B.TECH.
(SEM IV) THOERY EXAMINATION 2017-18
CHEMICAL ENGINEERING THERMODYNAMICS

Time: 3 hours   *Total Marks: 100*

Note: Attempt all questions. All question carries equal marks. Steam Table is allowed.

SECTION-A

1. **Attempt *all* questions in brief.**   **2 x10 = 20**

    (a) Explain the P-x-y diagram.

    (b) Define *first law of thermodynamics*.

    (c) Define Activity coefficients.

    (d) Differentiate between ideal and non-ideal solution.

    (e) Define 'Van't Hoff equation'.

    (f) Write Margules equation.

    (g) Define T-x-y diagram.

    (h) Define Triple point

    (i) What do you mean by Retrograde Condensation?

    (j) Define fugacity.

SECTION-B

2. **Attempt any *three* of the following:**   **10x3 = 30**

    (a) The excess enthalpy (heat of mixing) for a liquid mixture of species 1 and 2 at fixed T and P is represented by the equation:
    $$H^E = x_1x_2(40x_1 + 20x_2)$$
    Where H^E is in $Jmol^{-1}$, Determine expressions for $\underline{H_1}^E$ and $\underline{H_2}^E$ as function of x_1

    (b) Explain P-x-y and T-x-y diagram for azeotropic mixture.

    (c) Prove that if Raoult's law is valid for one constituent of a binary solution over the whole concentration range, it must also be applied to the other constituent.

    (d) Explain the concept of first law of thermodynamics and law of conservation of energy.

    (e) Derive the following:

    $$\ln K = \frac{-\Delta G^o}{RT}$$

SECTION-C

3. Attempt any *one* part of the following: 10x1 =10

   (a) What do you mean by 'Critical point for a pure substance'. Also discuss the virial expressions for compressibility factor Z.

   (b) Show that the internal energy of an incompressible substance is a function of temperature only, u = u(T).

4. Attempt any *one* part of the following: 10x1 =10

   (a) For pure liquid, derive the expression
$$fi = \varphi_i^{sat} \, P_i^{sat} \, exp[V_i^l(P-P_i^{sat})/RT]$$

   Where symbols have their usual meaning

   (b) Develop relation for equilibrium constants for gas phase reaction.

5. Attempt any *one* part of the following: 10x1 =10

   (a) A pump operating at 75% efficiency has an inlet specific enthalpy of 180 Btu/lbm. The exit specific enthalpy of the ideal pump is 600 Btu/lbm. What is the exit specific enthalpy of the actual pump?

   (b) Discuss P-T and P-V diagram for a pure substance.

6. Attempt any *one* part of the following: 10x1 =10

   (a) A mass of 200 g of saturated liquid water is completely vaporized at a constant pressure of 100 kPa. Determine the amount of energy transferred to the water.

   (b) Write short note on Gibbs-Duhem equation.

7. Attempt any *one* part of the following: 10x1 =10

   (a) Determine the fugacity coefficients for nitrogen (A) and methane (B) in a nitrogen-methane mixture at 200 K and 30 bar, if the mixture contains 40 moles% nitrogen.
   Experimental virial coefficient data are as follows:
   B_{11} = -35.2 B_{22} = -105.0 B_{12} = -59.8 cm^{2}mol^{-1}

   (b) Derive the fundamental property relation for single phase fluid system of variable mass and variable composition.