Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

IV SEMESTER B.TECH (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, APR/ MAY 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.	Calculate the fugacity of a component at 800 bar from the following data at 273 K. P, bar: 50, 100, 200, 400, 800, 1000 Z: 0.9846, 0.9846, 1.0365, 1.2257, 1.7959, 2.0641	**09**
1B.	Give the definition of chemical potential.	**02**
1C.	The molar volume of a binary solution at constant T and P is given by the relation $V = 120x_1 + 70x_2 + (15x_1 + 8x_2)x_1x_2$ where V is in m^3/mol. Determine the expression for $\overline{V_2}$ as a function of x_2 and get the value of $\left(\frac{d\overline{V_2}}{dx_2}\right)_{x_2=1}$.	**09**
2A.	The activity coefficient of component 1 in a binary solution is given by $ln\gamma_1 = ax_2^2 + bx_2^3 + cx_2^4$ Where a, b and c are constants independent of concentrations. Obtain an expression for γ_2 in terms of x_1.	**07**
2B.	(i) Raoult's law is a simplified form of Lewis-Randall rule. Justify the statement. (ii) Distinguish between ideal gaseous mixture and ideal gaseous solution.	**06**
2C.	Derive the different forms of Gibbs-Duhem equation.	**07**
3A.	Assuming that 2-propanol (1) and 1-propanol (2) forms an ideal solution, predict the P-x-y data (any 3 set of data) at 90°C. Given the Antione's constants for the components. 2-Propanol (1): A = 8.87829, B = 2010.330, C = 252.636 1-Propanol (2): A = 8.37895, B = 1788.020, C = 227.438	**08**
3B.	Explain maximum boiling azeotrope, with the help of phase diagrams.	**07**

3C. Discuss the effect of increasing pressure on the boiling point diagram. **05**

4A. Calculate the constants van Laar constants A and B from the following data. Check whether the data are consistent by mid-point method. **12**

x_1	0.28	0.40	0.60	0.675
y_1	0.420	0.516	0.656	0.710
T, K	331.5	330.4	329.3	328.3
P_1^s , kPa	109.16	104.77	101.17	97.70
P_2^s , kPa	77.17	73.44	69.98	67.04

Assume P = 101.3 kPa.

4B. Ethanol- water mixture forms an azeotrope boiling at 351.4 K under a pressure of 101.3 kPa and its composition is 89.4% (mol) ethanol. The vapour pressures of ethanol and water at 351.4 K are 100 kPa and 44 kPa respectively. Using the van Laar equation, calculate the van Laar constants and calculate the activity coefficients of the components in a solution containing 80% ethanol. **08**

5A. The equilibrium constant at 298 K for the vapour phase hydration of ethylene to ethanol according to the reaction **08**

$C_2H_4 + H_2O \rightarrow C_2H_5OH$

is 14.86 and the equilibrium constant at 420 K is 6.8×10^{-2} . The specific heat data is as follows.

	c_p, J/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	$29.358 + 166.9 \times 10^{-3}T - 50.09 \times 10^{-6}T^2$

Determine the values of integration constants.

5B. A gas mixture consisting of 60% H_2, 20% N_2, and the rest inert gas is passed over a suitable catalyst for the production of ammonia **12**

$\frac{1}{2}\ N_2\ + \frac{3}{2}\ H_2 \rightarrow NH_3$

The equilibrium constant is $k = 1.25 \times 10^{-2}$. The pressure is maintained at 50 bar. Assume ideal gas behavior for the gas mixture. Determine the values of mole fractions of all the components. Discuss on the effect of adding inert gas in the feed mixture.