Q. Code: 847703

Reg. No. | | | | | | | | | |

B.E. / B.TECH. DEGREE EXAMINATIONS, DEC 2019

Fifth Semester

CH16502 – CHEMICAL ENGINEERING THERMODYNAMICS II

(Chemical Engineering)

(Regulation 2016)

Time: Three Hours **Maximum : 100 Marks**

Answer **ALL** questions

PART A - (10 X 2 = 20 Marks)

		CO	RBT
1.	State Henrys law and gas solubility.	**1**	**U**
2.	Write the formula that directly relates the partial molar excess Gibbs free energy with the activity coefficient.	**1**	**U**
3.	Define fugacity.	**2**	**R**
4.	How does the tie line help in determining the amount of liquid and vapour in equilibrium?	**2**	**U**
5.	Mention the coexistence equation and its major applications.	**3**	**R**
6.	List the importance of UNIQUAC equation.	**3**	**U**
7.	What is the criterion for chemical reaction equilibria?	**4**	**U**
8.	Relate the standard free energy change and the equilibrium constant K.	**4**	**U**
9.	State COP and its applications.	**5**	**U**
10.	List the points that have to be considered while choosing a refrigerant.	**5**	**U**

PART B - (5 X16 = 80 Marks)

11.	(a)	(i)	Explain the tangent-intercept method for determination of partial molar properties of both components in a binary solution.	**(8)**	**1**	**U**
		(ii)	A 40 per cent by mole methanol-water solution is to be prepared. How many cubic metres of pure methanol (molar volume, 40.727×10^{-6} m^3 / mol) and pure water (molar volume, 18.068×10^{-6} m^3 / mol) are to be mixed to prepare $3m^3$ of the desired solution? The partial molar volumes of methanol and	**(8)**	**1**	**AN**

water in a 40 percent solution are 38.632×10^{-6} m^3 / mol and 17.765×10^{-6} m^3 / mol, respectively.

(OR)

	(b)	(i)	Derive the Gibbs-Duhem equation and its various forms.	**(8)**	**1**	**U**
		(ii)	The Henry's law constant for oxygen in water at 298K is 4.4×10^4 bar. Estimate the solubility of oxygen in water at 298K for a partial pressure of oxygen at 0.25 bar.	**(8)**	**1**	**AN**
12.	(a)	(i)	With neat sketches explain the T-x-y diagram for a partially miscible binary mixture and T-x-y diagram for an immiscible system.	**(16)**	**2**	**AN**

(OR)

	(b)	The vapor pressures of acetone (1) and acetonitrile(2) can be evaluated by the Antoine equations $\ln P_1^S = 14.5463 - \{2940.46 / (T - 35.93)\}$ $\ln P_2^S = 14.2724 - \{2945.47 / (T - 49.15)\}$ where T is in K and P is in kPa. Assuming that the solutions formed by these are ideal , calculate (a) x_1 and y_1 at 327K and 65kPa (b) T and y_1 at 65kPa and $x_1 = 0.4$ (c) P and y_1 at 327K and $x_1 = 0.4$ (d) T and x_1 at 65kPa and $y_1 = 0.4$	**(16)**	**2**	**AN**

13.	(a)	(i)	Explain in detail the consistency tests for VLE data using Slope of ln γ Curves	**(8)**	**3**	**AN**
		(ii)	Liquids A and B form an azeotrope containing 46.1 mole percent A at 101.3 kPa and 345K. At 345K, the vapour pressure of A is 84.8 kPa and that of B is 78.2 kPa. Calculate the van Laar constants.	**(8)**	**3**	**AN**

(OR)

	(b)	From the vapour – liquid equilibrium measurements for ethanol-benzene system at 318K and 40.25 kPa it is found that the vapour in equilibrium with a liquid containing 38.4% (mol) benzene contained 56.6% (mol) benzene. The system forms an azeotrope at 318K. At this temperature , the vapour pressures of ethanol and benzene are 22.9 and 29.6 kPa respectively. Determine the composition and total pressure of the azeotrope. Assume that van Laar equation is applicable for the system.	**(16)**	**3**	**AN**

14.	(a)	n-butane is isomerized to i-butane by the action of catalyst at moderate temperatures. It is found that the equilibrium is attained at the following compositions (at 317K, 31 mol % n-butane and at 391K, 43 mol % n-butane). Assuming that activities are equal to the mole fractions, calculate the standard free energy of the reaction at 317K and 391K and the average value of heat of reaction over this temperature range.	**(16)**	**4**	**AN**
		(OR)			
	(b)	In the synthesis of ammonia, stoichiometric amounts of nitrogen and hydrogen are sent to a reactor where the following reaction occurs $N_2 + 3H_2 \longrightarrow 2NH_3$ The equilibrium constant for the reaction at 675K may be taken equal to 2×10^{-4}. Determine the percent conversion of nitrogen to ammonia at 675K and 20 bar.	**(16)**	**4**	**AN**
15.	(a)	With a neat sketch explain the Claude liquefaction process.	**(16)**	**5**	**U**
		(OR)			
	(b)	A house has a winter heating requirement of 30 kJ/s and a summer cooling requirement of 60 kJ/s. Consider a heat-pump installation to maintain the house temperature at 20ºC(293.15K) in winter and 25ºC (298.15K) in summer. This requires circulation of the refrigerant through interior exchanger coils at 30ºC (303.15K) in winter and 5ºC (278.15K) in summer. Underground coils provide the heat source in winter and the heat sink in summer. For a year-round ground temperature of 15ºC (288.15K), the heat transfer characteristics of the coils necessitate refrigerant temperatures of 10ºC (283.15K) in winter and 25ºC (298.15K) in summer. What are the minimum power requirements for winter heating and summer cooling?	**(16)**	**5**	**AN**