Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME- SEMESTER II– EXAMINATION – SUMMER 2015

Subject Code: 2721604 **Date:30/05/ 2015**

Subject Name: Property Prediction of Mixtures

Time: 2:30 PM – 5:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q-(1) **(a)** Derive the following equilibrium relationship for multi component distillation between F, V and L for complex mixtures: **(06)**

$$F_i \cdot P = L_i\left[P + P_i^{'}\left(\frac{V}{L}\right)\right]$$

All symbols used have conventional meanings.

(b) Show that the degree of vaporization (e) is 0.665 for a ternary feed system containing molar 10% propane, 65%, n-butane and 25% n-pentane to be vaporized at t=5 °C and P=600 mmHg. The value of equilibrium constants for phase equilibrium for propane, n-butane and n-pentane are K_1=6.34, K_2=1.37 and K_3=0.32 respectively. Drive also the relevant equation starting from the first principles. **(08)**

Q-(2) **(a)** Explain ñConcept of Hypothetical Ideal Gas Stateò with reference to calculations of any energy function at any temp(T) and any pressure(P). **(07)**

(b) Derive relevant generalized equation for $\Delta S^{'}_{T,P}$ under reduced state conditions using equation of state PV=ZRT. **(07)**

OR

(b) Derive relevant generalized equation for $\Delta H^{'}_{T,P}$ under reduced state conditions using equation of state PV=ZRT. **(07)**

Q-(3) Starting with following two equations: **(14)**

$$T \cdot dS = Cp \cdot dT - T\left.\frac{\delta V}{\delta T}\right)_P dP \text{ and } T \cdot dS = Cv \cdot dT + T\left.\frac{\delta P}{\delta T}\right)_V dV$$

Prove the following equations:

$$Cp \text{ ï } Cv = \text{ï } T\left(\frac{\delta V}{\delta T}\right)_P^2 \cdot \left(\frac{\delta p}{\delta v}\right)_T$$

and $$\frac{Cp}{Cv} = \frac{\left.\frac{\delta P}{\delta V}\right)_S}{\left.\frac{\delta P}{\delta V}\right)_T}$$

OR

Q-(3) Derive the following thermodynamic relationships for properties: **(14)**

(i) $$\frac{\partial C_P}{\partial P} = -T\frac{\partial^2 V}{\partial T^2}\Big)_P \;\&\; \frac{\partial C_V}{\partial V} = T\frac{\partial^2 P}{\partial T^2}\Big)_V$$

(ii) $$ds = \frac{C_V}{T}\cdot\frac{\partial T}{\partial P}\Big)_V dp + \frac{C_P}{T}\cdot\frac{\partial T}{\partial V}\Big)_P \cdot dv$$

(iii) $$C_P = \frac{[-V]}{\left[\frac{\partial T}{\partial P}\Big)_H - \frac{\partial T}{\partial P}\Big)_S\right]}$$

Q-(4) Answer the following:

(a) Using concept of Hypothetically Ideal Component (Carlson and Coulburn Method) how constants of Van Laarôs Equation could be determined conveniently ? **(07)**

OR

(a) Outline stepwise procedure in detail with relevant equations for calculation of H, S, U and G at any temp (T) and any pressure (P) under ideal gas conditions. **(07)**

(b) Using the Duhring Plot, explain estimation of viscosity of solutions. **(07)**

OR

(b) Derive and explain in detail, Falkenhagen relations. **(07)**

Q-(5) **(a)** Write a note on thermal conductivity for polyatomic gases and explain the effects of temperature and pressure on thermal conductivity in brief. **(07)**

OR

(a) Enlist the various empirical methods for liquid mixture viscosity estimation and explain any one in detail. **(07)**

(b) Explain in detail, the estimation of thermal conductivity for pure liquids. **(07)**

OR

(b) Explain estimation of viscosities of emulsions formed by immiscible liquids **(07)**

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