

**B.TECH. SEM -IV (CHEMICAL ) 2014 COURSE (CBCS) :**  
**WINTER - 2017**

**SUBJECT : CHEMICAL ENGINEERING THERMODYNAMICS – II**

Day : **Thursday**  
Date : **23/11/2017**

Time : **02.30 PM TO 05.30 PM**  
Max. Marks : **60**

**W-2017-2065**

**N.B.:**

- 1) All questions are **COMPULSORY**.
- 2) Figures to the right indicate **FULL** marks.
- 3) Use of steam tables / mollier diagram is **ALLOWED**.
- 4) Use of non-programmable **CALCULATOR** is allowed.
- 5) Assume suitable data if **NECESSARY**.

**Q.1 a)** Prove ‘fugacity of species  $i$  in an ideal gas mixture is equal to its partial pressure’.

$$\hat{f}_i^{ig} = P_i = y_i P$$

**b)** Write a note on : “Heat effects of mixing for binary system”. **[04]**

**OR**

**Q.1 a)** “All property changes of mixing are zero for ideal solutions”. Justify. **[05]**

**b)** Elaborate the terms: **[05]**  
i) Ideal gas mixture  
ii) Ideal solution

**Q.2** Explain various phase diagrams for binary system. Also explain the effect of pressure on equilibrium of binary system. **[10]**

**OR**

**Q.2** Prepare P – xy diagram for the following system at 65°C. **[10]**  
Diethyl Ketone (1) and n-Hexane (2) conforms closely to Raoult’s law. Vapor pressures for pure species are given by Antoine equations as:

$$\ln P_1^{sat} \text{ kPa} = 11.3245 - \frac{2547.25}{T - 34.39}$$

$$\ln P_2^{sat} \text{ kPa} = 12.2349 - \frac{2547.31}{T - 51.29}$$

**Q.3** How the liquid phase property fugacity is evaluated from VLE data? Write the expressions for the same. **[10]**

**OR**

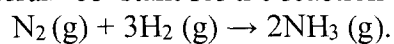
**Q.3 a)** State Lewis – Randall rule with its physical significance. **[04]**

**b)** Explain Redlich – Kister method for testing consistency of VLE data. **[06]**

**Q.4 a)** How phase rule is applied for reacting system? Explain with suitable example. **[04]**

**P.T.O.**

- b) The standard heat of formation and standard free energy of formation of  $\text{NH}_3$  at 298K are  $-46100 \text{ J/mol}$  and  $-16500 \text{ J/mol}$  respectively. Calculate the equilibrium constant for the reaction [06]



At 500K assuming that the standard heat of reaction is constant in the temperature range of 298 to 500 K.

OR

- Q.4 a) Consider a vessel which initially contains only  $n_0$  moles of water vapor. If decomposition occurs according to the reaction  $\text{H}_2\text{O} \rightarrow \text{H}_2 + 1/2 \text{O}_2$ . Find expressions which relate the number of moles and mole fraction of each chemical species to the reaction coordinate  $\epsilon$ . [06]

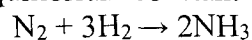
- b) Explain the methods for evaluation of equilibrium constant. [04]

- Q.5 a) Write a note on : Heterogeneous reaction equilibria for reactions in solutions. [05]

- b) Derive an expression for pressure of decomposition for heterogeneous reaction. [05]

OR

- Q.5 a) The equilibrium constant  $K_p$  for the reaction [06]



At 700 K and 100 atm is  $1 \times 10^{-4}$ . Calculate the partial pressure of  $\text{NH}_3$  at equilibrium.

- b) Enlist the industrial heterogeneous systems and discuss the role of thermodynamics. [04]

- Q.6 a) Explain the constant pressure LLE for binary system. [04]

- b) Write notes on: [06]

- i) Selection of solvent for extraction  
ii) Solubility parameter

OR

- Q.6 a) Define activity coefficient and write the equations for determination activity coefficient in liquid liquid equilibrium. [06]

- b) What do you mean by solubility parameter? How it is estimated? [04]

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