

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 m³/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 $\text{CO(g)} + \text{H}_2\text{O(g)} \rightarrow \text{CO}_2\text{(g)} + \text{H}_2\text{(g)}$ 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 H₂O vapor and 1 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

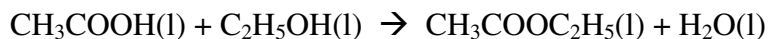
reactants.

- 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 $K = 1$.

OR

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



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_{298}^0 and ΔG_{298}^0 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 Antoine's equation. Prepare P-x-y diagram at 70°C . **07**

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

Use Antoine's equation: $\log_{10}P = A - (B / (T + C))$ where pressure P is in Torr and temperature T is in $^\circ\text{C}$.
