Register No.: ..... Name: .....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (S), AUGUST 2023
CHEMICAL ENGINEERING
(2020 SCHEME)

Course Code: **20CHT302**

Course Name: **Mass Transfer Operations - II**

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

PART A

(Answer all questions. Each question carries 3 marks)

1. Explain any 3 limitations of distillation.
2. Show that the relative volatility of an ideal solution is the ratio of the vapour pressures of pure components.
3. Differentiate between partial and total condenser.
4. Define feed quality factor. Write down the feed quality factor values for saturated liquid, saturated vapour, superheated vapour and subcooled liquid.
5. What is the significance of difference points on the H-x-y diagram?
6. How is the minimum reflux ratio predicted using the ponchon-Savarit method?
7. Define selectivity. Write its significance in liquid-liquid extraction.
8. What are the desirable characteristics of a good solvent?
9. What are the factors affecting leaching?
10. List out any 3 industrial applications of leaching.

PART B

(Answer one full question from each module, each question carries 14marks)

MODULE I

11. a) Two liquids A and B form ideal solution. Construct the Boiling point diagram and the equilibrium diagram for the system at a total pressure of 101.3kPa. The vapour pressures are given by: (12)

$$\ln P_A^S(kPa) = 14.5463 - \frac{2940.46}{T(K) - 35.93}$$

$$\ln P_B^S(kPa) = 14.2724 - \frac{2945.47}{T(K) - 49.15}$$

b) List out any 4 characteristic features of an ideal solution (2)

OR

12. a) Explain flash distillation with a neat sketch. (7)
    b) A mixture containing 60 mole% A and rest B is flash vaporised at 101.3 kPa until 40 mol% of original mixture is vaporised and the relative volatility is 2.5. Determine the composition of the product. (7)

MODULE II

13. a) Explain the principle of fractionation of binary mixtures. (4)
    b) List out the different feed conditions and q values with neat sketches. (10)

OR

14. a) Explain the assumptions in McCabe Thiele method. (2)
    b) A plate column equipped with a total condenser and a kettle type reboiler is used to separate 100 kmol/hr of a benzene-toluene containing 50 mol% benzene into a distillate product containing 95 mol% benzene and bottom product containing 5 mol% benzene. The column is operated at 101.3 kPa. The feed is partially vaporized with one third vapour and two-third liquid. Determine the following: (12)
    (a) Minimum number of plates
    (b) Minimum reflux ratio
    (c) Number of plates if the operating reflux ratio is 30% in excess of the minimum
    The equilibrium data for benzene – toluene system at 101.3kPa:

x	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	0.95	1
y	0	0.205	0.369	0.502	0.618	0.706	0.789	0.849	0.907	0.955	0.978	1

MODULE III

15. a) Compare Ponchon – Savarit method and McCabe Thiele method. (6)
    b) Explain extractive distillation with a neat sketch. Write the desired properties of solvent used in an operation. (8)

OR

16. a) An equimolar mixture of carbon tetrachloride (CCL_4) and toluene (C_7H_8) with an enthalpy 25460 kJ/kmol is fractionated in a plate column at 101.3 kPa to produce a distillate containing 90mol% CCL_4 and a bottom containing 5 mol% CCL_4. A reflux ratio 20% in excess of the minimum is used and the column is equipped with a total condenser and partial reboiler. The equilibrium data at 101.3 kPa (mole fraction CCL_4) are: (10)

x	0	0.06	0.16	0.29	0.43	0.56	0.64	0.78	0.95	1
y	0	0.13	0.31	0.49	0.64	0.76	0.81	0.9	0.97	1

Enthalpy data:

Component	Saturation Enthalpy, kJ/kg		Boiling point, K
	Liquid	Vapour	
Carbon tetrachloride	63	257.5	349.1
Toluene	130	460	383.6

Enthalpies of the liquid and the vapour may be assumed to be linear functions of compositions. Determine the number of theoretical plates required for the separation using Ponchon Savarit method. Assume feed to be an equimolar mixture of liquid and vapour.

    b) Explain azeotropic distillation with a neat sketch. (4)

MODULE IV

17. a) State mixer rule. (4)

b) An aqueous solution containing 1 wt.% nicotin in water is extracted using pure kerosene in a counter current multistage unit. The water and kerosene are essentially immiscible in each other.it is desired to reduce the nicotin content in the exit water to 0.1 % weight. The equilibrium data are as follows: (10)

Weight fraction, nicotin in water	0.0010	0.00246	0.005	0.00746	0.00988	0.0202
Weight fraction, nicotin in kerosene	0.000806	0.001959	0.00454	0.00682	0.00904	0.0185

OR

18. a) What are the applications of extraction? (6)

b) Explain the construction and working of a sieve –plate column used in extraction. (8)

MODULE V

19. a) Describe the construction and working of a shank's system. (8)

b) Explain the construction and working of a hollow fibre membrane. (6)

OR

20. a) Explain the construction and working of a continuous gravity thickener. (8)

b) What is ultrafiltration? Explain any 3 applications of ultrafiltration. (6)

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