GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER– V • EXAMINATION – WINTER 2016

Subject Code: 150503   **Date: 19/11/2016**
Subject Name: Chemical Engineering Thermodynamics-II
Time: 10:30AM – 01:00PM   **Total Marks: 70**
Instructions:
      1. **Attempt all questions.**
      2. **Make suitable assumptions wherever necessary.**
      3. **Figures to the right indicate full marks.**

Q.1 **(a)** Discuss various methods for checking the consistency of experimental VLE data. **07**

(b) Define partial molar properties and explain various methods for the evaluation of partial molar properties. **07**

Q.2 **(a)** Derive the relation between standard free energy change and equilibrium constant from the first principle. **07**

(b) In a laboratory 30 mol % of methanol – water solution is to be prepared. How many m^3 of pure methanol and pure water are to be mixed to prepare 2 m^3 of desired solution? Partial molar properties of methanol and water are given below.
Methanol: $V_1 = 38.632$ cm^3 / mol, Water: $V_2 = 17.765$ cm^3 / mol.
For the pure species at 25 ^0C,
methanol: $V_1 = 40.227$ cm^3 / mol and water: $V_2 = 18.068$ cm^3 / mol. **07**

OR

(b) Derive the equation for the criteria for phase equilibrium in terms of fugacity for a mixture of N components and π phases. **07**

Q.3 **(a)** Discuss minimum and maximum boiling azeotropes giving examples for each with neat diagrams. **07**

(b) Construct P-x-y diagram for the cyclohexane(1)/benzene(2) system at 40ºC. Use the following expressions for the liquid-phase activity coefficients: $\ln \gamma_1 = 0.458$ x_2^2, $\ln \gamma_2 = 0.458$ x_1^2. At 40ºC, $p_1^{sat} = 0.243$ atm and $p_2^{sat} = 0.241$ atm. **07**

OR

Q.3 **(a)** Define fugacity coefficient. Discuss any two methods to evaluate fugacity coefficient. **07**

(b) The experimental pressure-volume data for benzene at 675K from a very low pressure to about 75 bar may be approximated by the equation $V = 0.0561$ (1/P – 0.0046), where V is in m^3/mol and pressure P is in bar. What is fugacity of benzene at 1 bar and 675 K? **07**

Q.4 **(a)** Write short notes on any two: **07**
(i) Bubble-point equilibria, (ii) Dew-point equilibria, (iii) Flash vaporization

(b) Write a brief note on retrograde condensation and its application. **07**

OR

Q.4 **(a)** Discuss any two group contribution methods to determine activity coefficient. **07**
(b) For a binary system, if the activity coefficient for component '1' is $\ln\gamma_1 = \beta x_2^2$, then derive the expression for component '2'. **07**

Q.5 **(a)** Explain briefly evaluation of equilibrium conversion for heterogeneous reactions. **07**

(b) Write in brief a note on feasibility of chemical reaction. **07**

Q.5 **(a)** In the synthesis of ammonia, stoichiometric amounts of nitrogen and hydrogen are sent to a reactor where the following reaction occurs. **07**

$N_2 + 3H_2 \rightarrow 2NH_3$
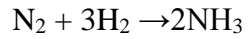
The equilibrium constant for the reaction at 675 K is 2×10^{-4}. Determine the percent conversion of nitrogen to ammonia at 675 K & 20 bar.

(b) Write the effect of temperature and pressure on equilibrium constant. **07**

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