Reg. No.										

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

II SEMESTER B.S. DEGREE EXAMINATION – NOV. / DEC. 2016

SUBJECT: CHEMICAL ENGINEERING THERMODYNAMICS (CHM 122)

(BRANCH: CHEMICAL)

Wednesday, 14 December 2016

Time: 3 Hours **Max. Marks: 100**

- ✓ **Answer ANY FIVE FULL Questions.**
- ✓ **Missing data, if any, may be suitably assumed and the same properly indicated.**

1A. What are the 4 basic thermodynamic processes?. Derive an expression for the work done in the case of an ideal gas undergoing (i) isobaric process (ii) isentropic process

1B. Explain the following by giving examples and using a PV diagram:

(i) Properties, state, path and process

(ii) State and Path functions

(iii) Reversible and Irreversible process **(10+10)**

2A. Derive the modified equations for internal energy and enthalpy and apply them to an ideal gas.

2B. What is compressibility factor? What are its applications? Give the outlines of a compressibility factor chart. How will you generalise this chart? **(10+10)**

3 Two liquids P and Q form an azeotrope containing 89.4 mol % P at 101.3kPa pressure. At the azeotropic temperature of 351.4 K, the vapour pressures of P and Q are 100kPa, 44kPa respectively. Construct the VLE (**x-y**) diagram. List the assumptions you make. **20 Marks**

4A. Explain: Redlich-Kwong equation of state.

4B. Define: Fugacity coefficient and Activity coefficient. What are their applications in VLE and chemical equilibrium calculations? Explain

4C. Distinguish: Ideal gas and Ideal liquid solution. Explain the various models used for ideal gas mixture and ideal solution giving the relevant equations and represent them graphically. **(4+6+10)**

5A. .

From the data on activity coefficient versus mole fraction for the system acetone (1) –dichloroethylene (2) given below, check their thermodynamic consistency.

x_1	0.023	0.053	0.357	0.516	0.883	0.979
γ_1	0.608	0.711	0.854	0.917	0.987	1.0
γ_2	0.993	0.974	0.934	0.891	0.781	0.694

5B. Explain: Redlich-Kister equation.

5C. Draw the T-x-y diagram for partially miscible system and label the phase fields. **(12+3+5)**

6A Estimate the fugacity of gaseous propane at 12 bar and 310K using the following data:

(i) Assuming ideal gas behaviour
(ii) Using the following PVT data:

P(bar)	1.7	3.4	6.8	10.2	11.7	13.6
V(m3/kg)	0.3313	0.1609	0.0754	0.0468	0.0382	0.021

6B. Give the complete definition of fugacity in case of (i) a pure component i (ii) component i in solution (iii) solution as a whole **(14+6)**

7A. Explain: van't Hoff's isotherm, van't Hoff's isobar

7B. For the reaction : $SO_2(g) + ½\ O_2(g) \rightarrow SO_3(g)$ in equilibrium at 775K, what pressure is required for a 90% conversion of SO_2,if the initial mixture is equimolar in the reactants. Free energy of the reaction at 775K is (-2.8626×10^4 J).Assume ideal gas behaviour. **(8+12)**

8A. Derive the summation form of Gibbs-Duhem equation from the fundamentals for a binary system of components 1 and 2. Represent the equation in terms of various thermodynamic functions. What are applications and limitations of these equations?

8B. Explain: Molar Property change of mixing, Molar excess properties and Molar residual properties **(14+6)**