Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. Sem. - V - Examination – June- 2011

Subject code: 150503

Subject Name: Chemical Engineering Thermodynamics-II

Date:24/06/2011 **Time: 10:30 am – 01:00 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 Chemical potential & establish Chemical potential as a criteria for phase Equilibrium. **07**

(b) Discuss various methods for determination of partial molar properties. **07**

Q.2 **(a)** Derive Gibbs-Duhem equation for a binary solution in terms of activity and activity coefficient. **07**

(b) Show that for a stable liquid phase ,the fugacity of each component in a binary mixture always increases with increase in concentration at constant temperature and pressure. **07**

OR

(b) Show that for a binary system ,if Henry's law is valid for component '1' ,then Lewis - Randall rule is valid for component '2'. **07**

Q.3 **(a)** At 300 K and 1 bar ,the volumetric data for a liquid mixture of benzene and cyclohexane are represented by $V=109.4 \times 10^{-6} - 16.8 \times 10^{-6} x - 2.64 \times 10^{-6} x^2$,where x is the mole fraction of benzene and V has the units of m^3/mol. Find expressions for the partial molar volumes of benzene and cyclohexane. **07**

(b) The azeotrope of the ethanol-benzene system has a composition of 44.8 % (mol) Ethanol with a 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. Calculate activity coefficients in a solution containing 10% ethanol, using Van Laar Equation. **07**

OR

Q.3 Mixtures of n-Heptane (A) and n-Octane (B) are expected to behave as an ideal solution .The total pressure over the system is 101.3 kpa. **14**

Using vapour pressure data given below, construct

a) T- x, y diagram b) Equilibrium diagram.

T,K	371.4	378	383	388	393	398.6
P_A ,kpa	101.3	125.3	140.0	160.0	179.9	205.3
P_B, kpa	44.4	55.6	64.5	74.8	86.6	101.3

Q.4 **(a)** Discuss various methods for checking the consistency of experimental VLE data. **07**

(b) Prove that $\Delta G^0 = -R\,T\,\ln K$ **07**

OR

Q.4 **(a)** Discuss various methods to determine equilibrium constant. **07**

(b) Prove that $K = K_{\Phi}\, Kv\, Kn\, \{P/n_t\}^{\Delta n}$ **07**

Q.5 **(a)** A gas mixture containing 25% CO,55% H_2, 20% inert gas is to be used for Methanol synthesis. The gases issue from the catalyst chamber are in chemical equilibrium with respect to the reaction: $CO\,(g) + 2H_2\,(g) \rightarrow CH_3OH(g)$ at a pressure of 300 bar and temperature of 625K. Assume that the equilibrium mixture forms an ideal solution and K_f and K_{Φ} are 4.9×10^{-5} and 0.35 respectively. Calculate the percentage conversion of CO. **07**

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

OR

Q.5 **(a)** The following data gives the composition v/s total pressure for the system chloroform(1)- ethyl alcohol(2) at 328 K are; **07**

X_1	0.0331	0.9652
P,kpa	40.84	84.88

Vapour pressures of chloroform and ethyl alcohol at 328 K are 82.35 and 37.30 kPa respectively. Estimate the constants in the Margules equation.

(b) Discuss the effect of temperature and pressure on fugacity. **07**

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