Seat No.: _____   Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER–VI (NEW) EXAMINATION – WINTER 2018

Subject Code:2163609   **Date:16/11/2018**
Subject Name:Basics of Mass Transfer
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.**

Q.1	**(a)**	Explain the law used for non ideal solutions.	03
	(b)	State and discuss the types of diffusion with suitable example.	04
	(c)	Derive the steady state equimolar counter diffusion equation for gases.	07
Q.2	**(a)**	State difference between penetration and surface renewal theories.	03
	(b)	Differentiate N and J flux with an example.	04
	(c)	Explain "Two-resistance theory" for overall mass transfer coefficient in case of interphase mass transfer.	07

OR

	(c)	Oxygen (A) is diffusing through carbon monoxide (B) under steady state conditions, with the carbon monoxide non-diffusing. The total pressure is $1.0 * 105$ N/m^2, and the temperature 0^0C. The partial pressure of oxygen at two planes 2 mm apart is, respectively, 13000 and 6500 N/m^2. The diffusivity for the mixture is $1.87 * 10^{-5}$ m^2/s. Calculate the rate of diffusion of oxygen in kmol/s through each square meter of the two planes.	07
Q.3	**(a)**	Prove that: ky P_{BM}/P_t = kc P_{BM}/RT	03
	(b)	Explain two component system equilibrium solubility of gases in liquid with neat diagram.	04
	(c)	Explain Penetration theory with the example of bubble.	07

OR

Q.3	**(a)**	Prove the equation $D_{AB} = D_{BA}$ with proper assumptions.	03
	(b)	Explain Film interphase theory.	04
	(c)	Calculate the rate of diffusion of acetic acid (A) across a film of non-diffusing water (B) solution 1 mm thick at 17^0C when the concentrations on opposite sides of the film are, respectively, 9 and 3 wt % acid. The diffusivity of acetic acid in the solution is $0.95 * 10^{-9}$ m^2/s. The density of 9 % solution is 1012 kg/m^3, The density of 3 % solution is 1003.2 kg/m^3	07
Q.4	**(a)**	Briefly explain the difference between Absorption, Adsorption and Extraction.	03
	(b)	Write a short note on a choice of solvent for Absorption.	04
	(c)	A coal gas is to be freed of its light oil by scrubbing with wash oil as an absorbent and the light oil recovered by stripping the resulting solution with steam. *Absorber:* Gas in 0.250 m^3/s at 26^0C, P$_t$ = 1.07 x 10^5 N/m^2 Containing 2.0% by volume of light oil vapors. The light oil will be assumed to be entirely benzene and a 95% removal is required. The wash oil is to enter at 26^0C, containing 0.005 mole fraction benzene and has an av mol wt 260. An oil circulation rate of 1.5 times the minimum is to be	07

used. Wash oil-benzene solutions are ideal. The temperature will be constant at 26^0C. At 26^0C, the vapor pressure of benzene is 13330 N/m^2. Assume the system as a counter current packed tower. Compute the oil circulation rate required.

OR

Q.4 **(a)** Define different moistures, (a) unbound (b) bound (c) equilibrium   03

(b) Discuss Minimum Liquid-Gas Ratio theory for absorbers.   04

(c) A porous solid is dried in a batch dryer under constant drying conditions. 9 hours are required to reduce the moisture content from 45 to 10%. The critical moisture content was found to be 25% and the equilibrium moisture 3%. All moisture contents are on the dry basis. If the rate of drying during falling rate period is proportional to the free moisture content, how long should it take to dry a sample of same solid from 35 to 5% under the same drying conditions?   07

Q.5 **(a)** Discuss the difference between wet bulb temperature and adiabatic saturation temperature.   03

(b) Explain role of Raoult's law in distillation and derive the following equation $y = \alpha x / 1 + (\alpha - 1)x$ 04

(c) An air-water vapor sample 101.3 Kpa has dry-bulb temperature of 330.7 K and is 20% saturated with water vapour. Using the psychrometric chart, (Fig.no. 1) determine the following:
(a) The absolute humidity. (b) The partial pressure of water vapour. (c) The absolute saturation humidity at 330.7 K (d) The vapour pressure of water at 330.7 K (e) The percent relative saturation. (f) The dew point temperature of the system. (g) The Wet bulb temperature of the system.   07

OR

Q.5 **(a)** Explain positive and negative deviation from ideality.   03

(b) Explain Drying Rate Curve.   04

(c) A Wet solid of 28% moisture is to be dried to 0.5 % moisture in a dryer. A laboratory test shows that it requires 8 hours to reduce the moisture content of the same solid to 2%. The critical moisture content is 6% and the equilibrium moisture is 0.2 %. The falling rate of drying is linear in the free moisture content. Calculate the drying time of the solid. If the drying condition is like those in the laboratory test are maintained. All the moisture are expressed as percent of bone dry mass of the solid.   07

Humidity chart (psychrometric chart): V_H = humid volume, m³/kg dry air; H' = enthalpy, kJ/kg dry air; Y' = absolute humidity, kg water vapour/kg dry air