

GUJARAT TECHNOLOGICAL UNIVERSITY**BE- SEMESTER-IV EXAMINATION – WINTER 2025****Subject Code:3140507****Date:28-11-2025****Subject Name:Chemical Engineering Thermodynamics II****Time:02:30 PM TO 05:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

		MARKS
Q.1	(a) Define: (1) Partial molar property, (2) Fugacity coefficient and (3) Activity coefficient.	03
	(b) Explain the difference between ideal and non-ideal solution.	04
	(c) Define azeotropes and explain minimum boiling and maximum boiling azeotropes with suitable examples and neat diagrams.	07
Q.2	(a) Explain the significance of phase equilibria in chemical engineering.	03
	(b) Write short note on flash vaporization.	04
	(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.	07
	OR	
	(c) Derive general form of Gibbs- Duhem equation.	07
Q.3	(a) Derive summability relation for partial molar properties.	03
	(b) Discuss any one group contribution methods to determine Activity coefficients.	04
	(c) The compressibility factor for oxygen gas at 20°C is given by expression in terms of pressure as $Z = a + bP + cP^2$. Where, a, b and c are empirical constants and pressure is in bar. Determine the fugacity of oxygen at 20°C and 100 bar for given values of empirical constants. $a = 1.0, b = 0.75 \times 10^{-3}$ and $c = 0.15 \times 10^{-5}$	07
	OR	
Q.3	(a) Define chemical potential and state its significance.	03
	(b) Discuss Margules equation with their merits and demerits.	04
	(c) Discuss any two methods to evaluate fugacity coefficient.	07
Q.4	(a) Show that for an ideal gas $\left(\frac{\partial \mu_i}{\partial P}\right)_T = \frac{RT}{P}$	03
	(b) Discuss about liquid – liquid equilibrium (LLE).	04
	(c) The azeotropic mixture of the ethanol-Methyl ethyl ketone has a composition of 52.5 mole% ethanol with boiling point of 250 K at 101.32 kPa. At this temperature the vapour pressure of methyl ethyl ketone is 93.65 kPa and vapour pressure of ethanol is 94.38 kPa. What is the activity	07

coefficient in a solution containing 75% methyl ethyl ketone? (Use Van Laar equation)

OR

- Q.4** (a) With neat diagram explain tangent-intercept method to estimate partial molar volume of a binary solution. **03**
- (b) What is gamma-phi formulation of VLE? **04**
- (c) The fugacity of ethanol in a binary liquid mixture with methyl-ethyl-ketone at 298 K and 10 bar is given by $\bar{f}_1 = 25x_1 - 40x_1^2 + 20x_1^3$, where \bar{f}_1 is in bar and x_1 is mole fraction of ethanol in liquid mixture, Determine;
1. Fugacity of a pure ethanol (f_1).
 2. Henry's law constant (K_1).
 3. Activity coefficient of ethanol for equimolar binary mixture (γ_1).
- Q.5** (a) List out various methods for checking the consistency of experimental VLE data. **03**
- (b) Derive the relationship between the mole fraction of the components taking part in the reaction and the extent of the reaction. **04**
- (c) Industrial grade methanol can be produced according to the reaction **07**
- $$CO(g) + 2H_2(g) \leftrightarrow CH_3OH(g)$$
- For this reaction, $\Delta G_{400}^0 = -1.3484 \text{ kJ}$. If an equimolar mixture of CO and H_2 is fed to a reactor maintained at 400 K and 10 bar, determine the fraction of CO that is converted into CH_3OH at equilibrium. Assume that the reaction mixture behaves like an ideal gas.

OR

- Q.5** (a) Differentiate activity coefficient model and equation of state. **03**
- (b) Write the effect of temperature on equilibrium constant. **04**
- (c) Establish the relationship between equilibrium constant and standard free energy change. **07**
