Registration No. : | | | | | | | | | | |

Total Number of Pages : 02 **M.Tech.**

P1CHBC05

1st Semester Regular Examination 2017-18

ADVANCED MASS TRANSFER

BRANCH : CHEMICAL ENGG.

Time : 3 Hours

Max Marks : 100

Q.CODE : B1056

Answer Question No. 1 which is compulsory and any FOUR from the rest.

The figures in the right hand margin indicate marks.

Assume suitable notations and any missing data wherever necessary.

Answer all parts of a question at a place.

Q1. **Answer the following questions :** **(2x10)**

(a) Draw the ternary diagrams for the following systems in liquid-liquid extraction.
One pair partly soluble and
Two pairs partly soluble.

(b) Write the Stefan's equation and define each term.

(c) Name at least three various model for mass transfer.

(d) What are the equipments used in liquid-liquid extraction ?

(e) State some common problems of packed columns.

(f) Write some assumptions in Mc-Cabe-Thiele's method.

(g) Write down the usefulness of liquid-liquid extraction.

(h) Define plait point.

(i) Define distribution coefficient.

(j) What do you mean by finite reflux condition ?

Q2. **(a)** Represent the analogy of heat, mass, and momentum transfer. **(10)**

(b) Explain about mass transfer co-efficient. **(5)**

(c) Write a short note on two film theory. **(5)**

Q3. **(a)** The diffusivity of toluene in air is determined by Stefan's method. A vertical glass tube of 0.3 cm in diameter is filled with toluene to a depth of 1.9 cm from the top open end. After 275 hours at 40^0C and total pressure of 1 atm, the level has fallen down to 7.9 cm from top. The density of toluene is 0.825 gm/cm^3 and its vapour pressure at 40^0C is 57.3 mmHg. Neglecting counter diffusion of air to replace liquid, calculate the coefficient of diffusion for toluene-air system. **(10)**

(b) Oxygen is diffusing through a non-diffusing gaseous mixture of methane and hydrogen in the volume ratio of 4:1. The diffusion takes place at a total pressure of 1 atm and 2^0C. The partial pressure of oxygen at the two planes 0.35 cm apart are 115 mmHg and 65 mmHg respectively. Determine the rate of diffusion of O_2 at 2^0C and 1 atm pressure. The diffusivity of the mixture O_2-H_2 is 0.728 cm^2/ sec and for methane-oxygen is 0.197 cm^2/sec. **(10)**

Q4. **(a)** Oxygen (A) is diffusing through carbon monoxide (B) under steady state conditions with carbon monoxide non-diffusing. The total pressure is 1 atm and the temperature 0^0C. The partial pressure of oxygen at the two planes of 0.2 cm apart are 100 and 50 mmHg. The diffusivity for the mixture is 0.185 cm^2/sec. Calculate the rate diffusion of oxygen in gmol/sec through **(10)**

each square centimetre of the two planes.

(b) Briefly explain inter phase mass transfer. **(10)**

Q5. **(a)** 1000 kmol/hr of an ethanol propanol mixture containing 65 mole percent ethanol is to be separated in a continuous plate column operating at 1 atm total pressure. The desired terminal compositions in units of mole fraction of ethanol are: **(10)**

X_D= 0.92 and X_W=0.07

The feed is a saturated vapour and total condenser is used. When the reflux flow rate is four times the amount of the top product, find the number of theoretical plates required for the separation.

Relative volatility of ethanol-propanol system is = 2.10.

(b) Derive the q-line equation. **(10)**

Q6. A steam of wastewater containing 2 % benzoic acid is to be extracted with benzene at a rate of 2000 kg/hr in order to remove 98% of solute. If water and benzene are assumed to be mutually immiscible and the distribution coefficient is $K=w_w/w_b$= 1.707 at the given temperature (where w_w and w_b are the mass fraction of the solute in water and benzene phases respectively), calculate the following: **(20)**

The minimum rate of benzene required for countercurrent separation of the mixture.

The number of stages required if 1.3 times the minimum solvent is used.

The fraction of the solute removed if the same amount of solvent is used for the separation using a four stage countercurrent cascade.

The amount of solvent required if the separation of 98 % is done in a countercurrent unit.

Q7. **(a)** Briefly explain T-x-y diagram. **(10)**

(b) Write a note on centrifugal extractor. **(10)**