GIET UNIVERSITY, GUNUPUR – 765022

B. Tech (Fourth Semester Regular) Examinations, May – 2024

22BCHPC24001 - Chemical Engineering Thermodynamics

(Chemical)

Time: 3 hrs Maximum: 70 Marks

(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

Q.1. Answer ***ALL*** questions

		CO #	Blooms Level
a.	Differentiate intensive property end extensive property giving examples.	CO1	K1
b.	What is the significance of Virial coefficients?	CO2	K3
c.	Write the reason behind the death of aquatic animals in summer season, through Henry's law.	CO2	K2
d.	What do you mean by partial molar property?	CO2	K2
e.	Write the criteria of feasibility of a chemical reaction in terms of Gibb's free energy.	CO1	K2

PART – B **(15 x 4 = 60 Marks)**

Answer ***ALL*** questions

		Marks	CO #	Blooms Level
2. a.	Derive the expression of first law of thermodynamics for closed system.	7	CO3	K2
b.	One mol of gas initially at 300 and 1000 kPa undergoes a change to 350 K and 500 kPa. Calculate the changes in internal energy and enthalpy for this process. Assume that the gas is ideal and $C_p = \frac{7}{2}$ R and $C_v = \frac{5}{2}$R	8	CO2	K3
	(OR)			
c.	Reported values of Virial coefficients of isopropanol vapor at 200 ^{0}C are B = -388 cm^3/mol. Calculate molar volume (V) and compressibility factor (Z) for isopropanol vap at 200 ^{0}C and 10 bar by using (i) Ideal gas equation (ii) $Z = \frac{PV}{RT} = 1 + \frac{B}{V}$	7	CO2	K3
d.	Derive the expression of entropy change for ideal gas.	8	CO2	K3
3.a.	Derive the expression of phase rule for intensive variables. Extend it to define both intensive and extensive variable of a system which is known as Duhem's rule.	7	CO3	K2
b.	Assuming validity of Raoult's law, do the following calculations for the benzene(1)/toluene(2) system: (i) Given x1 = 0.33 and T=100 ^{0}C, find y1 and P (ii) Given x1 = 0.33 and P =120 kPa, find y1 and T	8	CO2	K3

Vapor pressure of benzene and toluene can be calculated by Antoine equation

For benzene, $ln\ P^s/kPa = 13.7819 - \frac{2726.81}{T/K - 55.578}$

For toluene, $ln\ P^s/kPa = 13.9320 - \frac{3056.96}{T/K - 55.525}$

(OR)

c.	Binary system of acetonitrile (1)/ nitromethane (2) conforms closely to Raoults law. Vapor pressures for the pure species are given by the following Antoine equations: $\ln P_1^{sat}/kPa = 14.2724 - \frac{2945.47}{T-49.15}$ $\ln P_2^{sat}/kPa = 14.2043 - \frac{2972.64}{T-64.15}$ Given T is in K in the Antoine equation Prepare a graph showing P vs x_1 and P vs y_1 for a temperature of 75^0C.	10	CO2	K3
d.	Write short notes on Raoult's law for ideal solution.	5	CO1	K1
4.a.	Derive the expression for Gibbs-Duhem theorem from partial molar properties.	7	CO3	K2
b.	Derive the Maxwell's relation from the fundamental property relations of thermodynamics The enthalpy of a binary liquid system of species 1 and 2 at fixed T and P is represented by the equation $H= 400x_1+ 600\ x_2 + x_1\ x_2\ (40x_1 +20x_2)$ Where H is in J mol^{-1}. Determine expressions for H_1 and H_2 as a function of x_1, numerical values for the pure species enthalpies H_1 and H_2 , and the numerical values for the partial enthalpies at infinite dilution $\overline{H}_1^{\infty}$ and $\overline{H}_2^{\infty}$. (OR)	8	CO2	K3
c.	Derive the expression for the criteria for phase equilibrium in terms of chemical potential.	7	CO3	K2
d.	. The enthalpy of a binary liquid system of species 1 and 2 at fixed T and P is represented by the equation $H= 400x_1+ 600\ x_2 + x_1\ x_2\ (40x_1 +20x_2)$ Where H is in J mol^{-1}. Determine expressions for H_1 and H_2 as a function of x_1, numerical values for the pure species enthalpies H_1 and H_2 , and the numerical values for the partial enthalpies at infinite dilution $\overline{H}_1^{\infty}$ and $\overline{H}_2^{\infty}$.	8	CO1	K1
5.a.	Derive the expression of mole fraction in terms of reaction coordinate ε for single reactions.	7	CO1	K2
b.	Consider a system in which the following reaction occur $CH_4 + H_2O \longrightarrow CO + 3H_2$ (1) $CH_4 + 2H_2O \longrightarrow CO_2 + 4\ H_2$ (2) Where the numbers (1) and (2) indicate the values of j , the reaction index. If there are present initially 2 mol CH_4 and 3 mol H_2O, determine expressions for the y_i as a functions of $\varepsilon_1$and ε_2. (OR)	8	CO2	K3
c.	Derive the effect of temperature on equilibrium constant.	7	CO1	K2
d.	The water gas shift reaction $CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2(g)} + H_{2(g)}$ is carried out under following condition. The reactants consist of 1 mol of H_2O and 1 mol of CO. The temperature is 1100 K and the pressure is 1 bar. Given at 1100 K the value of lnK= 0. Calculate the fraction of steam reacted assuming ideal gas mixture.	8	CO2	K3

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