(3 Hours) **Total Marks: 80**

N.B.: 1. Question **No.1.iscompulsory.**

2. Attempt any **three** questions out of the remaining **five** questions.

3. Assume **suitable** data wherever **required.**

4. **Figures** to the **right** indicates **full** marks.

1. (a) Explain the characteristics of an ideal solution and discuss the applicability of Lewis/Randall rule to ideal solution. [5]

(b) Discuss important notes on theory of Lattice Model [5]

(c) Define fugacity coefficient and discuss its role to real and ideal gas mixtures [5]

(d) Discuss effect of temperature and pressure on chemical potential [5]

2 (a) Show that Chemical potential is a criteria for phase equilibrium. [8]

(b) The molar volume of binary liquid mixture is given by:

$V= 9\times10^{-3}x_1+50\times10^{-3}x_2+x_1x_2(6\times10^{-3}x_1+9\times10^{-3}x_2)$.

Obtain expression for $\overline{V_1}$ and $\overline{V_2}$ and show that they satisfy Gibbs-Duhem equation. [12]

3 (a) vapour liquid equilibrium data for the system Ethyl acetate (1) and Methyl ethyl ketone (2) is obtained at 55°C and at $x_1 = 0.498$, calculate

i) total pressure and y_1

ii) If t = 55°C and $y_1 = 0.876$ calculate total pressure and x_1 Van Laar constants at 55°C are A= 0.0855 and B= 0.2201 vapour pressure data are

Ethyl acetate, $\log_{10}p_1^0=7.09808-\frac{1238.7}{217+t}$

Methyl ethyl ketone, $\log_{10}p_2^0=6.97421-\frac{1209.6}{216+t}$

Where t is in °C and p is in mmHg. [12]

(b) The molar excess free energy for a particular system is given by $\frac{G^E}{RT}=Bx_1x_2$ where B is a function of temperature only. Show that for every temperature at which azeotrope exists. The azeotropic composition x_1^{az} and azeotropic pressure p^{az} are related by

$$\frac{1}{x_1^{az}}=1+\left[\frac{\ln(\frac{p^{az}}{p_1^0})}{\ln(\frac{p^{az}}{p_2^0})}\right]^{1/2}$$ [8]

4 (a) Derive Maxwell's equations [8]

(b) Derive an expression for the fugacity coefficient of a gas obeying the equation of state P(V-b) = RT and estimate the fugacity of ammonia at 10 bar and 298 K, given that b = 3.707×10^{-5} m^3/mol. [12]

5 (a) Show that Gibbs energy change of mixing for ideal solution is $RT\sum_i x_i \ln x_i$ [08]

(b) A vessel divided into two parts by a partition, contains 4 mol of nitrogen gas at 348.15K and 30 bar on one side and 2.5 mol of argon gas at 403.15K and 20 bar on the other. If the partition is removed and the gases mix adiabatically and completely, what is the change in entropy? Assume nitrogen to be an ideal gas with Cv =(5/2) R and argon to be an ideal gas with Cv=(3/2)R . [12]

6 Write short notes on (any **four**) [20]

(a) Excess property
(b) Gibbs-Duhem equation
(c) Flory-Huggins theory
(d) Margules equation
(e) UNIFAC method
