Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER – V (NEW) EXAMINATION – WINTER 2015

Subject Code: 2150503 **Date:08/12/ 2015**

Subject Name: Chemical Engineering Thermodynamics-II

Time:10:30am to 1:00pm **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)** Explain any two methods for estimating fugacity of a pure gas. **07**

(b) Discuss about the ideal solution model and the Lewis/Randall rule. **07**

Q.2 **(a)** Define partial molar properties. Discuss various methods for evaluation of partial molar properties. **07**

(b) Define chemical potential. Discuss the effect of temperature and pressure on chemical potential. **07**

OR

(b) The experimental pressure-volume data for benzene at 675 K from a very low pressures up to 75 bar may be approximated by the equation V= 0.0554(1/P-0.0046).Where V is in m^3/mol and pressure P is in bar. What is the fugacity of benzene at 1 bar and 675 K. **07**

Q.3 **(a)** What are azeotropes? With proper phase diagrams, distinguish between minimum and maximum boiling azeotropes. **07**

(b) Binary system acetonitrile(1)/ nitro methane (2) confirms closely to Roult's law. Vapor pressures of pure species are given by the following Antoine equations, where P is in kPa and T is in K . Prepare T- x_1,y_1 diagram at a pressure of 70 kPa . **07**

$$\ln P_1^s = 14.2724 - \frac{2945.47}{T+224.00} \qquad \ln P_2^s = 14.2043 - \frac{2972.64}{T+209.00}$$

OR

Q.3 **(a)** Enlist the methods to test consistency for any VLE data and describe any two in detail. **07**

(b) Discuss any two group contribution methods to determine Activity coefficients. **07**

Q.4 **(a)** How is the activity coefficient related to the excess free energy? **07**

(b) In a laboratory 30 mol % of methanol – water solution is to be prepared. How many cm^3 of pure methanol and pure water are to be mixed to prepare 2000cm^3 of desired solution? Partial molar properties of methanol and water are given below. **07**

Methanol: $\bar{V}_1$ = 38.632 cm^3 / mol, Water: $\bar{V}_2$ = 17.765 cm^3 / mol.

For the pure species at 25 ^{0}C, methanol: V_1 = 40.227 cm^3 / mol and water: V_2 = 18.068 cm^3 / mol.

OR

Q.4 **(a)** Prove "Henry's law applies to a species as it approaches infinite dilution in a binary solution, and the Gibbs/Duhem equation insures validity of the the Lewis/Randall rule for the other species as it approaches purity". **07**

(b) The azeotrope of the ethanol-benzene system has a composition of 44.8% (mol) ethanol with boiling point of 341.4 K at 101.3 Kpa. At this temperature **07**

the vapor pressure of benzene is 68.9 Kpa and the vapor pressure of ethanol is 67.4 Kpa. What are the activity co-efficient in a solution containing 10% alcohol.(Use Van Laar equation).

Q.5 (a) The water-gas shift reaction $CO_{(g)} + H_2O_{(g)} \longrightarrow CO_{2(g)} + H_{2(g)}$ is carried out under the different sets of condition described below. Calculate the fraction of steam reacted in each case. Assume the mixture behaves as an ideal gas. **10**

i) The reactants consist of 1 mol of H_2O vapor and1 mol of CO. The temperature is 1100K and the pressure is 1 bar.

ii) Same as (i) except that the pressure is 10 bar.

iii) Same as (i) except that 2 mol of N2 is included in the reactants.

iv) The reactants are 2 mol of H_2O and 1 mol of CO. Other conditions are the same as in (i).

v) The reactants are 1 mol of H_2O and 2 mol of CO. Other conditions are the same as in (i).

vi) The initial mixture consists of 1 mol of H_2O, 1 mol of CO and 1 mol of CO_2. Other conditions are the same as in (i).

Assume for the given reaction at 1100K, value of K = 1.

(b) Discuss phase rule and Duhem's theorem for reacting systems. **04**

OR

Q.5 (a) (i) Discuss the effect of temperature on equilibrium constant. **05**

(ii)What is the criterion of chemical reaction equilibria? **05**

(b) Discuss about liquid – liquid equilibrium (LLE). **04**

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