TRANSFER OPERATION - II
(BIOT 3104)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Solvent extraction is basically known as
(a) Gas Liquid extraction (b) Liquid- liquid extraction
(c) Perveporation (d) Differential fractionation.

(ii) During constant rate drying period, vaporization rate per unit drying surface area
(a) increases with time
(b) decreases with time
(c) does not change with time
(d) does not affect the moisture content of the wet solid.

(iii) What is the first step in crystallization?
(a) Nucleation (b) Cooling
(c) Supercooling (d) None of (a), (b) & (c).

(iv) Plate efficiency
(a) is a function of the mass transfer between liquid and vapour
(b) increases due to foaming
(c) increases due to liquid entrainment
(d) increases due to weeping and dumping of liquid.

(v) Which product is not dried by a spray dryer?
(a) Bacterial & viral cultures (b) Fruit juice
(c) Lactose (d) None of (a), (b) & (c).

(vi) The gradual build-up of non-permeating component at the membrane surface leads to
(a) Scaling (b) Fouling
(c) Concentration polarization (d) Membrane rupture.

(vii) For steady-state equimolar counter diffusion, $N_A/(N_A+N_B)$ is
(a) 0 (b) 1 (c) ∞ (d) ½.

(viii) 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.

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

(x) Consequence of concentration polarization is
(a) solvent diffuses back from the membrane surface to the solution
(b) solute diffuses back from the membrane surface to the solution
(c) rate of diffusion increases
(d) none of the above.

Fill in the blanks with the correct word

(xi) Molecular diffusion induced by temperature is _____.

(xii) After extraction, the liquid present in the lower phase is known as _____ phase.

(xiii) Absorption is a _____ process

(xiv) The most important application of reverse osmosis is _____.

(xv) An example of a membrane separation process is _____.

Group - B

2. (a) Liquid acetone is contained in a capillary tube at 292 K and 102 kPa. The initial level of acetone was at 20 mm from the top of the tube. The vapour pressure of acetone at 292 K is 22.7 kPa and density of liquid acetone is 790 kg/m^3. Determine the fall in level of acetone after 2hours if the diffusivity of acetone in air at 292 K is $9 \times 10^{-6} m^2/s$. *[(CO1)(Remember/LOCQ)]*

(b) Derive an expression for diffusion of gases by equimolal counter diffusion. *[(CO1)(Remember/LOCQ)]*

(c) What is the difference between absorption and adsorption? *[(CO2)(Understand/LOCQ)]*

6 + 4 + 2 = 12

3. Water at 293 K and 101.3 kPa is contained in a narrow vertical tube. The level of liquid is maintained 150mm below the open end, across which air with a humidity of 0.002 kg water/kg dry air is passed at 293 K and 101.3 KPa. If the diffusivity of water vapour in air is $2.5 \times 10^{-5} m^2/s$, and the vapour pressure of water is 2.34 KPa, calculate the rate of evaporation of water. What will be the rate of evaporation if dry air is passed over the tube? *[(CO1,CO2)(Apply/IOCQ)]*

(6 + 6) = 12

Group - C

4. (a) Describe the principle of batch (differential) distillation Write down Rayleigh equation with explanation of each term in the equation. *[(CO3)(Understande/LOCQ)]*

   (b) Draw saturated liquid line and saturated vapor line on constant pressure VLE diagram. *[(CO3)(Understand/LOCQ)]*

(4 + 4) + (2 + 2) = 12

5. (a) Draw the feed lines for different type of feed (based on temperature of feed) given in a distillation column, with a free hand diagram. *[(CO3)(Analyse/HOCQ)]*

   (b) Derive the expression of Rectification line equation for a continuous distillation process in a distillation tower. *[(CO4)(Remember/LOCQ)]*

5 + 7 = 12

Group - D

6. Write short note on (i) adsorption isotherm (ii) Counter current extraction process *[(CO4)(Analyse/IOCQ)]*

(6 + 6) = 12

7. (a) Sodium acetate solution is available at temperature 70°C with solute content 58%. Find out (i) % saturation (ii) Yield of crystal if 2000 kg of solution is cooled to 10°C.
   Solubility of sodium acetate at 70°C is 146 gm acetate/100 gm water
   Solubility of sodium acetate at 10°C is 121 gm acetate/100 gm water *[(CO4)(Analyse/HOCQ)]*

   (b) Define: (i) Relative humidity (ii) Dew point temperature. *[(CO5) (Remember/LOCQ)]*

(3 + 5) + 4 = 12

Group - E

8. A reverse osmosis membrane to be used at 25˚C for a NaCl feed solution containing 2.5g NaCl/L (ρ=999kg/m^3) has a water permeability constant K_p=4.81× 10^{-4}kg/s.m^2.atm and a solute permeability constant, K_P'=4.42×10^{-7}m/s. Calculate the water flux and solute flux through the membrane using ΔP=27.20 atm and the solute rejection R. Also calculate concentration of the solute in the product solution (π=1.89 atm). *[(CO5)(Analyse & Apply/HOCQ)]*

12

9. 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 a) the transmembrane pressure drop and b) If the mass transfer coefficient (k) for protein flux is k= 5cm/s, determine the flux of liquid through the UF membrane. *[(CO6)(Analyse/HOCQ)]*

(6 + 6) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	36.50	25	38.50

Course Outcome (CO):

After completion of the course, the students will be able to:

1. Understand the basic structure and function of cells and cellular organelles.
2. Understand the fundamental concepts of DNA, RNA and central dogma of cells.
3. Characterize the different types of proteins, lipids and carbohydrates.
4. Analyze the mechanism of inheritance of characters through generations.
5. Understand and implement the working principles of enzymes and their applications in biological systems and industry.
6. Design and evaluate different environmental engineering projects with respect to background knowledge about bioresources, biosafety and bioremediation

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