaseous system consisting of H_2O, HCl, O_2 and Cl_2.	[3]	CO2,BL5
Q.5(c)	One mole steam undergoes the water-gas shift reaction at a temperature of 1100 K and a pressure of 1 bar. CO (g) + H2O (g) = CO2 (g) + H2 (g) The equilibrium constant for the reaction is K = 1. Assuming ideal gas behaviour, calculate the fractional dissociation of steam in the following cases and discuss the effect of the presence of excess reactant on the extent of reaction. (a) CO supplied is 100% in excess of the stoichiometric requirement. (b) CO supplied is only 50% of the theoretical requirement.	[5]	CO2,BL5

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