

Total No. of Questions :10]

SEAT No. :

**P2899**

[Total No. of Pages :4

[4958] - 1092

**T.E. (Chemical Engineering)**

**CHEMICAL ENGINEERING THERMODYNAMICS - II**

**(2012 Course) (Semester - I) (309345)**

*Time : 2½ Hours]*

*[Max. Marks :70*

*Instructions to the candidate:*

- 1) *Answer five questions.*
- 2) *Neat diagrams must be drawn wherever necessary.*
- 3) *Figures to the right indicates full marks.*
- 4) *Use of logarithmic tables, slide rule, Mollier Charts, Electronic pocket calculator and steam table is allowed.*
- 5) *Assume suitable data, if necessary.*

**Q1) a)** Explain the property changes of mixing for various thermodynamic properties. [6]

b) Explain and derive Chemical Potential as a criterion for phase equilibrium. [4]

OR

**Q2) a)** Derive the equation for Lawis/Randall Rule. [6]

b) Estimate a value for the fugacity of 1Butene vapor at 200°C and 70 bar. Where,  $T_r = 1.13$ ,  $P_r = 7.74$ ,  $\omega = 0.187$ ,  $\varphi^o = 0.620$  and  $\varphi^l = 1.095$ . [4]

**P.T.O.**

**Q3)** A Vapor-liquid equilibrium data for Chloroform

**[10]**

- a) and 1-4 Dioxane
- b) at 50°C is given below

P (kN/m <sup>2</sup> )	15.79	17.51	18.50	19.30	19.89	21.37	24.95	29.82	34.80	42.10	60.38	65.39	69.36
X <sub>1</sub>	0	0.093	0.125	0.176	0.200	0.263	0.361	0.475	0.555	0.672	0.878	0.940	1.00
Y <sub>1</sub>	0	0.179	0.238	0.330	0.369	0.463	0.418	0.755	0.838	0.914	0.986	0.994	1.00

Calculate  $\gamma_1, \gamma_2, G^E/RT, G^E/RTx_1x_2$  and plot  $\ln\gamma_1, \ln\gamma_2, GE/RT, G^E/RTx_1x_2$  vs  $x_1$ . Find the values of  $\ln\gamma_1^\infty, \ln\gamma_2^\infty$ .

OR

- Q4)** a) Explain the procedure for bubble temperature calculations. **[5]**
- b) For the binary system we have Wilsons constants  $A_{12}''=0.1258$  &  $A_{21}''=0.7292$

The Antonie equation is

$$\ln P_1^{\text{sat}} = 16.68 - (3640.2 / (T - 53.54))$$

$$\ln P_2^{\text{sat}} = 16.29 - (3816.44 / (T - 46.13))$$

Where T is in K and P is in kN/m<sup>2</sup>

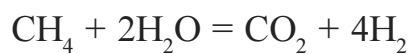
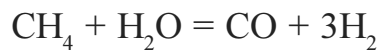
Assuming validity of modified Raoult's Law, Calculate pressure and vapor phase composition at T = 353 K and  $x_1 = 0.25$ . **[5]**

- Q5)** a) Explain the criteria of stability. **[8]**
- b) Derive Clausius Clapeyron equation. **[8]**

OR

- Q6) a)** Explain Osmotic pressure and derive the equation for osmotic pressure. **[8]**
- b) Explain criteria of phase equilibrium at constant parameters. **[8]**

- Q7) a)** For the following reactions obtain the relation between mole fraction & reaction coordinate.



Assume 2 moles of  $\text{CH}_4$ , 2 moles of  $\text{H}_2\text{O}$  and 3 moles of  $\text{H}_2$  initially present. **[6]**

- b) Derive the equation for equilibrium constant and effect of temperature on it. **[10]**

OR

- Q8) a)** n-Butane is isomerised to i-Butane by the action of catalyst at moderate temperature, it is found that the equilibrium is attend at the following compositions. **[8]**

Temp (k)	mole % of n-Butane
317	31.00
319	43.00

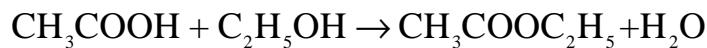
Assuming that, activities are equal to the mole function. Calculate the standard free energy of the reaction at 317 k and 319 K and average value of heat reaction over this temperature range.

- b) Derive the equation for relation between composition and reaction coordinate for multireaction system. **[8]**

- Q9)** a) Explain and derive the relation between equilibrium constant and composition in case of gas phase reactions. [6]
- b) Explain the Duhem's Theorem for reacting systems. [6]
- c) Explain in detail fuel cell with its types. [6]

OR

- Q10)**a) Explain and derive the relation between equilibrium constant and composition in case of liquid phase reactions. [6]
- b) Acetic acid is esterified in the liquid phase with ethanol at 100°C & at atmospheric pressure to produce ethyl acetate & water according to the reaction [8]



If initially there is 1 mole of each acetic acid and ethanol. Estimate the mole fraction of ethyl acetate in the reacting mixture at equilibrium with the help of following data

Component	$\Delta H^\circ_f_{298}$ (J/mol)	$\Delta G^\circ_{298}$ (J/mole)
CH <sub>3</sub> COOH	-484500	-389900
C <sub>2</sub> H <sub>5</sub> OH	-277690	-174780
CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub>	-463250	-318280
H <sub>2</sub> O	-285830	-237130

- c) Explain the phase rule for reacting systems. [4]

