Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- Vth SEMESTER–EXAMINATION – MAY/JUNE - 2012

Subject code: 150503 Date: 04/06/2012

Subject Name: Chemical Engineering Thermodynamics-II

Time: 02:30 pm – 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.**

Q.1 **(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**

Q.2 **(a)** i) Define excess properties. **02**
ii) Define fugacity and fugacity coefficient of pure substance. **04**
iii) What is ideal solution? **01**

(b) The experimental pressure volume data for benzene at 675K from a very low pressure up 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 the fugacity of benzene at 1 bar and 675K? **07**

OR

(b) Explain T-xy diagram for an immiscible system. **07**

Q.3 **(a)** Discuss the consistency tests for VLE data by using Gibbs-Duhem equation. **07**

(b) Derive Van-Laar equations and Margules equations from basic Redlich Kister expansion. **07**

OR

Q.3 **(a)** Write a brief note on retrograde condensation. **07**

(b) i) Write Lewis-Randall rule and its significance. **03**
ii) Define activity and activity coefficient. **04**

Q.4 **(a)** Discuss the criteria of chemical equilibrium. **07**

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

OR

Q.4 **(a)** Write a brief note on multireaction equilibria. **07**

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

Q.5 The water-gas shift reaction $CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$ 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. **14**

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 N_2 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.

OR

Q.5 **(a)** Acetic acid is esterified in the liquid phase with ethanol at 100^0C and atmospheric pressure to produce ethyl acetate and water according to the reaction: **07**

$CH_3COOH(l) + C_2H_5OH(l) \rightarrow CH_3COOC_2H_5(l) + H_2O(l)$

If initially there is one mole each of acetic acid and ethanol, estimate the mole fraction of ethyl acetate in the reacting mixture at equilibrium.

The value of ΔH^0_{298} and ΔG^0_{298} for the above reaction are 13110 J and 9270 J respectively.

(b) Mixtures of n-Pentane (1) and n-Heptane(2) conform to ideal solution behavior. The vapor pressures of pure components are adequately described by Antoines equation. Prepare P-x-y diagram at 70^0C. **07**

	A	**B**	**C**
n-Pentane	6.87632	1075.780	233.205
n-Heptane	6.89386	1264.370	216.640

Use Antoines equstion: $\log_{10}P = A - (B / (T + C))$ where pressure P is in Torr and temperature T is in ^{0}C.

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