

**NOVEL SEPARATION PROCESS
(CHEN 3232)**

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) The separation mechanism for microfiltration is
 - (a) solution-diffusion
 - (b) sieving
 - (c) sorption-diffusion
 - (d) sieving, solution-diffusion
- (ii) The required range of pressure differential for nanofiltration is
 - (a) < 2 bar
 - (b) 1 – 10 bar
 - (c) 7 – 70 bar
 - (d) 10 -100 bar
- (iii) Knudsen diffusivity (D_K) and absolute temperature (T) are related as follows:
 - (a) $D_K \propto T$
 - (b) $D_K \propto T^{-1}$
 - (c) $D_K \propto T^{0.5}$
 - (d) $D_K \propto T^{1.5}$
- (iv) The number of transfer units (N_T) for dialysis is related to the overall mass transfer coefficient (K_L) as:
 - (a) $N_T \propto K_L$
 - (b) $N_T \propto K_L^{-1}$
 - (c) $N_T \propto K_L^2$
 - (d) $N_T \propto K_L^{0.5}$
- (v) The transport mechanism in pervaporation is
 - (a) Molecular diffusion
 - (b) Advection
 - (c) Facilitated diffusion
 - (d) Solution-diffusion
- (vi) For desalination of water which process needs to be used?
 - (a) Pervaporation
 - (b) Electrodialysis
 - (c) Filtration
 - (d) Crystallization
- (vii) Cetylpyridinium chloride is a/an _____ surfactant
 - (a) cationic
 - (b) anionic
 - (c) amphoteric
 - (d) nonionic
- (viii) Ultrasonic cavitation involves
 - (a) Bubble collapse
 - (b) Bubble growth
 - (c) Bubble aggregation
 - (d) Bubble growth and collapse

- (ix) With decrease in ionic strength, zeta potential
 (a) decreases (b) increases
 (c) may increase or decrease (d) remains unaltered
- (x) At the Iso electric point (IEP), solubility of protein is _____.
 (a) maximum (b) minimum
 (c) neither maximum nor minimum (d) infinite

Fill in the blanks with the correct word

- (xi) Pore structure of a membrane can be determined by _____.
- (xii) Using _____ method, the largest pore size of a membrane can be determined.
- (xiii) The most common material for a hemodialysis membrane is _____.
- (xiv) For medical applications, _____ frequency ultrasound is used.
- (xv) _____ may be a reason for flux decline during ultrafiltration

Group - B

2. (a) Obtain the expression of *concentration polarization modulus*. [[CO1](Apply/IOCQ)]
 (b) An enzyme is being concentrated in a cross-flow ultrafiltration module. The mass transfer coefficient at the membrane surface is 2.8×10^{-5} cm/sec. The bulk concentration is 0.3 mass%. If the water flux is $0.42 \text{ m}^3/\text{m}^2\cdot\text{h}$ and the diffusivity of the enzyme is $8 \times 10^{-7} \text{ cm}^2/\text{sec}$., calculate the polarization modulus and thickness of mass-transfer 'film'. [[CO1](Evaluate/HOCQ)]
 (c) Write down the applications of reverse osmosis. [[CO1](Remember/LOCQ)]
- 5 + 5 + 2 = 12**

3. (a) In case of reverse osmosis, prove that,

$$R = \frac{B(\Delta P - \Delta \Pi)}{1 + B(\Delta P - \Delta \Pi)}$$
 [[CO1](Apply/IOCQ)]
 (b) A reverse-osmosis membrane to be used at 25°C for a NaCl feed solution containing 2.5 g NaCl/L, (density 999 Kg/m³) has a water permeability constant $4.81 \times 10^{-4} \text{ Kg}/(\text{s}\cdot\text{m}^2\cdot\text{atm})$ and a solute permeability constant $4.42 \times 10^{-7} \text{ m/s}$. Calculate the water flux, solute rejection and solute concentration in permeate. Given: $\Delta P = 27 \text{ atm}$., $\Delta \pi = 1.9 \text{ atm}$. [[CO1](Evaluate/HOCQ)]
- 6 + 6 = 12**

Group - C

4. (a) A dialysis membrane is 20 micron thick, with a distribution coefficient of 0.5. The diffusivity of the solute through the membrane is $2 \times 10^{-4} \text{ m}^2/\text{s}$. If the film mass transfer coefficients for the feed side and permeate side are $1.5 \times 10^{-6} \text{ m/s}$ and $3 \times 10^{-6} \text{ m/s}$ respectively, calculate the solute flux for a feed solute concentration of 3 kmol/m^3 and a permeate solute concentration of 0.2 kmol/m^3 . [[CO2](Apply/IOCQ)]

- (b) Draw the solute concentration profile for solute transport across a dialysis membrane and explain the pattern.

[[CO2](Analyse/IOCQ)]

8 + 4 = 12

5. (a) A kidney patient's blood is being dialysed at 300 ml/minute, to reduce creatinine concentration from 150% to 10%. The overall mass transfer coefficient is 1.5×10^{-6} m/s. If the blood volume is 5 litres and it is to be dialyzed within 3 hours, how many membrane tubes need to be installed within the dialyser? Assume that each membrane tube is 1 m long and 20 cm in diameter. Also assume that the dialysate fluid is solute free and the dialysate flow rate is much more than the blood flow rate.

[[CO2](Evaluate/HOCQ)]

- (b) Which type of dialyser will take a shorter time for dialysis: a co-current one or a counter-current one? Also which one will require a lesser area? Justify.

[[CO2](Evaluate/HOCQ)]

6 + 6 = 12

Group - D

6. (a) With example discuss supercritical fluid extraction. State its advantages.

[[CO3](Apply/IOCQ)]

- (b) Obtain the expression for *terminal velocity* during centrifugation?

[[CO3](Apply/IOCQ)]

- (c) How can relative centrifugal force be calculated?

[[CO3](Analyse/HOCQ)]

5 + 4 + 3 = 12

7. (a) What is liquid membrane? With schematic diagrams, discuss transport through various types of Liquid membranes.

[[CO3](Apply/IOCQ)]

- (b) Discuss an industrial application of separation using liquid membrane and its separation mechanism.

[[CO3](Remember/LOCQ)]

- (c) Mention the applications and advantages of cloud point extraction.

[[CO3](Understand/LOCQ)]

5 + 4 + 3 = 12

Group - E

8. (a) Define electro-osmotic flow. How does it affect electrophoresis performance?

[[CO4](Apply/IOCQ)]

- (b) Write down Poisson-Boltzman equation and state its significance.

[[CO4](Remember/LOCQ)]

- (c) Define isoelectric point.

[[CO4](Apply/IOCQ)]

6 + 4 + 2 = 12

9. (a) What do you understand by *electrophoretic mobility*?

[[CO4](Apply/IOCQ)]

- (b) Give an example of *electric field enhanced ultrafiltration*.

[[CO4](Remember/LOCQ)]

- (c) Discuss the sequence of steps carried out during ion-exchange chromatography of a sample. Give example of an ion exchanger.

[[CO4](Apply/IOCQ)]

3 + 3 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	16.67	56.25	27.08

