A **Reg. No. :** | | | | | | | | | | |

Question Paper Code: 55901

B.E./B.Tech. DEGREE EXAMINATION, NOV 2018

Fifth Semester

Chemical Engineering

15UCH501-CHEMICAL ENGINEERING THERMODYNAMICS

(Regulation 2015)

(Steam table and compressibility chart permitted in examinations)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. Air is CO1- R

(a) A gas (b) A mixture of gases

(c) A mixture of gases and vapour (d) A mixture of vapours

2. The activity of a component in an ideal solution is equal to CO1 R

(a) Its fugacity at the same temperature and pressure. (b) Its mole fraction.

(c) Its partial pressure. (d) One.

3. The equilibrium constant of a reaction CO2- R

(a) Depends on temperature only (b) Depends on pressure only

(c) Depends on temperature as well as pressure (d) Is independent of temperature and pressure

4. For system of two miscible non-reacting species in vapour-liquid equilibrium, forming an azeotrope,the number of degrees of freedom is CO2- R

(a) 0 (b) 1 (c) 2 (d) 3

5. Le Chatelier principle applies to CO3- R

(a) Physical equilibria (b) Chemical equilibria

(c) To all reaction. (d) To all system at equilibrium

6. For the reaction $C_2H_4(g) + H_2O(g)$ which gives $C_2H_5OH(g)$ the equilibrium conversion depends on the CO3 R

(a) Temperature (b) Pressure (c) Steam-to-ethylene ratio (d) All of above

7. The standard Gibbs free-energy change of a reaction is a function of the equilibrium CO4- R

(a) Temperature only (b) Pressure only

(c) Composition only (d) Pressure and composition

8. The equilibrium constant of a reaction CO4- R

(a) Has the units of temperature (b) Has the units of pressure

(c) Has the units of concentration (d) Is dimensionless

9. For an ideal refrigeration cycle the change in internal energy of the fluid CO5- R

(a) Is zero (b) Is positive

(c) Is negative (d) May be zero, positive or negative depending upon the fluid

10. The refrigeration is the CO5- R

(a) Heating process (b) Cooling and heating process

(c) Cooling process (d) Heating and cooling process

PART – B (5 x 2= 10Marks)

11. What is the application of Gibb's Duhem equation in thermodynamics? CO1- R

12. Write is the effect of pressure on azeotropes? CO2- R

13. Define Bubble point and dew point temperatures. CO3- R

14. Write the effect of Pressure on Equilibrium composition? CO4- R

15. List any four application of refrigeration. CO5- R

PART – C (5 x 16= 80 Marks)

16. (a) Briefly explain the three methods for the determination of partial molar properties. CO1-U (16)

Or

(b) (i)The volume of an aqueous solution of NaCl at 298 K was measured for a series of molalities (moles of solute per kg of solvent) and it was found, that the volume varies with molality according to the following expression. CO1- App (8)

$V=1.003 \times 10\text{-}3 + 0.1662 \times 10\text{-}4\ m + 0.177 \times 10\text{-}5\ m1.5 + 0.12 \times 10\text{-}6\ m^2$

Where m is the molality and V is in m3. Calculate the partial molar volumes of the components at m = 0.1 mol / kg.

(ii) Derive Gibb's Duhem equation for solutions. CO1- App (8)

17. (a) (i) Using the criterion of phase equilibrium, show that the change in entropy during phase changes can be calculated from the latent heat of phase change and the absolute temperature as $\Delta S = \Delta H/T$. CO2- App (8)

(ii)What are azoetropes? With proper phase diagrams distinguish between minimum boiling and maximum boiling azeotropes. CO2- App (8)

Or

(b) (i) Briefly explain detail liquid - liquid equilibrium diagrams. CO2- App (8)

(ii) The activity coefficients for component 1 in a binary solution can be represented by in $y_1= aX^2_2+bX^3_2+cX^4_2$, where a, b and c are concentration independent parameters. Derive an expression for In Y_2. CO2- App (8)

18. (a) Briefly explain the activity coefficient equations with all the parameters. CO3- U (16)

Or

(b) The following values refer to the Wilson parameters for the system acetone (1) – water (2): A12 = 1225.31 J/mol, a21 = 6051.01 J/mol, V1 = 74.05 × 10-6 m3/mol, V2= 18.07 × 10-6 m3/mol. The vapour pressures are given by In P_1 = 14.39155-2795.817 / T-43.198, In P_2 = 16.26205-3899.887 / T-46.854.Where P is in kPa and T is in K. Calculate the equilibrium pressure and composition of CO3- Ana (16)

(a) Vapour in equilibrium with a liquid of composition x1 = 0.43 at 349 K.

(b) The liquid in equilibrium with a vapour of concentration y1 = 0.8 at 349K.

19. (a) (i) Describe the factors affecting equilibrium conversion. CO4- U (8)

(ii) How would the equilibrium yield in a gaseous chemical reaction be affected by increasing the pressure, if there is a decrease in the number of moles during the reaction? How would you explain the effect of pressure on reactions such as water – gas shift reaction, where there is no change in the number of moles? CO4- U (8)

Or

(b) A mixture of 1 mol CO, and 1 mol water vapour is undergoing 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. Assume that the gas mixture behaves as ideal gas. Calculate : CO4- Ana (16)

(a) The fractional dissociation of steam.

(b) The fractional dissociation of steam if the reactant stream is diluted with 2 mol nitrogen.

20. (a) (i) Describe briefly about vapor compression cycle along with the required diagrams. CO5- U (8)

(ii) What are the criterions for the selection of refrigerant? CO5- U (8)

Or

(b) Explain briefly : CO5- U (16)

(i) Joule Thomson expansion and

(ii) Linde process for gas liquefaction.