Reg.No.										

MANIPAL UNIVERSITY

First Semester M.Tech.(Chemical Engg.) End - Semester Examinations, NOV/DEC 2015

ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS (CHE - 501)

TIME: 3 HOURS **December 01, 2015** **MAX. MARKS: 100**

Instructions to candidates:

- **Answer any FIVE FULL questions**
- **Missing data, if any, may be suitably assumed**

1A.	Define: Partial molar property. What is the thermodynamic importance? Explain the graphical procedure for its determination. Derive the analytical equations for its calculation from the graph. Show that the analytical equations are thermodynamically consistent.	**(10)**
1B.	Explain the various *thermodynamic parameters* that are used for characterizing non-ideal behavior of (i) pure gas (ii) gas mixture (iii) liquid solutions. Give the defining equations using the standard notations. Show them in a graph wherever possible.	**(10)**
2.	The vapour pressures of Benzene (1) and Toluene (2) are given by: **$\log_{10}[P^{sat}] = A - B/(t+C)$;** P is in torr, t is in deg C. (i)Prepare a T-x-y diagram at 101.3 kPa and label the phase fields, bubble and dew point lines. (ii) Prepare the corresponding (x-y) diagram. List the assumption that you make. Comment on results. Antoine constants are:	**(20)**

	A	**B**	**C**
Benzene(1)	**6.87987**	**1196.76**	**219.161**
Toluene(2)	**6.95087**	**1342.31**	**219.187**

<table>
<tr><td>3.</td><td>Explain the various data sources available for calculation of the thermodynamic properties of real gases such as Z, H and S. Describe the generalized correlations available for the calculation of Z, H and S giving relevant equations and graphs and range of application.</td><td>(20)</td></tr>
<tr><td>4.</td><td>Test the thermodynamic consistency of the following data using the (i) differential (ii) integrated forms of Gibbs-Duhem equations

<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>1.000</td></tr>
<tr><td>γ_2</td><td>1.000</td><td>0.985</td><td>0.930</td><td>0.814</td><td>0.626</td><td>0.379</td></tr>
</table></td><td>(20)</td></tr>
<tr><td>5A.</td><td>Benzene(1) –Cyclohexane(2) form an azeotrope at 0.525 mole fraction benzene at a temperature of 350.8K and 101.3kPa. At this temperature , the vapour pressure of benzene is 99.3 kPa and that of cyclohexane is 98 kPa. Using van Laar model estimate the activity coefficients at x1= 0.2 and 0.9</td><td>(08)</td></tr>
<tr><td>5B.</td><td>Determine the equilibrium composition in case of the following simultaneous reactions. Feed contains : 2 mol A and 1 mol B. Temperature = 1500 K, Pressure = 10 bar. What is the assumption you make to solve the problem?. Show the details of the mathematical procedure used

A+B $\rightarrow$C+D …..(1) K_1= 2.67

A+C$\rightarrow$ 2E ….. (2) K_2= 3.20</td><td>(12)</td></tr>
<tr><td>6A.</td><td>Derive the condition (criterion) for: (i) VLE in a multicomponent system (ii) Chemical reaction equilibrium. Give the relevant graphs also.</td><td>(10)</td></tr>
<tr><td>6B.</td><td>Derive an equation for the standard Gibbs free energy of reaction at a temperature T. (i) How will you evaluate the constants in the equation (ii)How will you use the equation to determine the spontaneity of a reaction ?</td><td>(10)</td></tr>
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