Reg. No.										

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

II SEMESTER B.S. DEGREE EXAMINATION – APRIL / MAY 2017

SUBJECT: CHEMICAL ENGINEERING THERMODYNAMICS (CHM 122)

(BRANCH: CHEMICAL ENGINEERING)

Wednesday, 3 May 2017

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

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

1A. Define : Fugacity, fugacity coefficient and activity

1B. Calculate the fugacity of Carbon Dioxide gas at 50 bar and 400 bar:
(i) Assuming ideal gas behaviour
(ii) Using the following compressibility factor data

P(bar)	25	50	100	200	400	800	1000
Z	0.989	0.9792	0.9741	1.0196	1.2482	1.8057	2.0819

(6+14)

2A. Define Thermodynamic System? How are they classified? Explain the different types of systems giving examples.

2B. Derive the modified equations for internal energy and enthalpy and apply them to an ideal gas. **(10+10)**

3A. What is a equation of state? What is its application? Explain any 2 equations of state applicable to real gases

3B. Define partial molar property. What is its thermodynamic importance? Explain the graphical met.hod of its determination for a binary solution of components 1 and 2 **(10+10)**

4A. Derive the most general form of Gibbs -Duhem equation from the fundamentals. Give the different forms of Gibbs- Duhem equations.

4B. Explain the various forms of integrated form of Gibbs- Duhem equation. **(14+6)**

5A. Define activity coefficient. What is its thermodynamic importance?
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. Write briefly on : van Laar equations and its applications **(14+6)**

6A. What are the factors affecting the equilibrium in chemical reaction? Explain giving relevant equations.

6B. Derive the steady flow energy equation from the fundamentals for a flow system: liquid of mass m flowing through a system when heat is added and shaft work is produced. **(10+10)**

7. The binary system acetone(1)-acetonitrile(2) obeys Raoult's law.Using the vapour pressure data given below plot the following: *P-x_1 and P-y_1 curves at 323 K* **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

8A. Derive the condition for chemical reaction equilibrium.

8B. Calculate the equilibrium constant for the vapour-phase hydration of ethylene to ethanol $C_2H_4 + H_2O = C2H5OH$ feasible at 327 °C ?.

The following data are available:

	$\Delta H^0_{f,298} \times 10^{-3}$ (J/mol)	$\Delta G^0_{f,298} \times 10^{-3}$ (J/mol)	C_p (J/mol K)
Ethylene	52.51	68.46	$11.886 + 120.12 \times 10^{-3}\,T - 36.649 \times 10^{-6}\,T^2$
Water	-241.818	-228.57	$30.475 + 9.652 \times 10^{-3}\,T + 1.189 \times 10^{-6}\,T^2$
Ethanol	-235.1	-168.49	$29.358 + 166.9 \times 10^{-3}\,T - 50.09 \times 10^{-6}\,T^2$

(5+15)