Seat No: _____ **Enrollment No: _____**

PARUL UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

B. Tech. Summer 2018 - 19 Examination

Semester: 5 **Date: 18/05/2019**
Subject Code: 03103303 **Time: 10:30am to 01:00pm**
Subject Name: Chemical Engg Thermodynamics-II **Total Marks: 60**

Instructions:
1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Start new question on new page.

Q.1 Objective Type Questions - **(15)**

1. Fugacity has same dimension as that of _____.
2. What is full form of UNIQUAC?
3. Forward reaction takes place if _____.
4. A solution exhibiting positive deviation from ideality
   a) Always forms a minimum boiling azeotrope
   b) Always forms a maximum boiling azeotrope
5. Which one of the following is true for the excess property M^E?
   a) $M^E = M - \Sigma x_i M_i$ **b)** $M^E = M - M^{id}$ **c)** $S^R = S - S^{id}$ **d)** both b and c
6. The chemical potential of a component in the equilibrium state of the reaction mixture is related to its _____.
7. For a highly favorable chemical reaction, the standard free energy change is
   a) zero **b)** Unity **c)** Positive **d)** Negative
8. The stoichiometric numbers are _____ for product.
9. Define: activity coefficient
10. What is phase rule?
11. What is extent of reaction?
12. State the Raoult's Law
13. List the different types of equilibria?
14. Which one of the following is the correct form of Gibbs Duhem equation for binary solution?

A. $x_1\left(\frac{\partial \ln \gamma_1}{\partial x_1}\right) = x_2\left(\frac{\partial \ln \gamma_2}{\partial x_2}\right)$ B. $x_1\left(\frac{\partial \ln \gamma_1}{\partial x_1}\right) = -x_2\left(\frac{\partial \ln \gamma_2}{\partial x_2}\right)$

C. $x_1\left(\frac{\partial \ln \gamma_1}{\partial x_1}\right) = x_2\left(\frac{\partial \ln \gamma_2}{\partial x_1}\right)$ D. $x_1\left(\frac{\partial \ln \gamma_1}{\partial x_1}\right) = (1 - x_1)\left(\frac{\partial \ln \gamma_2}{\partial x_1}\right)$

15. Define: Partial molar property

Q.2 Answer the following questions. (Attempt **any three**) **(15)**

A) Sketch the T-x-y and P-x-y diagram for minimum and maximum boiling azeotrope.

B) One mole steam undergoes the water-gas shift reaction at a temperature of 1100 K and a pressure of 1 bar. CO (g) + H_2O (g) ---> CO_2 (g) + H_2 (g) The equilibrium constant for the reaction is K =

1. Assuming ideal gas behavior, calculate the fractional dissociation of steam in the following cases and discuss the effect of the presence of excess reactant on the extent of reaction.

(a) CO supplied is 100% in excess of the stoichiometric requirement. **(b)** CO supplied is only 50% of the theoretical requirement.

C) Write a note on Liquid-liquid equilibria

D) N-Heptane and toluene form ideal solution. At 373K, their vapor pressure are 106 and 74 kPa respectively. Determine the composition of the liquid and vapours in equilibrium at 373K and 101.3 kPa

Q.3 A) The following values refer to the Wilson parameters for the system acetones (1) water (2): a_{12} = 1225.31 J/mol, a_{21} = 6051.01 J/mol, V_1 = 74.05 x 10^{-6} m^3/mol, V_2 = 18.07 x 10^{-6} m^3/mol. **(07)**

The vapour pressures are given by

$\ln P_1^S = 14.39 - 2795.817/(T-43.198)$, $\ln P_2^S = 16.26 - 3799.887/(T - 46.854)$

Calculate vapour composition at x_1=0.43 and 349 K.

B) Mixtures of n-Heptane (A) and n-Octane (B) are expected to behave ideally. The total pressure over the system is 101.3 kPa. Using the vapour pressure data given below, Construct boiling point diagram. **(08)**

T, K	371.4	378	383	388	393	398.6
P_A^S kPa	101.3	125.3	140	160	179.9	205.3
P_B^S kPa	44.4	55.6	64.5	74.8	86.6	101.3

OR

B) Write a note on **i)** Lewis Randall Rule and **ii)** Gibbs Duhem equation **(08)**

Q.4 A) Derive the relation of equilibrium constant and standard Gibbs free energy **(07)**

OR

A) 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 vapour pressure of benzene is 68.9 kPa and the vapour pressure of ethanol is 67.4 kPa. What are the activity coefficients in a solution containing 10% alcohol? **(07)**

B) The vapour pressures of acetone (1) and acetonitrile (2) can be evaluated by, Antoine equations **(08)**

$\ln P_1^S = 14.5463 - 2940.46/(T - 35.93)$

$\ln P_2^S = 14.2724 - 2945.47/(T - 49.15)$

Where T is in K and P is in kPa. Assuming that the solutions formed by these are ideal, calculate, **a)** x_1 and y_1 at 327 K and 65 kPa **b)** P and y_1 at 327 K and x_1 = 0.4