(3 Hours)   [Total Marks : 80]

N.B. :   (1)   Questions number one is **compulsory**.
         (2)   Attempt any **three** questions from the rest
         (3)   Assume suitable data wherever necessary

1. (a)   Define q factor in distillation and give its significance.   4
    (b)   Discuss the selection criteria for solvent in liquid-liquid extraction.   4
    (c)   Explain the factors affecting leaching operation.   4
    (d)   Give the properties of adsorbents.   4
    (e)   State and explain the ΔL law of crystal growth.   4

2. (a)   For a binary system of heptane-ethylbenzene the equilibrium data are as follows: 20

x	0	0.08	0.185	0.251	0.333	0.487	0.651	0.788	0.914	1
y	0	0.233	0.428	0.514	0.608	0.729	0.834	0.904	0.963	1

A feed mixture composed of 42 mole% heptane and 58 mole %ethyl benzene is to be fractionated to yield an overhead product of 97 mole% heptane and a residue of 99 mole ethyl benzene.

    (i)   Using reflux ratio of 1.5 find the number of equilibrium stages needed for saturated liquid feed and a bubble point reflux by the McCabe-Thiele method.
    (ii)   Find the minimum reflux ratio.
    (iii) Find the number of equilibrium stages at total reflux.

3. (a)   Give the procedure to find the height of packed bed for liquid -liquid extraction tower.   10
    (b)   Derive Fenske's equation for minimum no. of stages at total reflux.   10

4. (a)   Explain the construction and working of Bollmann extractor.   6
    (b)   For extraction of dioxane from water, benzene is used as an extraction solvent. At 298 K, the equilibrium distribution of dioxane between water and benzene is as given below: 14

Weight % dioxane in water	5.1	18.9	25.2
Weight % dioxane in benzene	5.2	22.5	32

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At these concentrations, water and benzene are substantially insoluble. 1000 kg of solution containing 25% dioxane is to be extracted with benzene to remove 95% of the dioxane. The dioxane free benzene is used.

(i) Calculate the solvent requirement for single batch operation.

(ii) If the extraction were done in four stages cross current unit using 750 kg of pure benzene each time, determine the final raffinate concentration and the percentage removal of dioxane from feed solution.

5. (a) Discuss the adsorption in fixed beds. Explain break through curve and adsorption zone. **10**

(b) A hot solution of 5000 kg containing Na_2CO_3 and water with a concentration of 25% by weight Na_2CO_3 is cooled to 20^0c and crystals of $Na_2CO_3 \cdot 10H_2O$ are precipitated. At 20^0c the solubility is 21.5 kg anhydrous Na_2CO_3 per 100 kg of water. Calculate the yield of Na_2CO_3 crystals obtained if 15% of the original water in the system is evaporated. **10**

6. Write short notes on any **FOUR** out of the following:

(a) Minimum and maximum boiling azeotropes

(b) Ion Exchange **5**

(c) Hollow and spiral wound membranes **5**

(d) Reverse Osmosis **5**

(e) Oslo cooling crystallizer **5**

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