Reg. No.



MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal)

# **IV SEMESTER B.TECH. (CHEMICAL ENGINEERING)**

## **ENDSEM EXAMINATIONS, APR 2018**

SUBJECT: CHEMICAL ENGINEERING THERMODYNAMICS-II [CHE 2201]

### REVISED CREDIT SYSTEM (17/04/2018)

Time: 3 Hours

#### MAX. MARKS: 50

### Instructions to Candidates:

- ✤ Answer ALL the questions.
- ✤ Missing data may be suitable assumed.

1A.	Calculate the fugacity of a component at 400 bar and 273 K from the following data.								
	P, bar	25	50	100	200	400	800	1000	05
	Ζ	0.9890	0.9792	0.9741	1.0196	1.2482	1.8057	2.0819	05
18	The molar volume of a binary solution at constant temperature and pressure is given								
ID.	by the relation								
	$V = 1000x_2 + 500x_1 + (40x_2 + 50x_1)x_1x_2$								04
	where V is in m <sup>3</sup> . Determine $\overline{V_1}$ as a function of $x_1$ and the numerical value of pure								
	component volume of component 1.								
1C.	Define the terms: residual volume, chemical potential.								01
2A.	For a mixture of acetic acid and toluene containing 0.486 mole fraction toluene, the								
	partial pressures of acetic acid and toluene are found to be 0.118 bar and 0.174 bar								
	respectively at 343 K. The vapour pressures of pure components at this temperature are 0.269 bar and 0.181 bar for toluene and acetic acid respectively. The Henry's law constant for acetic acid and toluene are 0.55 bar and 0.15 bar respectively. Calculate								
									04
	the activity and activity coefficient for toluene in the mixture (a) based on Lewis-								
	Kandali rule (b) based on Henry s law.								
2B.	Distinguish between ideal gaseous solution and ideal gaseous mixture.								01
2C.	Derive the different forms of Gibbs-Duhem equation.								05
30	Mixtures of n-pentane(1) and n-heptane(2) conform to ideal solution behavior. The								
54.	vapour pressures of components are adequately described by the Antoine equation.								
	$\log_{10} P = A - \frac{B}{T+C}$								
	Calculate the T-x-y data (3 sets of data) at a pressure of 760 Torr.								05
		A B C							
	n-pentane	e(1)	6.87632		1075.780		233.205		
	n-Heptan	e(2)	6.89386		1264.370		216.640		
3B.	The vapour pressures of acetone(1)- acetonitrile(2) are given as 85.12 kPa and 39.31								
00.	kPa at 327 K. Assuming that the solution formed are ideal, calculate $x_1$ and $v_2$ at								02

	327K and 65 kPa and find P and $y_1$ at 327K and $x_1=0.4$ .										
3C.	With the help of phase diagrams, explain minimum boiling azeotrope.									03	
4A.	The follo thermody $x_1$ $y_1$ P, kPa	wing da namic c 0 0 24.46	ta refer t onsisten 0.141 0.507 46.52	o the VL cy using 0.304 0.531 48.32	E of a bi zero area 0.468 0.543 48.73	nary syst a method 0.643 0.566 48.81	em at 31 0.750 0.578 47.65	3 K. Ch 0.915 0.753 42.99	1.00         1.000         35.12		06
4B. 5A.	Carbon to and $t=64$ Antoine of $\log_{10} P =$ CCl <sub>4</sub> (1) Acetono N <sub>2</sub> + 3H	$\frac{\text{ide}(1) - \text{e}}{\text{for the s}}$ for the s $\frac{1}{2 - c}$ $6.8$ $8.1$ action rep	thanol(2) van Laa system is A 4083 1220 presents	) forms as ar model j given ar the amme	n azeotrope at 760 To predict the P-x-y data ad the constants are B 1177.910 1592.864 onia synthesis			orr where $x_1 = 0.6130$ (2 sets of data). The C 220.576 226.184		04	
	The feed stream consists of 1 mol $N_2$ , 3 mol $H_2$ and 2 mol inert material. The temperature and pressure of the reaction are 675 K and 20 bar. The equilibrium constant for the reaction is $2 \times 10^{-4}$ . What is the equilibrium conversion for the reaction?									04	
5B.	The equilibrium constant at 420 K for the vapour phase hydration of ethylene to ethanol according to the reaction $C_2H_4 + H_2O \rightarrow C_2H_5OH$ is $6.8 \times 10^{-2}$ and the standard heat of reaction at 298 K is $-45.95 \times 10^3$ J. The specific heat data is as follows. $\boxed{C_p, J/\text{mol K}}$ Ethylene $11.886 + 120.12 \times 10^{-3}T - 36.649 \times 10^{-6}T^2$ Water $30.475 + 9.652 \times 10^{-3}T + 1.189 \times 10^{-6}T^2$ Ethanol $29.358 + 166.9 \times 10^{-3}T - 50.09 \times 10^{-6}T^2$ Formulate general relationships for estimating the equilibrium constant and standard free energy change as functions of temperature.									06	