Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

IV SEMESTER B.TECH. (CHEMICAL ENGINEERING)

MAKEUP EXAMINATIONS, JUN 2018

SUBJECT: CHEMICAL ENGINEERING THERMODYNAMICS-II [CHE 2201]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A.	Calculate the fugacity of nitrogen 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, 1.2557, 1.7959, 2.0641	**04**
1B.	The molar volume of a binary liquid mixture is given by $90 \times 10^{-3}x_1 + 50 \times 10^{-3}x_2 + x_1x_2(6 \times 10^{-3}x_1 + 9 \times 10^{-3}x_2)$ Obtain the expressions for $\overline{V_1}$ in terms of x_2.	**04**
1C.	Derive the expression for showing the effect of temperature on fugacity.	**02**
2A.	Derive an expression for fugacity of a gas following RK equation of state given by $P = \frac{RT}{V-b} - \frac{a}{(V+b)V}$ where a and b are empirical constants.	**04**
2B.	Check whether the given equations satisfy Gibbs Duhem equation. $ln\gamma_1 = 500 + 140x_1 - 60x_1x_2 - 20x_2^2 + 20x_1x_2^2$ $ln\gamma_2 = -120x_2 + 90x_2 - 90x_1x_2 - 20x_2^2 + 20x_1x_2^2$ (Note: The final answer on both sides of the Gibbs Duhem equation should be in terms of x_1.)	**04**
2C.	Define Raoult's law, Lewis-Randal rule and Henry's law.	**02**
3A.	Discuss the effect of temperature on the P-x-y diagram.	**02**
3B.	2-propanol and 1-propanol forms an ideal solution. Calculate the T-x-y data (3 sets of data) at 760 Torr. The Antoine equation is given as $\log_{10} P = A - \frac{B}{T+C}$ A: 2-propanol (1): 8.87829; 1-propanol (2): 8.37895 B: 2-propanol (1): 2010.330; 1-propanol (2): 1788.020 C: 2-propanol (1): 252.636; 1-propanol (2): 227.438	**05**
3C.	Discuss positive and negative deviation from ideality with the help of phase diagrams.	**03**

<table>
<tr><td>4A.</td><td>The activity coefficient and mole fraction data for the system acetone (1)-dichloroethylene (2) given below. Check their thermodynamic consistency by midpoint method.
<table>
<tr><td>x_1</td><td>0.023</td><td>0.053</td><td>0.357</td><td>0.516</td><td>0.883</td><td>0.979</td></tr>
<tr><td>γ_1</td><td>0.608</td><td>0.711</td><td>0.854</td><td>0.917</td><td>0.987</td><td>1.0</td></tr>
<tr><td>γ_2</td><td>0.993</td><td>0.974</td><td>0.934</td><td>0.891</td><td>0.781</td><td>0.694</td></tr>
</table></td><td>05</td></tr>
<tr><td>4B.</td><td>Construct the P-x-y diagram for cyclohexane(1)- benzene(2) system at 313 K given that at 313 K the vapour pressures are P_1^S=24.62 kPa and P_2^S=24.41 kPa. The liquid phase activity coefficients are given by $\ln \gamma_1 = 0.458x_2^2$, $\ln \gamma_2 = 0.458x_1^2$.</td><td>05</td></tr>
<tr><td>5A.</td><td>A gas mixture containing 25% CO, 55% H_2, and 20% inert gas is to be used for methanol synthesis. The gases enters the reactor as per the following reaction
$CO(g) + 2H_2(g) \rightarrow CH_3OH\ (g)$
at a pressure of 300 bar and temperature of 625 K. Assume that the equilibrium mixture forms an ideal solution and k and $k_\emptyset$ are 4.9×10^{-5} and 0.35 respectively. What is the conversion of CO and equilibrium composition of all the components?</td><td>05</td></tr>
<tr><td>5B.</td><td>Starting with Lechatelier’s principle, derive van’t Hoff equation for showing the effect of temperature on equilibrium constant.</td><td>05</td></tr>
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