

THE KAVERY ENGINEERING COLLEGE
(An Autonomous Institution)

**B.E/B.TECH DEGREE END SEMESTER THEORY EXAMINATIONS, APRIL-MAY
2025**

Fifth Semester

Chemical Engineering

CH3501 - Chemical Engineering Thermodynamics II

Regulations - 2021

Duration : 3 Hrs

Maximum : 100 Marks

PART – A (ANSWER ALL QUESTIONS) (Marks 10*2=20)

Q.No	Questions	BLT	CO	Marks
1.	What is non ideal solution?	L2	1	2
2.	Define partial molar volume.	L1	1	2
3.	State Henry's law.	L1	2	2
4.	List the significance of a pressure-temperature phase diagram for azeotropes.	L2	2	2
5.	Define dew point temperature.	L1	3	2
6.	State the "van laar" equation.	L1	3	2
7.	Write the van't Hoff equation.	L1	4	2
8.	Show the effect of presence of excess reactant on chemical reaction equilibrium constant.	L2	4	2
9.	Define refrigerator capacity.	L1	5	2
10.	List some properties of an ideal refrigerant.	L2	5	2

PART – B (ANSWER ALL QUESTIONS) (Marks 5*16 = 80)

Q.No	Questions	BLT	CO	Marks
11.	a i Explain partial molar properties. Discuss various methods for evaluation of partial molar properties.	L3	1	8
	ii The enthalpy of a binary liquid mixture containing components 1 and 2 at 298 K and 1.0 bar is given by $H = 400x_1 + 600x_2 + x_1x_2(40x_1 + 4x_2)$ where H is in J/mol. Determine (a) Pure component enthalpies (b) Partial molar enthalpies	L4	1	8
	Or			
	b i Explain Gibbs-Duhem equation relation? Derive various forms of Gibbs-Duhem equation.	L3	1	8
	ii At 303 K, vapour pressures of benzene (1) and toluene (2) are 15.75 kPa and 4.89 kPa respectively. Determine the	L4	1	8

partial pressure and composition of the benzene vapour in equilibrium with a liquid mixture consisting of equal weight of the two components.

12. a i The two-suffix Margules equation for excess Gibbs free energy is $G^E = Ax_1x_2$, Where A is empirical constant. Evaluate the expression for the activity coefficient. L4 2 8
- ii The fugacity of component 1 in binary liquid mixture of components 1 and 2 at 298 K and 20 bar is given by $\bar{f}_1 = 50x_1 - 80x_1^2 + 40x_1^3$ where f_1 is in bar and x_1 is the mole fraction of component. Determine:
 (a) The fugacity (f_1) of pure component 1
 (b) The fugacity coefficient, ϕ_1
 (c) The Henry's law constant, K_1
 (d) The activity coefficient, g_1
- Or**
- b i For a mixture of acetic acid and toluene containing 0.486 mole fraction toluene, the partial pressures of acetic acid and toluene are found to be 0.118 bar and 0.174 bar respectively at 343 K. The vapour pressures of pure components at this temperature are 0.269 bar and 0.181 bar for Toluene and acetic acid respectively. The Henry's law constant for acetic acid is 0.55 bar. Estimate the activity and activity coefficient for acetic acid in the mixture
 (a) Based on Lewis–Randall rule
 (b) Based on Henry's law L4 2 10
- ii Define azeotrope and explain the minimum boiling and maximum boiling azeotropes with suitable examples. L3 2 6
13. a A mixture contains 45% (mol) methanol (A), 30% (mol) ethanol (B) and the rest *n*-propanol (C). Liquid solution may be assumed to be ideal and perfect gas law is valid for the vapour phase. Determine the total pressure of 101.3 kPa.
 (a) The bubble point and the vapour composition
 (b) The dew point and the liquid composition
 The vapour pressures of the pure liquids are given below:
- | Temperature (K) | 333 | 343 | 353 | 363 |
|-----------------|-------|--------|--------|--------|
| P^S_A , kPa | 81.97 | 133.29 | 186.61 | 266.58 |
| P^S_B , kPa | 49.32 | 73.31 | 106.63 | 166.61 |
| P^S_C , kPa | 39.32 | 62.65 | 93.30 | 133.29 |
- Or**
- b Explain any two methods of determining the thermodynamic consistency of VLE data. L3 3 16
- 14 a i Explain reaction coordinate. What are the criteria of chemical reaction equilibrium? L3 4 8
- ii The standard heat of formation and standard free energy of L4 4 8

reaction at 298 K are -46100J/mol and -16500J/mol respectively. Calculate the equilibrium constant for the reaction.

Or

- b i 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. L4 4 8

Temperature, K	Mol %, n-butane
317	31.00
391	43.00

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.

- ii Explain how the equilibrium constant for liquid-phase reactions is evaluated. L3 4 8

- 15 a Explain with a schematic diagram the working of an absorption refrigeration process. L3 5 16

Or

- b i Illustrate the three general methods available for gas liquefaction? Why is it necessary that a gas be compressed to a high pressure before it is subjected to liquefaction by throttling? L3 5 8

- ii Explain linde liquefaction process with flow sheet. L3 5 8