Reg. No.										

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

II SEMESTER B.S. DEGREE EXAMINATION – JUNE 2016

SUBJECT: CHEMICAL ENGINEERING THERMODYNAMICS (CHM 122)

(BRANCH: CHEMICAL)

FRIDAY, 17th JUNE, 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 basic characteristics of an ideal gas?. Derive an expression for the work done in the case of an ideal gas undergoing (i) isothermal process (ii) isochoric process **10**

1B. Discuss the following equations of state:

(i) Virial equations in terms of volume (ii) Virial equations in terms of pressure

(ii) Redlich-Kwong equation **10**

2A. Derive the TdS equations and apply them to an ideal gas undergoing a general process. **10**

2B. Derive an equation for the fugacity of a vander Waal gas **10**

3. The binary system acetone(1)-acetonitrile(2) obeys Raoult's law.Using the vapour pressure data given below plot the following: *T-x_1 and T-y_1 curves at 53.32kPa* **20**

T, K	311.45	315	319	323	327	331	335.33
P_1,^{sat},kPa	53.32	61.01	70.91	81.97	94.36	108.2	124.95
P_2,^{sat},kPa	21.25	24.61	28.90	33.79	39.35	45.62	53.32

4A. Explain: Partial molar properties. Describe the graphical method of determination of partial molar properties with a neat diagram. Hence derive the equation for the determination of partial molar properties. Show that these equations are thermodynamically consistent. **14**

4B. Explain: Raoult's law, Lewis Randall rules, Henry's law. Give the equations and show them graphically also. **06**

5A. Assuming Raoult's law to be valid for the system benzene (1)-ethyl benzene (2) and the vapour pressure are given by the Antoine equations: **15**

$\ell n\, P^{sat} = A - B / (T - C)$; P^{sat} is vapour pressure is in kPa , T is in K

Components	A	B	C
Benzene(1)	13.8858	2788.51	52.41
Ethyl Benzene(2)	14.0045	3279.47	60.00

Construct the following:
(i) The ***T-x-y*** diagram at 101.3 kPa.
(ii) The isobaric VLE diagram ***(x-y)*** at 101.3kPa

5B. Draw the T-x-y diagram for an immiscible system and label the phase fields. **05**

6A The equilibrium constant at 420K for the vapour-phase hydration of ethylene to ethanol according to the reaction: $C_2H_4 + H_2O = C2H5OH$ is $6.8 \times 10^{(-2)}$ and the standard heat of reaction at 298K is (-45.95×10^3 J). The specific heat data are as follows: Cp (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 :	$29.358 + 166.9 \times 10^{-3}\, T - 50.09 \times 10^{-6}\, T^2$

Formulate a generation equation for estimating the equilibrium constant and standard Gibb's free energy change as functions of temperature, **16**

6B. Explain the various types of equilibrium constants that you have studied. **04**

7. An alcohol (1) and water(2) form an azeotrope containing 42 mol % water at 101.3 kPa pressure. At the azetopic composition the vapour pressures of alcohol and water are 200kPa, 125.3kPa respectively. Construct the VLE (x-y) diagram. List the assumptions you make. **20**

8. Calculate the fugacity of Nitrogen at 800 bar and 273K:
(i) Assuming ideal gas behaviour
(ii) Using the following PVT data **20**

P(bar)	50	100	200	400	800	1000
PV/RT	0.9846	0.9846	1.0365	1.2557	1.7959	2.0641