Paper Code: CH-501	**Roll No.**

B. Tech.

FIFTH SEMESTER EXAMINATION, 2016-17

MASS TRANSFER-I

[Time: 3 Hours] [Total Marks: 100]

Note: Attempt ***ALL*** questions. Assume suitable data, if required. All question carry equal marks.

1. Attempt any four parts of the following:- **(5x4=20)**

(a) Derive the expression for steady state unimolal unidirectional diffusion.

(b) Show that for binary diffusion of A and B, $D_{AB} = D_{BA}$

(c) Write the effect of temperature and pressure on gas diffusivity and liquid diffusivity.

(d) Describe the criteria used for solvent selection.

(e) Calculate the rate of diffusion of NaCl at 18^0C through the stagnant film of water 1 mm thick when the concentrations are 20 and 10% respectively, on either side of the film.

(f) Derive the relation between overall and individual mass transfer coefficient for liquid film controlling.

2. Attempt any two parts of the following:- **(10x2=20)**

(a) If mass-transfer resistance is essentially all in the gas phase, derive the following expression:
$HTU_{OG} = HTU_G + (\frac{mG}{L})HTU_L \frac{(1-x)_{iM}}{(1-y)_{*M}}$ and for dilute solutions,
$HTU_{OG} = HTU_G + \frac{mG}{L} HTU_L$

(b) Carbon disulphide is to be absorbed from a dilute gas mixture of CS_2-N_2 into a pure nonvolatile oil at atmospheric pressure in a countercurrent absorber. The mole fraction of CS_2 in inlet gas stream is 0.05 and the flow rate of gas stream, G, is 1500 kmol/h. equilibrium relation is given by $y = 2x$ where x is mole fraction of CS_2 in liquid stream. It is desired to reduce the mole fraction of CS_2 in exit gas stream is 0.005. Calculate the minimum value of L/G where L is the liquid flow rate in kmol/h. and also derive the equation for the operating line if L/G is equal to 1.5 times the minimum value.

(c) A narrow tube is partially filled with liquid and maintained at a constant temperature. A gentle stream of a gas is passed across the open end of the tube. As the liquid evaporates, the level drops slowly. At a given time t, this level in the tube is Z from the top. Derive an expression to calculate the value of diffusivity of the following vapour in the gas.

3. Attempt any two parts of the following: - **(10x2=20)**

(a) Explain detail the Rotary dryers and also discuss their advantage and disadvantage.

(b) In the laboratory drying test with a solid material the following relation for the falling rate period was obtained, $\frac{dX}{d\theta} = -0.8(X - 0.05)$
Where X is the moisture content on dry basis of $\boldsymbol{\theta}$ is the time in hours. The critical moisture content is 1.4 kg moisture per kg of dry material.
Calculate:
(i) The time required for drying the material from $X_1 = 4.0$ to $X_2 = 0.1$
(ii) The equilibrium moisture content.

(c) A batch of solid for which the following table of data applies is to be dried from 25% to 6% moisture under conditions identical to those for which the data were tabulated. The initial weight of the wet solid is 300kg and the drying surface is $1 m^2/8$ kg dry weight. Determine the time of drying.

X	0.35	0.25	0.20	0.18	0.16	0.14	0.12	0.10	0.09	0.08	0.064
N	0.3	0.3	0.3	0.266	0.239	0.208	0.180	0.150	0.097	0.07	0.025

$$\text{Where } X = \frac{kg\ \ moisture}{kg\ dry\ solid}$$

$$N = \frac{kg\ \ moisture\ evaporated}{hr\ m^2}$$

4. Attempt any two parts of the following:- **(10x2=20)**

(a) Give the classification of cooling tower. Explain the mechanical draft cooling tower.

(b) A mixture of air and water vapour has dry bulb temperature of 60^0C and an absolute humidity of 0.03 kg water vapour/ kg dry air. The system pressure is at 1 atmosphere absolute. Evaluate.

(i) Saturation absolute humidity
(ii) Relative humidity or relative saturation
(iii) Dew point temperature
(iv) Humid volume
(v) Humid heat

(c) Explain the following terms:

(i) wet bulb temperature
(ii) Relative humidity.

5. Write short note on any four parts of the following: - **(5x4=20)**

(a) Absorption with chemical reaction
(b) Simultaneous heat and mass transfer
(c) Mechanism of crystallization
(d) Rate of drying curve
(e) Surface renewal theory of mass transfer
(f) Tray efficiency