End-Semester Make-up Exam
May-June 2024
Manipal Institute of Technology (MIT)
Manipal
IV SEMESTER B. TECH (CHEMICAL ENGINEERING) END SEMESTER EXAMINATIONS

(Mak-up)– May/June 2024

SUBJECT: Chemical Engineering Thermodynamic-II [CHE-2251]

(Date:--/05/24 and Time:..... Pm)

Time: 3 Hours **Max. Marks: 50**

Instructions to Candidates:

- Answer ALL questions.
- Missing data may be suitably assumed.

S. N.		Question	Marks
1	a	Explain the concept of chemical potential in thermodynamics and its significance in various physical and chemical processes. What is the effect of temperature and pressure on chemical potential?	04
	b	A binary liquid mixture consists of two species, 1 and 2. Let γ and x represent the activity coefficient and the mole fraction of the species, respectively. Using a molar excess Gibbes free energy model, ln γ_1 verses x_1 curve at a molar faction of X1=0.2 has a slope =1.728. The slope of the tangent drawn to the ln γ_2 verses X_1 curve at the same mole fraction in three decimal points.	03
	c	The partial molar enthalpy of species 1 in a binary system is given by $\overline{h_1} = 2 - 60x_2^2 + 100x_1x_2^2$ Where x_1 and x_2 are the mole fraction of species 1 and 2, respectively, calculate the partial molar enthalpy to the first decimal places of species 1 at infinite dilution.	03
2	a	Write the equations in terms of enthalpy, entropy and Gibbs free energy using maxwll relations.	04
	b	Derive the expression for the change in property mixing.	03
	c	For a given binary system at a constant temperature and pressure, the molar volume is given by $v = 30x_A + 20x_B + x_Ax_B(15x_A - 7x_B)$ x_A and x_B are the mole fraction of the components A and B, respectively. Calculate the volume change of mixing Δv_{max} at x_A=0.5.	03
3	a	Derive the equation for the ideal gas mixture model.	03
	b	Derive the expression for the below terms: I. Fugacity II. Fugacity coefficient	04
	c	The vapour pressure of a pure substance at a temperature T is 30 bar. The actual and ideal gas values of G/RT for the saturated vapour at this temperature T and 30 bar are 7.0 and 7.7, respectively. Here, G is the molar	03

		gibs free energy, R= Gas constant. Calculate the fugacity of the saturated liquid at these conditions.	
4	a	Derive the expression for the following terms: I. Activity coefficient II. Modified Raults law for non-ideal gas phase and ideal liquid page.	04
	b	At the same temperature, the infinite dilution activity coefficient $\gamma_1^\infty and\ \gamma_2^\infty$ is given as $\ln\gamma_1^\infty = 0.4 and \ln\gamma_2^\infty = 0.2$. The vapour pressure of methyl ethyl ketones and toluene at 323 K is 36.90 kPa and 12.30 kPa, respectively. Calculate the equilibrium pressure (kPa) of a liquid mixture containing 90 mole% toluene, assuming the vapure pressure phase is ideal.	03
	c	Derive the expression of fugacity of compressed liquid. Also, write the applications.	03
5	a	Describe the following terms: I. Degree of Freedom (DOF) II. Vant's half equations	04
	b	100 kg of a feed containing 50 wt.% of a solute C is contacted with 80 kg of a solvent containing 0.5 wt.% of C in a water settler unit. From this operation, the resultant extract and raffinate phases contain 40 wt.% of C, respectively. If E and R denote the mass of the extract and raffinate phase, respectively, calculate the ratio of E/R.	03
	c	Derive the expression for fugacity in terms of the compressibility factor. Also, write the application.	03