U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

December 2023 Supplementary Examinations

Programme: B.E. **Semester: IV**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 22CH4PCTD2 **Max Marks: 100**
Course: Process Engineering Thermodynamics-II

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	Derive the Maxwell relationships using the four fundamental property relations.	*CO1*	*PO1*	**10**
	b)	From the expression $(\partial S/\partial T)\ p$ =Cp/T and $(\partial H/\partial T)\ p$ =Cp justify that the entropy change of system at constant pressure is less than the enthalpy change under same conditions.	*CO2*	*PO2*	**10**
		OR			
2	a)	Mercury has a density of 13690 kg/m^3 in the liquid state and 14193 kg/m^3 in the solid state. Both were measured at the melting point of 234.33 K at 1 bar pressure. If the heat of fusion of mercury is 9.7876 kJ/kg, what is the melting point of mercury at 10 bar pressure?	*CO3*	*PO2*	**07**
	b)	Using Maxwell and fundamental relations, show that for ideal gases$C_P - C_V = R$.	*CO1*	*PO1*	**07**
	c)	Justify the significance of Helmholtz equation and free energy change in the estimation of thermodynamic properties.	*CO2*	*PO3*	**06**
		UNIT - II			
3	a)	Illustrate the effect of temperature and pressure on fugacity using relevant equations.	*CO3*	*PO3*	**10**
	b)	Justify that entropy change of mixing supports 2nd Law of thermodynamics and free energy change supports irreversible mixing process.	*CO3*	*PO3*	**10**
		OR			
4	a)	Derive Gibbs-duhem equation for a binary component system.	*CO6*	*PO3*	**10**

		b)	Define partial molar property and illustrate the different methods used to estimate the partial molar properties.	*CO6*	*PO3*	**10**
			UNIT - III			
	5	a)	Prove that if Raoult's law is valid for one constituent of a binary solution over the whole concentration range, it must also apply to the other constituent.	*CO6*	*PO3*	**10**
		b)	Binary system acetonitrile-nitromethane confirms closely to Raoult's law. Vapour pressure for the pure species is given by the Antoine equations. $\ln P_1^{sat} = 14.2724 - \frac{2945.47}{T-49.15}$ and $\ln P_2^{sat} = 14.2043 - \frac{2972.64}{T-64.15}$ Plot P-x-y diagram for the given system at 75°C.	*CO3*	*PO2*	**10**
			UNIT - IV			
	6	a)	Water (1)–hydrazine (2) system forms an azeotrope containing 60% (mol) hydrazine at 393 K and 101.3 kPa. Calculate the equilibrium vapour composition for a solution containing 30% (mol) hydrazine. The relative volatility of water with reference to hydrazine is 1.6 and may be assumed to remain constant in the temperature range involved. The vapour pressure of hydrazine at 393 K is 124.76 kPa.	*CO3*	*PO2*	**10**
		b)	Explain the salient features of minimum boiling azeotropes and maximum boiling azeotropes using a suitable two component system.	*CO4*	*PO3*	**10**
			UNIT - V			
	7	a)	Derive the relationship between mole fraction of species in single and multiple reactions and the extent of reactions.	*CO 5*	*PO 3*	**07**
		b)	n-Butane is isomerized to i-butane by the action of catalyst at moderate temperatures. It is found that the equilibrium is attained at the following compositions. Temperature, K | Mole % (n -Butane) 317 | 31 391 | 43 Assuming that activities are equal to the mole fractions, calculate the standard free energy of the reaction at 317 K and 391 K and average value of heat of reaction over this temperature range.	*CO5*	*PO3*	**07**
		c)	Illustrate the effect of temperature on equilibrium constant and derive the relevant equation.	*CO2*	*PO2*	**06**

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