



Name :

Roll No. :

Invigilator's Signature :

CS/B.TECH(CHE)/SEM-7/CHE-704E/2011-12

2011

ADVANCED SEPARATION PROCESSES

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

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

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10
- i) Which arrangement of membrane separation processes is right based an ascending order of solute particle size ?
 - a) RO<UF<NF<MF
 - b) RO<NF<UF<MF
 - c) MF<UF<NF<RO
 - d) NF<RO<UF<MF.
 - ii) The fittest option for the concentration of fermentation broth from the following is
 - a) RO
 - b) UF
 - c) NF
 - d) MF.
 - iii) Which of the following types of membrane module is having maximum packing density (m^2/m^3) ?
 - a) Plate and frame
 - b) Tubular
 - c) Spiral wound
 - d) Hollow fibre.



GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

3 × 5 = 15

2. How is a porous membrane characterized by its pore size distribution ? How is 'perporometry' technique used for this purpose ? 3 + 2

3. A UF membrane offers a steady state solvent flux of $0.052 \text{ m}^3/\text{m}^2 \cdot \text{s}$ under gel polarization. The applied pressure drop is 4 bar and the resistance offered by the membrane is $2.4 \times 10^9 \text{ m}^{-1}$. What is the resistance offered by the gel layer ?

(Viscosity of water = 0.9 cp)

4. Why are liquid membranes also known as 'partraction' ? Explain the mechanism of mass transfer in liquid membrane. 2 + 3

5. What is the basic theory behind chromatographic separation ? Briefly explain about the advantages & disadvantages of chromatographic separation. 2 + 3

6. Why is electrodeionization found advantageous over traditional ion exchange process ?

**GROUP – C****(Long Answer Type Questions)**

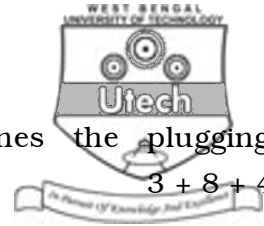
Answer any *three* of the following. $3 \times 15 = 45$

7. a) How the effect of concentration polarization on solvent flux can be quantified with the introduction of 'concentration polarization modulus' in ultrafiltration ?
- b) A macromolecular solution (M.W. = 6000, concentration = 1 mass%) is passed through a tubular UF membrane of 1 cm internal diameter and 1m long at 27°C. The membrane admits of a pure water permeability of 2.11 gal/(ft²) (day) (psi). Calculate the flow velocity to be maintained in the tube in order to prevent formation of a gel layer on the membrane surface. (Rejection coefficient, $R = 0.995$; pressure diff. $\Delta P = 1.5$ bar; diffusivity of the solute, $D = 8 \times 10^{-7}$ cm²/s; viscosity of the solution = 3cp; concentration at which the solute forms a gel = 10.5%).

5 + 10

8. a) Discuss about the selection criteria of RO membrane.
- b) A cellulose triacetate membrane is being used for reverse osmosis of a saline water solution containing predominantly NaCl at 27°C. The concentration of NaCl in the feed solution is 2500 ppm and its density is 999 kg/m³. Water permeability constant is 4.79×10^{-4} kg/s.m² atm and solute (NaCl) permeability constant is 4.38×10^{-7} m/s. Calculate the water flux and solute flux through the membrane using an applied pressure difference of 28.5 atm and solute rejection R . Also calculate the concentration of NaCl in the permeate.

(Given osmotic pressure difference, $\Delta \pi = 1.89$ atm & permeate density = 997 kg/m³)



- c) "Slit density index (SDI) determines the plugging propensity of an RO feed." Explain. 3 + 8 + 4
9. a) Explain the theory and mechanism of solute transfer from aqueous bulk phase into the internal emulsion phase for Emulsion liquid membrane (ELM). How does Biot number (Bi) determine the performance of Emulsion liquid membrane (ELM) ?
- b) How has permeation through the non-porous membrane been modelled from Fick's law and Henry's law in pervaporation ?
- c) Discuss about the factors affecting pervaporation. (3 + 2) + 7 + 3
10. a) Give typical specifications of a dialysis membrane. What is the difference between extracorporeal and extracorporeal dialysis ? Mention some popular applications of dialysis.
- b) Selective permeation of CO₂ from a mixture of 10% CO₂ (A) and 90% CH₄ (B) occurs at 35°C in a small apparatus with a well-mixed feed compartment. An asymmetric polysulphone membrane of 1 micron skin is layer thickness used. The permeate side is continuously swept with nitrogen gas. Given the following data, calculate; (i) the flux of CO₂ (ii) the average diffusivity of CO₂ in polysulphone (iii) the permeance of CH₄ in polysulphone. Permeation of the sweep gas (N₂) through the membrane may be neglected. (Given : Ideal separation factor of CO₂ over CH₄, $\alpha_{AB} = 22$; Henry's law constant for solubility of CO₂ at 35°C in polysulphone, $S_A = 2.1 \text{ cm}^3 \text{ (STP) / (cm}^3\text{)(atm)}$; permeability of CO₂, $P_A = 5.6 \text{ barrer}$. (2 + 2 + 3) + 8



11. Write short notes on any *three* of the following : 3 × 5

- a) Ion exchange membrane
 - b) Molecular weight cut-off
 - c) Membrane fouling & cleaning
 - d) Liquid chromatography
 - e) Supported liquid-membrane.
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