

GUJARAT TECHNOLOGICAL UNIVERSITY**BE- SEMESTER- V EXAMINATION – SUMMER 2026****Subject Code:3150501****Date:25-05-2026****Subject Name:Mass Transfer Operations I****Time:02:30 PM TO 05:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

		MARKS
Q.1	(a) Define: Decoction, Absorption factor, Plait point	03
	(b) Explain Fick's law in brief discuss about N and J flux.	04
	(c) Enlist the tower internals for packed and tray tower and explain their roles. Also compare Tray tower with Packed tower.	07
Q.2	(a) Classify G-L mass transfer operations and give examples of each operation.	03
	(b) Deduce an equation for molar flux for equimolar counter-current diffusion in case of steady state molecular diffusion for gas phase.	04
	(c) In an oxygen–nitrogen gas mixture at 1 atm. 25°C, the concentrations of oxygen at two planes 0.2 cm apart are 10% and 20% (by volume) respectively. Determine the flux of oxygen when (i) nitrogen is non-diffusing and (ii) there is equimolar counter diffusion. Diffusivity of oxygen in nitrogen is 0.215 cm ² /s.	07
	OR	
	(c) Determine the flux of butanol at 20°C under unidirectional steady state conditions through a 0.1 cm thick film of water when the concentrations of butanol at the opposite sides of the film are, respectively 10% and 4% butanol by weight. The diffusivity of butanol in water solution is 5.9 x 10 ⁻⁶ cm ² /sec. The densities of 10% and 4% butanol solutions at 20°C may be taken as 0.971 and 0.992 g/cc respectively. Also determine the flux if equimolar countercurrent diffusion is taking place.	07
Q.3	(a) 1000 kg of crushed oil seed (19.5 % oil and 80.5 % meal) is extracted with 1500 kg of pure hexane in a single stage batch extraction vessel. Determine coordinates of point M1 representing mixture of solid- solvent.	03
	(b) At high temperature, two pair partially soluble liquid system behaves like one pair partially soluble liquid system. Agree or not? Support the answer.	04
	(c) A gas containing 4 % cyclohexane and rest inert has to be treated with Non-volatile absorption oil in a packed tower. It is required to remove 98 % of cyclohexane of the gas. The feed solvent is free from cyclohexane. If the feed gas rate is 80 kmol/hour, calculate the minimum solvent rate and actual liquid rate if it is 1.8 times of L _{min} . Equilibrium relation is given Y = 0.2X / (1+0.8X)	07
	OR	
Q.3	(a) Discuss various parameters to be considered for selecting solvent for Liquid-Liquid Extraction. For single stage, determine distribution coefficient if feed, pure solvent and extract amounts are 500, 400 and 600 kg respectively. Feed and extract has 45% and 30 % solute respectively.	03

- (b) Discuss the effect of agitation and temperature on leaching? “High temperature is not always preferable for leaching.” Justify the statement. **04**
- (c) Pure isopropyl ether of 450 kg/h is being used to extract an aqueous solution of 30 wt % acetic acid by counter-current multistage extraction. Rate of aqueous solution is one third of solvent rate. The exit acid concentration in the aqueous phase is 10 wt %. Calculate the number of stages required. Data on wt % basis is given: **07**

Aqueous phase			Ether phase		
Acetic acid	water	Ether	Acetic acid	water	Ether
0.69	98.1	1.2	0.18	0.5	99.3
1.41	97.1	1.5	0.37	0.7	98.9
2.89	95.5	1.6	0.79	0.8	98.4
6.42	91.7	1.9	1.93	1	97.1
13.3	84.4	2.3	4.82	1.9	93.3
25.5	71.1	3.4	11.4	3.9	84.7
36.7	58.9	4.4	21.6	6.9	71.5
44.3	45.1	10.6	31.1	10.8	58.1
46.3	37.1	16.5	36.2	15.1	48.7

- Q.4** (a) Differentiate between physical and chemical adsorption and cite examples of the same. “Absorption is preferable at low T and high P.” True or false/? Justify. **03**
- (b) Explain Shanks’s system with neat sketch. **04**
- (c) State various theories of mass transfer co-efficient and discuss film theory at length. Also derive its equation and mention its limitations. **07**

OR

- Q.4** (a) Define HETP, NTU, Stripping factor **03**
- (b) Explain min L/G ratio with neat sketch for gas absorption. “Absorber cannot be operated at min L/G” Justify. **04**
- (c) Enlist different industrial liquid extraction equipment and explain any one in detail with neat sketch. **07**

- Q.5** (a) Define: Weeping, Coning, Dumping **03**
- (b) Define super saturation and discuss Mier’s theory. **04**
- (c) Explain Swenson walker equipment with neat sketch. **07**

OR

- Q.5** (a) Discuss steps of crystallization. **03**
- (b) The solubility of copper sulphate in water at 80 °C is 55 g CuSO₄ per 100 g of water and that at 30 °C is 25 g CuSO₄ / 100 g water. One ton of saturated solution at 80 °C is slowly cooled down to 30 °C. 5 % water is lost by evaporation. Determine weight of crystals and mother liquor. Hydrated form is represented as CuSO₄ · 5H₂O. **04**
- (c) Enlist different industrial leaching equipment and explain any one in detail with neat sketch. **07**
