Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2023

Subject Code:3150501 Date:07-12-2023

Subject Name: Mass Transfer Operations I

Time:10:30 AM TO 01:00 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.**

Q.1	**(a)**	Explain film theory for mass transfer coefficient.	**03**
	(b)	Differentiate between packed towers and tray tower.	**04**
	(c)	Derive Fick's law of diffusion and explain N_A and J_A. Also prove that For unidirectional binary diffusion $J_A=-J_B$.	**07**
Q.2	**(a)**	Define: (i)Flooding (ii)Priming (iii)Coning	**03**
	(b)	Explain material balance for single stage extraction.	**04**
	(c)	Discuss in detail classification of mass transfer operations and explain with examples.	**07**
		OR	
	(c)	Derive equations to calculate rate of steady state diffusion of 'A' through non-diffusing 'B' and also for steady state equimolal counter diffusion in case of gases.	**07**
Q.3	**(a)**	Explain Meir's theory for crystallization.	**03**
	(b)	Define (i)Weeping (ii) Dumping (iii)Tray Spacing (iv)Theoretical Tray	**04**
	(c)	Ammonia and air are in equimolal counter diffusion of each other in a cylindrical tube of 3 mm diameter and 20 m length. The total pressure is 1 atm and the temperature is 25 ^oC. One end of the tube is connected to a large reservoir of NH_3 and the other end of the tube is open to atmosphere. Estimate the mass transfer rates in kg/sec of ammonia and air. The mass diffusivity of mixture is 0.28×10^{-4} m^2/sec	**07**
		OR	
Q.3	**(a)**	Explain random packings and regular packing.	**03**
	(b)	Explain selection criteria of solvent for gas absorption.	**04**
	(c)	Explain equilateral–triangular co-ordinate, plaint point, tie line, one pair partially soluble system with examples and the mixture rule.	**07**
Q.4	**(a)**	Discuss construction and working of Sparged Vessel.	**03**
	(b)	Discuss local and overall mass transfer coefficients.	**04**
	(c)	Explain selection criteria of solvent for extraction.	**07**
		OR	
Q.4	**(a)**	What is Extraction? Give the industrial applications of Extraction.	**03**
	(b)	Explain mass, heat and momentum transfer analogies.	**04**
	(c)	Enlist different leaching equipment and explain any one in detail with neat figure.	**07**

Q.5	**(a)**	Explain preparation of solids for leaching.	**03**
	(b)	Explain material balance for single stage leaching.	**04**
	(c)	A gas mixture containing 3% by volume pentane vapour and 97 % inerts. The mixture is treated with a non-volatile absorption oil in an absorber and 97 % removal is required. The feed solvent is free from solute. The feed gas rate is 50 kmol/hr. equilibrium relation is Y=0.25X/(1+0.75X). where Y and X are mole ratio. Calculate minimum solvent required.	**07**

OR

Q.5	**(a)**	Explain diffusion in solids.	**03**
	(b)	Explain construction and working agitated tank crystallizer with the help of a neat sketch.	**04**
	(c)	5000 kg/hr of a SO_2-air mixture containing 5% by volume of SO_2 is to be scrubbed with 2,00,000 kg/hr of water in a packed tower. The exit concentration of SO_2 is reduced to 0.15%. The tower operates at 1 atm. The equilibrium relation is given by: Y = 30 X. Y = Mole SO_2 / Mole air; X = Mole SO_2 / Mole water If the packed height of tower (Z) is 0.42 m, Calculate the height of transfer unit (HTU).	**07**

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