TRANSFER OPERATION - II
(BIOT 3104)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

   (i)   Crystallisation is based on the _____
         (a) Difference in melting point   (b) Difference in boiling point
         (c) Difference in pressure   (d) Difference in solubility

   (ii)   The most important application of dialysis is
         (a) Artificial kidneys
         (b) Desalination of brackish water
         (c) Recovery of salts and sugars from natural products
         (d) Removal of alcohol from beer

   (iii)   This is not separated by distillation
         (a) chloroform and aniline   (b) milk and water
         (c) impurities in seawater   (d) acetone and water

   (iv)   The gradual build-up of non-permeating component at the membrane surface leads to
         (a) scaling   (b) fouling
         (c) concentration polarization   (d) membrane rupture

   (v)   In liquid-liquid extraction, if the selectivity is unity, then answer choices
         (a) separation of the constituents is most effective
         (b) no separation is possible
         (c) amount of solvent requirement is minimum
         (d) solvent flow rate should be very high

   (vi)   Which of the following is a pressure driven membrane separation process?
         (a) Dialysis   (b) Osmosis
         (c) Electrodialysis   (d) Reverse osmosis

(vii) The process of distillation is used for the liquids having _____
(a) Sufficient difference in their boiling point
(b) Sufficient difference in their melting point
(c) Sufficient difference in their solubility
(d) None of the mentioned

(viii) For steady-state equimolar counter diffusion, $N_A/(N_A+N_B)$ is
(a) 0   (b) 1   (c) ∞ (d) 1/2

(ix) Crystal phases can be inter-converted by varying _____
(a) Temperature   (b) Pressure   (c) Size   (d) Viscosity

(x) If the operating line coincide with the equilibrium curve, which one of the following is not true for absorbers?
(a) The solvent rate is minimum   (b) The number of plates is infinity
(c) The L/G ratio is maximum   (d) The driving force becomes zero

Group- B

2. CO_2 and O_2 experience equimolal counter diffusion in a circular tube whose length and diameter are 1m and 50mm respectively. The total pressure is 10atm and temperature is 25°C. The ends of the tube are connected to large chambers in which the species concentration are maintained at fixed values. The partial pressure of CO_2 at one end is 190mm of Hg and at the other end 95mm of Hg.
i) Estimate the rate of mass transfer.
ii) Find the partial pressure of CO_2 at 0.75m from the end where the partial pressure is 190mm of Hg. $D_{AB}= 2.1\times10^{-5}m^2/s$. [(CO1)(Analyze/IOCQ)]

(6 + 6) = 12

3. A tray tower is to be designed to absorb SO_2 from an air stream by using pure water at 293K. The entering gas contains 20 mol% SO_2 and that leaving 2 mol% at a total pressure of 101.3 kPa. The inert air flow rate is 150 kg air/h.m², and the entering water flow rate is 6000 kg water/h.m². Assuming an overall tray efficiency of 25%, how many theoretical trays are needed? What should be the number of trays actually to be employed? Assume the tower to operate at 293K and equilibrium relationship is given by $y^*= 20x$. [(CO2) (Evaluate/IOCQ)]   [(CO1) (Evaluate/IOCQ)]

12

Group - C

4. (a) State the objective of McCabe Thiele diagram in distillation?
[(CO3) (Remember/LOCQ)]

(b) Illustrate the steps to draw McCabe Thiele diagram? [(CO3) (Understand/LOCQ)]

(c) Draw a diagram to show different types of q lines that can be drawn (McCabe Thiele diagram) depending on type of feed in distillation. [(CO3) (Analyse/IOCQ)]

2 + 5 + 5 = 12

5. 100 kmol of 60 mol% benzene-toluene mixture is subjected to batch distillation until 30 mol% residue is obtained. How many kg of distillate is obtained and what is its benzene content?
VLE data for benzene-toluene system:

X	0.6	0.55	0.50	0.45	0.4	0.35	0.3
y	0.79	0.75	0.71	0.67	0.62	0.57	0.51

[(CO3) (Evaluate /IOCQ)]

12

Group - D

6 . A batch of wet solid whose drying rate characteristics is given in the following table, to be dried from free moisture content 0.38 kg moisture/kg of dry solid to 0.06 kg moisture/kg of dry solid. The weight of dry solid is 399 kg and surface area of drying is 18.58 sqm. If critical moisture content is 0.195 kg moisture/kg of dry solid, then calculate
i)   Time for drying by graphical method.
ii) Compare the result by analytical method if falling period is assumed to be linear.

X (kg moisture/kg of dry solid)	0.195	0.150	0.1	0.065	0.05	0.04
R(kg moisture/m^2.hr)	1.51	1.21	0.9	0.71	0.37	0.27

[(CO4) (Evaluate/HOCQ)]
(8 + 4) = 12

7. (a) What is extraction factor? How is this factor related to composition of inflow solution and composition of raffinate? [(CO4) (Analyse/IOCQ)]

   (b) Explain breakthrough curve for adsorption with a diagram.
   [(CO4) (Understand/LOCQ)]

   (c) How to express solubility of a solute in a solvent? [(CO4)(Remember/LOCQ)]
   5 + 5 + 2 = 12

Group - E

8. In a cross flow ultra filtration system for separation of protein from the fermentation broth, the flow rate of liquid through a tube of diameter d=2cm and length L= 50cm is Q= 2L/min. The flow regime is turbulent, f=0.0005, and C_4= 2[atm$(s/cm)^2$]. The inlet pressure is P_i= 2 atm. Protein concentration in the solution and on gel film are C_B= 30mg/L and C_G =100 mg/L, respectively. Determine:
(i) The transmembrane pressure drop.
(ii) If the mass transfer coefficient (k) for protein flux is k= 5cm/s, determine the flux of liquid through the UF membrane. [(CO6)(Evaluate/HOCQ)]

(6 + 6) = 12

9. Write short notes on:
(i) Electrodialysis
(ii) Reverse osmosis. [(CO6) (Remember/LOCQ)]

(6 + 6) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	27.08%	47.92%	25%

Course Outcome (CO):

After completing the course, the students will be able to:
1. Understand the concept of diffusion and diffusivity and identify the type of diffusion in a given problem and solve it.
2. Determine gas-liquid mass transfer coefficient in a wetted wall column or packed bed absorption column and calculate the number of stages required for the unit operation.
3. Apply McCabe-Thiele Method and Rayleigh's equation as required in a distillation process.
4. Comprehend different other unit operations like adsorption, liquid-liquid extraction and crystallization explicitly.
5. Draw the drying characteristic curve under a given constant drying condition.
6. Study and apply the principle and operation of different advanced separation processes like dialysis, ultrafiltration, reverse osmosis, pervaporation and electrodialysis in the field of biotechnology.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
BT	https://classroom.google.com/c/NDY0MTU0OTg0MTk1/a/NDY0MTU0OTg0MjU2/details