

GUJARAT TECHNOLOGICAL UNIVERSITY**M.E Sem-I Examination January 2010****Subject code: 711601****Subject Name: Advanced Thermodynamics****Date: 20 / 01 / 2010****Time: 12.00 – 2.30 pm****Total Marks: 60****Instructions:**

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

Q.1 Explain with neat sketch Lithium bromide-water vapour absorption cycle. Also discuss about the selection criteria of this refrigeration cycle. **12**

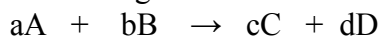
Q.2 (a) For 200 kw (56.869 TR) ammonia – water absorption refrigeration plant determine the followings: **06**

- i) Flow rate of ammonia required in cycle. Consider 2.5% heat loss. Evaporation temperature in chiller is - 10° C.
- ii) Calculate heat duty of absorber. Heat of solution of ammonia is 2000 kJ/kg NH₃.
- iii) Calculate heat duty of condenser of distillation column. Reflux ratio of distillation column is 0.3137. Condensation temperature of ammonia vapour in condenser is 40° C.
- iv) Calculate the heat duty of generator (reboiler) of distillation column.
- v) Calculate the COP.

Data

<u>Temperature C</u>	<u>Enthalpy kJ/kg.</u>	
	Liquid	Vapour
- 10	301.4	1597.8
40	538.5	1637.2

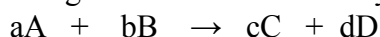
(b) With reference to a generalized reaction of type. **06**



evaluate equilibrium constant for chemical reaction equilibrium from basic thermodynamics data, ΔH_f° , ΔG_f° and C_p equations. Derive the necessary equation from first principles.

OR

(b) With reference to generalized reaction of type. **06**



evaluate heat of reaction at any temperature T and pressure P under nonideal conditions. Derive the necessary equation from first principles.

Q.3 Explain method for DEWP calculation with the help of block diagram and all supportive equations. **12**

OR

Q.3 Explain method for DEWT calculation with the help of block diagram and all supportive equations. **12**

Q.4 A feed stock of n-butane is cracked at 750 K and 1.2 bar to produce olefins. Only two reactions have favourable equilibrium conversions at these conditions. **12**

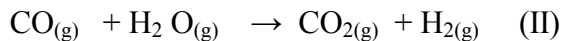
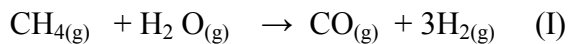


If these reactions reach equilibrium what is product composition? At 750 K equilibrium constants for both reactions are

$$K_{\text{I}} = 3.856, \quad K_{\text{II}} = 268.4$$

OR

Q.4 Synthesis gas for methanol may be produced by the catalytic reforming of methane with steam. **12**



$$K_{\text{I}} \text{ at } 1300 \text{ K} = 13.845$$

$$K_{\text{II}} \text{ at } 1300 \text{ K} = 0.5798$$

Assume equilibrium is attained for both reactions at 1 bar and 1300 K.

- Would it be better to carry out the reaction at pressure above 1 bar?
- Would it be better to carry out the reaction at a temperature below 1300 K. Reaction (I) is endothermic and reaction (II) is exothermic.
- Estimate the molar ratio of H_2 to CO in the synthesis gas if the feed consists of an equimolar mixture of steam and methane.
- Repeat part (iii) for a steam to methane mole ratio in the feed of 2.

Q.5 The following isomerization reaction occurs in liquid phase: $\text{A} \rightarrow \text{B}$, where A and B are miscible liquids for which **12**

$$\frac{G^{\text{E}}}{RT} = 0.1 x_{\text{A}} x_{\text{B}}$$

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?

OR

Q.5 A feed to a column has the composition given in the table below, and is a pressure of 14 bar and a temperature 60° C. Based on calculations verify that the given mixture is a Vapour-liquid mixture at given conditions. **12**

Feed	kmol/h	Ki
ethane	20	3.8
propane	20	1.3
isobutene	20	0.43
n-pentane	<u>20</u>	0.16
	<u>80</u>	

Also determine the flow rates and composition of vapour and liquid phases.
