Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) - EXAMINATION – SUMMER 2017

Subject Code: 2163609 **Date: 27/04/2017**

Subject Name: Basics of Mass Transfer

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.**

Figures to the right indicate full marks.

Q1. **a)** $CuSO_4.5H_2O$ crystals dissolve in water. If $CuSO_4$ and H_2O are designated as A and B respectively, what is the value of flux ratio $N_A/(N_A+N_B)$ for this process? **14**

b) State the relationship between N_A and J_A in case of equimolar counter diffusion.

c) State the relationship between overall mass transfer coefficient based on gas phase (K_y), gas phase mass transfer coefficient (k_y), liquid phase mass transfer coefficient (k_x) and the slope of equilibrium line (m).

d) Define tie line.

e) What is critical moisture in drying operation?

f) State the effect of pressure on distillation.

g) Define relative humidity.

h) Define wet bulb temperature.

i) If solvent B is used to extract C from the liquid mixture of A+C, then obtain selectivity in terms of the weight fractions at equilibrium. The equilibrium weight fractions of A, B and C in raffinate phase are x_A, x_B and x_C respectively and the corresponding weight fractions in extract phase are y_A, y_B and y_C respectively.

j) If the vapor pressures of the two components in a binary liquid mixture (ideal solution) are P_1^{sat} and P_2^{sat} (component 1 is more volatile), express relative volatility in terms of vapor pressures.

k) State one difference between penetration and surface renewal theories.

l) How does the binary gas diffusivity vary with pressure?

m) State Rayleigh equation.

n) Define F type mass transfer coefficient.

Q2. **a)** In the absorption of ammonia from air into water at 20^0C, the slope of equilibrium line is about 1. Conclude whether the mass transfer operation is gas phase controlled or liquid phase controlled by finding the ratio of individual mass transfer coefficients with the application of penetration theory to both the phases. The diffusivities of ammonia at 20^0C in air and water are 0.244 and 2.08×10^{-5} cm^2/s, respectively. **07**

b) Briefly explain mass transfer operations with respect to direct contact of immiscible phases. **07**

OR

b) State the applications of molecular diffusion. **07**

Q3. **a)** Define bound moisture, unbound moisture, equilibrium moisture and free moisture using a diagram. **07**

b) A wet solid of 100 kg is dried from a moisture content of 40 wt% to 10 wt%. The critical moisture content is 15 wt% and the equilibrium moisture content is negligible. All moisture contents are on dry basis. The falling rate is considered to be linear. It takes 5 hours to dry the material in the constant rate period. Calculate the duration (in hours) of the falling rate period. **07**

OR

Q3.	**a)**	Explain the fields of usefulness of extraction operation.	**07**
	b)	150 kg of a nicotine-water solution containing 1% nicotine is to be extracted with 250 kg of kerosene at 20^0 C. Water and kerosene are essentially immiscible in each other. Determine the percentage extraction of nicotine in a single stage. The equilibrium system is $Y^* = 0.8X$ where Y and X are expressed as kg nicotine/kg kerosene and kg nicotine/kg water, respectively.	**07**
Q4.	**a)**	Explain the desirable properties of solvent used in extraction operation.	**07**
	b)	A mixture of benzene and toluene boils at 95^0C under a pressure of 101.3 kPa. Calculate the mole fraction of benzene in the boiling liquid assuming that the mixture obeys Raoult's law. At 95^0C, the vapor pressure of benzene is 155 kPa and that of toluene is 64 kPa.	**07**

OR

Q4.	**a)**	Explain the desirable properties of solvent used in absorption operation.	**07**
	b)	An alcohol-water vapor mixture is being rectified by contact with an alcohol-water solution. Alcohol is being transferred from gas to liquid and water from liquid to gas. The molar flow rates of alcohol and water are equal but in opposite directions. Both components are diffusing through a gas film of 0.1mm thick. The mole percent of the alcohol at the outside of the film is 80% and that on the inside is 10%. Calculate the flux of alcohol vapor using the following data. T=97^0C, P=1atm, $D_{AB}=1x10^{-5}m^2/s$.	**07**
Q5.	**a)**	The liquid film resistance is 5 times that of the gas film for a gas absorption process. What will be the percent increment in the rate of absorption if the liquid film coefficient could be doubled without changing other parameters?	**07**
	b)	What would be the effect of doubling the gas film coefficient?	**05**
	c)	What is your conclusion?	**02**

OR

Q5.	**a)**	Explain the characteristics of ideal solutions and the corresponding law to be used for ideal solutions.	**07**
	b)	Explain the law used for non ideal solutions.	**04**
	c)	Elaborate the effect of temperature on the gas solubility in a liquid.	**03**

****