U.S.N.										

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

Autonomous Institute Affiliated to VTU

August 2024 Semester End Main 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.

				CO	PO	Marks
			UNIT - I			
1	a)		Derive Maxwell's relations starting from fundamental property relations.	CO1	PO1	10
	b)		Mercury has density of 13690 kg/m^3 in the liquid state and 14193 kg/m^3 in the solid state, both measured at the melting point of 234.33K at 1 bar. If the heat of fusion of mercury is 9.7876 kJ/kg, Estimate the melting point of mercury at 10 bars.	CO2	PO2	06
	c)		Show that Cp and Cv of ideal gases are independent of pressure and volume.	CO 2	PO2	04
			OR			
2	a)		Explain Joule-Thomson coefficient with the state of gas.	CO1	PO1	06
	b)		Derive Gibbs-Hemholtz equation and its applications.	CO2	PO2	06
	c)		Derive the relationship $C_P - C_V = \frac{TV\beta^2}{\kappa}$ Where, β= the coefficient of compressibility and κ= The coefficient of volume expansion.	CO2	PO2	08
			UNIT - II			
3	a)		Explain any three methods for estimating the fugacity of pure gas.	CO3	PO3	10
	b)		Explain effect of pressure and temperature on activity.	CO3	PO3	06
	c)		Define the residual properties.	CO3	PO3	04
			OR			
4	a)		The volume of an aqueous solution of NaCl at 298 K was measured for a series of molalities (moles of solute per kg of solvent) and it was found that the volume varies with molality according to the following expression. $V = 1.003 \times 10^{-3} + 0.1662 \times 10^{-4} m + 0.177 \times 10^{-5} m^{1.5} + 0.12 \times 10^{-6} m^2$ Where m is the molality and V is in m^3. Calculate the partial molar volumes of the components at m = 0.1 mol/kg.	CO4	PO3	10

		b)	Derive Gibbs-Dehum equation in terms of activity coefficient.	***CO3***	***PO3***	**10**
			UNIT - III			
	5	a)	Explain the criteria of phase equilibrium.	***CO6***	***PO3***	**05**
		b)	With neat sketch explain T-x-y diagram and equilibrium diagram.	***CO5***	***PO3***	**08**
		c)	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.	***CO5***	***PO3***	**07**
			UNIT - IV			
	6	a)	Prove that at the azeotropic composition, the vapour and liquid have the same composition.	***CO5***	***PO3***	**08**
		b)	The azeotrope of the ethanol–benzene system has a composition of 44.8% (mol) ethanol with a boiling point of 341.4 K at 101.3 kPa. At this temperature the vapour pressure of benzene is 68.9 kPa and the vapour pressure of ethanol is 67.4 kPa. What are the activity coefficients in a solution containing 10% alcohol?	***CO6***	***PO3***	**12**
			UNIT - V			
	7	a)	Explain the effect of temperature on equilibrium constant.	***CO6***	***PO3***	**08**
		b)	Estimate the standard free energy change and equilibrium constant at 700 K for the reaction $N_2\,(g) + 3\,H_2(g) \rightarrow 2\,NH_3(g)$ The standard heat of formation and standard free energy of formation of ammonia at 298 K to be – 46,100 J/mol and –16,500 J/mol respectively. The specific heat (J/mol K) data are given below as function of temperature (K): $C_p = 27.27 + 4.93 \times 10^{-3}T$ for N_2 $C_p = 27.01 + 3.51 \times 10^{-3}T$ for H_2 $C_p = 29.75 + 25.11 \times 10^{-3}T$ for NH_2	***CO6***	***PO3***	**12**

****