**BACHELOR OF TECHNOLOGY (C.B.C.S.) (2020 COURSE)**
**B.Tech.Sem - IV CHEMICAL : WINTER- 2022**
**SUBJECT : CHEMICAL ENGINEERING THERMODYNAMICS-II**

Day : Friday | Time : 02:30 PM-05:30 PM

Date : 25-11-2022 | **W-24441-2022** | Max. Marks : 60

**N. B. :**

1) All questions are **COMPULSORY.**
2) Figures to the right indicate **FULL** marks.
3) Draw neat and labelled diagrams **WHEREVER** necessary.
4) Use of non-programmable calculator is **ALLOWED.**
5) Assume suitable data, if necessary.

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**Q. 1** Elaborate the following terms: **(10)**

i) Ideal gas mixture
ii) Ideal solution
iii) Partial molar property
iv) Chemical Potential

**OR**

State Gibb's theorem and obtain the following expression for ideal gas mixture model: **(10)**

$$\mu_i^{IG} = \bar{G}_i^{IG} = \Gamma_i(T) + RT\ ln(y_i P)$$

**Q. 2** Define fugacity coefficient for a species in solution. Obtain an expression to evaluate fugacity coefficient for species in solution $(\hat{\phi}_i)$ using Virial equation of state. **(10)**

**OR**

Derive the relation between residual Gibb's free energy and fugacity coefficient of a species in solution. **(10)**

**Q. 3** Obtain an expression which will predict the effect of temperature and pressure on activity coefficient. **(10)**

**OR**

Define property change of mixing. Derive expressions for Gibb's energy change of mixing, entropy change of mixing, volume change of mixing and enthalpy change of mixing. **(10)**

**Q. 4** Test the thermodynamic consistency of the VLE data for binary system of Acetone (1) and Dichloroethylene (2), using zero area method. **(10)**

| Mole fraction of Acetone | $x$ | 0.023 | 0.053 | 0.357 | 0.516 | 0.883 | 0.979 |
|---|---|---|---|---|---|---|---|
| Activity coefficients | $\gamma_1$ | 0.608 | 0.711 | 0.854 | 0.917 | 0.987 | 1.0 |
| | $\gamma_1$ | 0.993 | 0.974 | 0.934 | 0.891 | 0.781 | 0.694 |

**OR**

Enumerate the criteria of vapour liquid equilibrium and criteria of stability. **(10)**

**P. T. O.**

**Q. 5** Enumerate the quantitative behaviour of LLE using constant pressure liquid – liquid solubility diagram. **(10)**

**OR**

Define distribution coefficient, state and derive Nernst distribution law. **(10)**

**Q. 6** Develop expressions for the mole fractions of reacting species as functions of the reaction coordinate for: **(10)**

**i)** A system initially containing 2 mol NH and 5 mol $O_2$ and undergoing the reaction:
$4NH_3\ (g) + 5O_2(g) \rightarrow 4NO\ (g) + 6H_2O(g)$.

**ii)** A system initially containing 3 mol $H_2S$, 5 mol $O_2$ and undergoing the reaction:
$2H_2S(g) + 3O_2(g) \rightarrow 2H_2O(g) + 3SO_2(g)$.

**iii)** A system initially containing 3 mol $NO_2$ and 4 mol $NH_3$ and 1 mol $N_2$ and undergoing the reaction:
$6NO_2(g) + 8NH_3(g) \rightarrow 7N_2(g) + 12H_2O(g)$.

**OR**

Derive the relationship between the mole fraction of the component taking part in the simultaneous reaction and extent of reaction. **(10)**

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