

**B.TECH SEM - V (2007 COURSE) (CHEMICAL ENGG.) : WINTER  
- 2017**

**SUBJECT : CHEMICAL ENGINEERING THERMODYNAMICS - II**

Day **Saturday**  
Date **20/01/2018**

Time **02.30 PM TO 05.30 PM**  
Max. Marks : 80

**W-2017-2447**

**N. B. :**

- 1) **Q. No. 1 and Q. No. 5 are COMPULSORY.** Out of the remaining questions attempt **ANY TWO** questions from each section.
- 2) Answers to both sections should be written in **SEPARATE** answer books.
- 3) Use of non-programmable **CALCULATOR** is allowed.
- 4) Figures to the right indicate **FULL** marks.
- 5) Assume suitable data, if necessary.

**SECTION - I**

- Q.1** a) Define osmotic pressure and explain osmotic equilibrium. **(05)**  
b) Elaborate the concept of non ideal solution. **(05)**  
c) Explain Phase rule for reacting system. **(04)**
- Q.2** a) Illustrate the criteria of stability. **(06)**  
b) Derive Clapeyron equation using criteria of phase equilibrium. **(07)**
- Q.3** a) Explain zero area method of consistency test of VLE data. **(07)**  
b) Liquids A & B form an azeotrope containing 46.1 mole percentage A at 101.3 kPa and 345 K. At 345 K the vapor pressure of A is 84.8 kPa and that of B is 78.2kPa. Calculate Van Laar constants. **(06)**
- Q.4** a) Determine expressions for mole fractions as a function of reaction coordinate for the following reaction. **(07)**  
$$\text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO} + 3\text{H}_2$$
  
Assume there are 2 mole CH<sub>4</sub>, 1 mole H<sub>2</sub>O and 1 mole CO and 4 mole H<sub>2</sub> present initially.
- b) Derive the relation of equilibrium constant and composition for gas phase reaction. **(06)**

**SECTION - II**

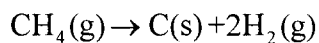
- Q.5** a) What is the effect of temperature on equilibrium constant? For what type of chemical reactions is the equilibrium constant independent of temperature? **(05)**  
b) Explain thermodynamics of electrochemical processes. **(04)**  
c) How the activity coefficient is related to excess Gibbs free energy? **(05)**

**P.T.O.**

**Q.6 a)** Derive equilibrium showing effect of temperature and pressure on activity coefficient. **(05)**

**b)** How liquid phase properties (such as fugacity and activity) are determined using VLE data? Explain in detail. **(08)**

**Q.7** Carbon black is produced from methane at 1000k and 1 bar according to reaction **(13)**



Estimate the equilibrium constant at 1000K and determine the fraction of methane converted into carbon black. Assume that the molar heat capacity of carbon is constant and is equal to 80792 J/mol K.

$$\Delta H_{298}^0 = 74.943 \text{ kJ}$$

$$\Delta G_{298}^0 = 50.660 \text{ kJ}$$

$$C_{\text{PCH}_4} = 17.449 + 60.449 \times 10^{-3}T + 1.117 \times 10^{-6}T^2 - 7.204 \times 10^{-9}T^3$$

$$C_{\text{PH}_2} = 27.012 + 3.509 \times 10^{-3}T + 0.69 \times 10^{-5}T^2$$

**Q.8 a)** Calculate the mean heat capacity of a 20 mole percent solution of alcohol in water at 298 k. given the following: **(07)**

Heat capacity of water :  $4.18 \times 10^3 \text{ J/kgK}$

Heat capacity of ethanol :  $2.18 \times 10^3 \text{ J/kgK}$

Heat of mixing for 20 mole percent ethanol water at 298 K : - 785 J/mol.

Heat of mixing for 20% (mole) ethanol – water at 323 K: - 145 J/mol.

Assume that the heat capacities of pure liquids are constant between 298 and 523K.

**b)** A container is divided into two compartments. One contains 3.0 moles hydrogen at 298 k and 1.0 bar and the other contains 1.0 mole nitrogen partition is removed. **(06)**

\* \* \* \* \*