

GUJARAT TECHNOLOGICAL UNIVERSITY
BE SEM-V Examination-Nov/Dec.-2011

Subject code: 150503

Date: 26/11/2011

Subject Name: Chemical Engineering Thermodynamics-II

Time: 2.30 pm -5.00 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) 1. Define(i) Fugacity (ii) Activity coefficient 04
 2. Explain Ideal Solution 03
 (b) Discuss about partial molar properties 07

- Q.2** (a) List out various methods for evaluation of fugacity coefficient of pure component. Discuss any two in detail. 07
 (b) Derive the equation for the criteria for phase equilibrium in terms of fugacity for mixture of N components and JI phases 07

OR

- (b) Explain Retrograde condensation in detail with figure. 07

- Q.3** (a) The enthalpy at 300 K and 1 bar of a binary liquid mixture is $H = 400X_1 + 600X_2 + X_1X_2(40X_1 + 20X_2)$ 07
 Where H is in J/mol for the stated temperature and pressure determine
 (i) Expression for partial molar enthalpies of both components 1 and 2.
 (ii) Numerical value for pure component enthalpies H_1 and H_2 .
 (iii) Numerical value of the partial molar enthalpies for both the components at infinite dilution.

- (b) Prepare P-X-Y diagram at temperature of 100 °C for a binary system Benzene(1) and Ethyl benzene(2). Assume that Raoult's law is valid and use the following Antoine equation.

$$\ln P_1^{\text{sat}} = A - B/(T + C) \quad \text{Where } P_1^{\text{sat}} \text{ in Kpa and } T \text{ is in } ^\circ\text{C}$$

Component	Value of constant		
	A	B	C
Benzene	13.8594	2773.78	220.07
Ethyl benzene	14.0045	3279.47	213.20

OR

- Q.3** (a) 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 the vapor pressure of benzene is 68.9 Kpa and the vapor pressure of ethanol is 67.4 Kpa. What are the activity coefficient in a solution containing 10% alcohol. (Use Van Laar equation) 10

- (b) Calculate the equilibrium constant at 298 K of the reaction **04**

$$\text{N}_2\text{O}_{4(g)} \rightarrow 2\text{NO}_{2(g)}$$
 Given that the standard free energies of formation at 298 K are 97,540 J/mol for N_2O_4 and 51,310 J/mol for NO_2

- Q.4** (a) Derive from first principle $\Delta G^0 = RT \ln K$. **07**
 (b) Discuss the effect of pressure and temperature on equilibrium constant for chemical reaction equilibrium. **07**

OR

- Q.4** (a) Explain briefly evaluation of equilibrium conversion for heterogeneous reaction. **07**
 (b) Write short note on T-X Y diagram for partially miscible system. **07**

- Q.5** (a) Write short note on Van Laar equation and Margulas equation. **07**
 (b) Discuss thermodynamic analysis of any two reactions having industrial relevance. **07**

OR

- Q.5** (a) Ammonia synthesis reaction is represented by **10**

$$\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$$
 The reaction stream consists of 1 mol N_2 , 3 mol H_2 and 2 mol argon. The temperature and pressure of the reaction are 675 K and 20 bar. The equilibrium constant for the reaction is 2×10^{-4} . Determine the percent conversion of nitrogen to ammonia.
 (b) Define (i) Excess properties (ii) Chemical potential **04**
