

**GUJARAT TECHNOLOGICAL UNIVERSITY****BE – SEMESTER V • EXAMINATION – WINTER - 2012****Subject code: 150503****Date: 17-01-2013****Subject Name: Chemical Engineering Thermodynamics - II****Time: 02:30 pm to 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) Derive the equation for the criteria for phase equilibrium in terms of fugacity for a mixture of N components and  $\pi$  phases. **07**  
 (b) Explain the analytical and graphical method to determine partial molar properties of components in mixtures. **07**

- Q.2** (a) For a binary system, if the activity coefficient of component 1 is given by  $\ln \gamma_1 = A x_2^2$ , find the expression for the component 2. **07**  
 (b) A gas obeys the equation  $P(V-b) = RT$ . For this gas  $b = 0.0391 \text{ dm}^3/\text{mol}$ . Calculate the fugacity and fugacity coefficient of the gas at  $1000^\circ\text{C}$  and  $1000 \text{ atm}$ . **07**

**OR**

- (b) Write in brief a note on feasibility of chemical reaction. **07**
- Q.3** Assuming the validity of Raoult's law, do the following calculations for the system of acetone (1), acetonitrile (2) and nitromethane (3). **14**  
 (a) Given  $x_1 = 0.30$  and  $x_2 = 0.40$ ,  $T = 75^\circ\text{C}$ , find  $y_1$  and  $P$ .  
 (b) Given  $y_1 = 0.45$  and  $y_2 = 0.35$ ,  $T = 80^\circ\text{C}$ , find  $x_1$  and  $P$ .

$$\ln P^{\text{sat}} = A - [B / (t + C)]$$
 where  $P^{\text{sat}}$  is in kPa and  $t$  is in  $^\circ\text{C}$ 

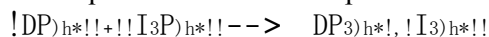
| Component        | A       | B       | C     |
|------------------|---------|---------|-------|
| Acetone(1)       | 14.3916 | 2795.82 | 230.0 |
| Acetonitrile (2) | 14.2724 | 2945.47 | 224.0 |
| Nitromethane (3) | 14.2043 | 2972.64 | 209.0 |

**OR**

- Q.3** (a) Write a brief note on retrograde condensation and its application. **07**  
 (b) Explain the methodology to be adopted for calculating the bubble point calculation for the mixtures of hydrocarbons at high pressure. **07**
- Q.4** (a) Write a brief note on ideal solutions and non-ideal solutions. **07**  
 (b) Write a brief note on thermodynamic consistency test of VLE data. **07**

**OR**

- Q.4** (a) Derive from first principle  $\Delta G^\circ = -RT \ln K$ . **07**  
 (b) Calculate the equilibrium constant  $K_p$  at  $25^\circ\text{C}$  for the water gas shift reaction **07**



Given that the standard free energies of formation at  $298 \text{ K}$  are  $(-32.8) \text{ kcal/mol}$  for carbon monoxide,  $(-54.64) \text{ kcal/mol}$  for steam and  $(-94.26) \text{ kcal/mol}$  for carbon dioxide.

- Q.5**    **(a)** Explain T-x,y diagram for partially miscible system. **07**  
          **(b)** Explain the effect of inert and presence of product in initial mixture of reacting system **07**

**OR**

- Q.5**    **(a)** Write short note on Van Laar equation and Margules equation/ **07**  
          **(b)** Write in brief on phase rule for the reacting system. **07**

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