

GUJARAT TECHNOLOGICAL UNIVERSITY
M. E. - SEMESTER – I • EXAMINATION – WINTER • 2013

Subject code: 711601N**Date: 23-12-2013****Subject Name: Advanced Thermodynamics****Time: 10.30 am – 01.00 pm****Total Marks: 70****Instructions:**

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

Q.1 (a) Discuss on the selection criteria of Lithium bromide-water vapor absorption refrigeration cycle with neat sketch **14**

Q.2 (a) Starting from first principle, derive an expression for Heat of Reaction for a reaction of type $a \cdot A + b \cdot B \rightleftharpoons c \cdot C + d \cdot D$ occurring at any temperature (T) and any pressure (P) under non-ideal conditions. **07**

(b) Describe with the help of appropriate data & equations and relevant graphs, the calculation of equilibrium conversion under adiabatic conditions for a reaction of type $A \rightleftharpoons B$ being highly reversible and endothermic in nature. **07**

OR

(b) A refinery gas contains of 50% Methane, 25% Ethylene, 15% Ethane and 10% Propylene by volume at a pressure of 10 bars. Calculate: Dew Temperature and Liquid composition. **07**

Q.3 (a) Explain in detail about the Liquid-Liquid Equilibrium with constant pressure solubility diagram? **07**

(b) Explain method for DEWP calculation with the help of block diagram and all supportive equations. **07**

OR

Q.3 (a) Derive the function for the solution of a P-T Flash calculation problem and explain the block diagram of P-T Flash calculations? **07**

(b) Explain calculations of equilibrium conversion values under isothermal conditions for the following two reactions proceeding simultaneously: **07**



Derive relevant equations for equilibrium constant (K) as a function of P, n_i & x_e . Also briefly describe stepwise procedure for calculation of values of x_e when both reactions proceed simultaneously.

Q.4 The free energy change under standard conditions for ethyl benzene to styrene and hydrogen is given by $\Delta G^\circ (\text{I}) = 29720 - 31.1 (T)$ and for ethyl benzene to benzene and ethylene reaction is given by $\Delta G^\circ (\text{II}) = 27550 - 33.03 (T)$. **14**

Calculate the values of X_e at 800 K and 1atm if both the reactions proceed simultaneously.

Note: τG° is in cal/gmol and T is in K.

OR

Q.4 The following isomerization reaction occurs in liquid phase: $A \rightarrow B$, where A and B are miscible liquids for which $G^E/RT = 0.1 x_A x_B$ **14**
 If $\Delta G^\circ_{298} = -1000 \text{ J/mol}$ what is the equilibrium composition of mixture at 25° C? How much error is introduced if one assumes that A and B form an ideal solution?

- Q.5** The following is a set of VLE data for system Methanol (1) / Water (2) at 331.15 K. **14**

P in kPa.	x_1	y_1
19.953	0.0000	0.0000
39.223	0.1686	0.5714
42.984	0.2167	0.6268
48.852	0.3039	0.6943
52.784	0.3681	0.7345
56.652	0.4461	0.7742
60.614	0.5282	0.8085
63.998	0.6044	0.8383
67.924	0.6804	0.8733
70.229	0.7255	0.8922
72.832	0.7776	0.9141
84.562	1.0000	1.0000

Calculating $\gamma_i = y_i P / x_i P_i^{\text{sat}}$, Find parameter values for the Margules equation that provide the best fit of G^E / RT to the data. Prepare the P-x-y diagram that compares the experimental points with the curves determined from the correlations.

Data: $P_1^{\text{sat}} = 84.562 \text{ kPa}$ and $P_2^{\text{sat}} = 19.953 \text{ kPa}$

$$\ln \gamma_1 = x_2^2 [A_{12} + 2(A_{21} - A_{12})x_1] \quad \& \quad \ln \gamma_2 = x_1^2 [A_{21} + 2(A_{12} - A_{21})x_2]$$

OR

- Q.5** Given a plant process that requires cooling of 54.5 m³/h of water from 12.6 to 70 °C, assume that the cooler heat transfer area will enable a 50°C differential between the chilled water leaving the cooler and the R-12 evaporating temperature. Also assume that the condenser heat transfer area enable a 50°C differential between the condenser water out and R-12 condensing temperature. Water is available for the condensing medium at 300°C inlet and 350°C outlet. Assume no liquid sub cooling or suction gas superheating. **14**

Find.

(a) Tons of refrigeration.	(b) Evaporator pressure.
(c) Condenser operating pressure.	(d) Refrigeration effect.
(e) Mass flow rate of R-12 circulated.	(f) Compression ratio.
(g) Coefficient of performance.	(h) Condenser water quantity.

DATA:

Exponential coefficient for isentropic compression of R-12 is $n = 1.19$.

Properties of R-12

T, K	P, bar	h_l , kJ/kg	h_g , kJ/kg
260	1.959	387.7	546.1
270	2.784	397	550.7
280	3.825	406.5	555.1
290	5.184	416.1	559.4
300	6.84	426	563.5
310	8.86	436	567.3
320	11.29	446.2	570.9

Specific heat of water = 4.1868 kJ / (kg.°C)

Specific heat of R-12 in gas phase = 0.25 kJ / (kg.°C)
