Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

IV SEMESTER B.TECH (CHEMICAL ENGINEERING)

END SEMESTER MAKEUP EXAMINATIONS, JUN/JUL 2017

SUBJECT: CHEMICAL ENGINEERING THERMODYNAMICS-II [CHE 2201]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 100

Instructions to Candidates:

- Answer **ALL** questions.
- Missing data, if any, may be suitably assumed.

1A.	Determine the fugacity of a component at 150°C and 100 bar from the given data. P, bar: 10, 20, 40, 60, 80, 100 Z: 0.985, 0.970, 0.942, 0.913, 0.885, 0.869	**11**
1B.	The molar enthalpy of a component in a binary solution is given by the relation $H = (0.01x_1x_2)(3x_1 + 5x_2)$ Where H is in J/mol. Determine $\overline{H_1}$ as function of x_2 and the numerical values of the pure component enthalpy H_1.	**09**
2A.	Check whether the following equations satisfy Gibbs- Duhem equations. $ln\gamma_1 = Ax_2^2 + Bx_2^2(3x_1 - x_2)$ $ln\gamma_2 = Ax_1^2 + Bx_1^2(x_1 - 3x_2)$	**10**
2B.	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 constant for acetic acid is 0.55 bar. Calculate the activity and activity coefficient for acetic acid in the mixture (i) Based on Lewis –Randall rule. (ii) Based on Henry's law.	**06**
2C.	Derive the expression for the effect of pressure on activity coefficient.	**04**
3A.	Discuss the step by step procedure for the construction of P-x-y diagram, for an ideal solution having two components.	**09**
3B.	Explain positive and negative deviation from ideality with the help of P-x-y diagram.	**06**

3C.	The vapour pressures of acetone (1)- acetonitrile (2) is given by Antoine equations. $lnP_1^s = 14.5463 - \frac{2940.46}{T-35.93}$ $lnP_2^s = 14.2724 - \frac{2945.47}{T-49.15}$ where T is in K and P is in kPa. Assuming the solutions formed are ideal. Calculate T and y_1 at 65 kPa and x_1=0.4	**05**
4A.	Verify whether the following data are consistent by zero area method. <table><tr><td>x_1</td><td>0</td><td>0.2</td><td>0.4</td><td>0.6</td><td>0.8</td><td>1.0</td></tr><tr><td>γ_1</td><td>0.576</td><td>0.655</td><td>0.748</td><td>0.856</td><td>0.950</td><td>1.00</td></tr><tr><td>γ_2</td><td>1.00</td><td>0.985</td><td>0.930</td><td>0.814</td><td>0.626</td><td>0.379</td></tr></table>	**10**
4B.	From VLE measurements for ethanol-benzene system at 318 K 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 318 K. 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.	**10**
5A.	A gas mixture containing 25% CO, 55% H_2 and 20% inert gas is to be used for methanol synthesis. The gases are passed to a catalyst chamber where the following reaction takes place $CO\ (g)\ + 2H_2(g)\ \rightarrow CH_3OH\ (g)$ at a pressure of 300 bar and temperature of 625 K. Assume that the equilibrium mixture forms an ideal solution and k_f and k_ϕ are 4.9×10^{-5} and 0.35 respectively. What are the composition of all the components?	**10**
5B.	For the vapour phase hydration of ethylene to ethanol according to the reaction $C_2H_4 + H_2O \rightarrow C_2H_5OH$ the standard heat of reaction at 298 K is -45.95×10^3 J and the equilibrium constant at 298 K is 14.86 The specific heat data is as follows. <table><tr><td></td><td>c_p, J/mol K</td></tr><tr><td>Ethylene</td><td>$11.886 + 120.12 \times 10^{-3}T - 36.649 \times 10^{-6}T^2$</td></tr><tr><td>Water</td><td>$30.475 + 9.652 \times 10^{-3}T + 1.189 \times 10^{-6}T^2$</td></tr><tr><td>Ethanol</td><td>$29.358 + 166.9 \times 10^{-3}T - 50.09 \times 10^{-6}T^2$</td></tr></table>Calculate the values of integration constants.	**08**
5C.	List out the assumptions used for the establishment of vapour-liquid equilibrium in ideal solutions.	**02**