



Name :

Roll No. :

Invigilator's Signature :

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2013

ADVANCED SEPARATION PROCESS

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) Rejection coefficient of a reverse osmosis membrane is given by

- a) $B (\Delta P - \Delta \Pi) / (1 + B (\Delta P - \Delta \Pi))$
- b) $B (\Delta P + \Delta \Pi) / (1 + B (\Delta P + \Delta \Pi))$
- c) $B / (1 + B (\Delta P - \Delta \Pi))$
- d) $B (\Delta P - \Delta \Pi)$

where symbols have their usual meanings.

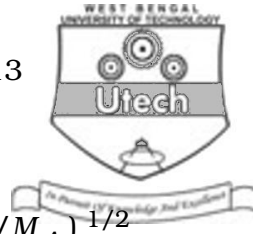
ii) Permeability coefficient can be defined as

- a) Diffusivity × Selectivity
- b) Diffusivity / Solubility
- c) Diffusivity × Solubility
- d) Selectivity × Solubility.

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iii) Knudsen diffusivity is proportional to

- a) $r (T/M_A)$ b) $r (T/M_A)^{1/2}$
- c) $r \times T/M_A$ d) $r (T/M_A)^{3/2} .$

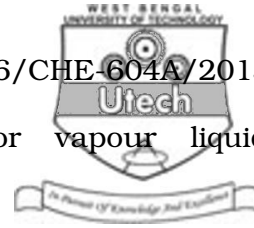
iv) The driving force for dialysis is

- a) Electrical potential difference
- b) Chemical potential
- c) Pressure difference
- d) Temperature difference.

v) The interaction between retained components and membrane surface resulting in irreversible fouling is called

- a) concentration polarization
- b) pore blocking
- c) pore diffusion
- d) none of these.

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vi) The membrane process used for vapour liquid separation like ethanol dehydration

- a) Ultrafiltration
- b) Microfiltration
- c) Pervaporation
- d) Reverse osmosis.

vii) How does solute rejection change with rise in pressure ?

- a) Decreases b) Increases
- c) Remains same d) None of these.

viii) Which of the following is not a colligative property ?

- a) Depression of freezing point
- b) Osmotic pressure
- c) Lowering of vapour pressure
- d) None of these.

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ix) Solutions having same osmotic pressure are called

- a) Isotonic solutions
- b) Dilute solutions
- c) Saturated solutions
- d) Ideal solutions.

x) Which type of membrane is used in dialysis ?

- a) Porous
- b) Micro-porous
- c) Semipermeable
- d) None of these.

xi) In reverse osmosis the effect of temperature is

- a) significant
- b) negligible
- c) very large
- d) very small.

xii) In membrane process, flux is proportional to pressure as

- a) inversely
- b) directly
- c) square
- d) square – root.

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GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following.

3 × 5 = 15

2. Why is nanofiltration also known as loose RO ?
3. Deduce equation for mass transport of pervaporation for a pure liquid (ideal case).
4. Write short notes on the following :
 - i) Membrane module
 - ii) Isotropic membranes.
5. Discuss in brief the methodology of conducting SDS-PAGE Electrolysis.
6. Explain the phenomenon of extracorporeal haemodialysis.
 What type of membrane is used for dialysis ? 4 + 1

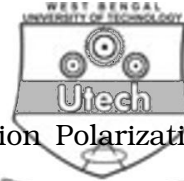
GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following.

3 × 15 = 45

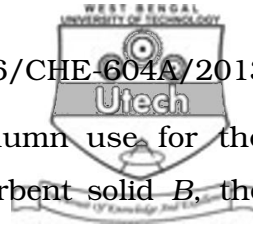
7. What is liquid membrane ? Explain different types of liquid membrane with example. Derive flux expression for facilitated transport liquid membrane. Give a flow diagram for the emulsion liquid membrane. 2 + 5 + 5 + 3

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8. What is ultra-filtration ? Explain 'Concentration Polarization' for UF system with a neat sketch. Briefly explain two applications of UF system in industry. What are the limitations of UF system ? 2 + 5 + 5 + 3
9. An RO module is to be designed for production of $1000 \text{ cm}^3/\text{day}$ of potable water containing 200 ppm salt from brackish water containing 34 g salt per litre. An asymmetric cellulose acetate membrane with an inherent salt rejection ability of 98% is to be used. The water permeation coefficient is $0.035 \text{ m}^3/\text{m}^2 \cdot \text{day} \cdot \text{atm}$. The recovery of feed water should be 45% and an operating pressure of 50 atm gauge is suggested. The permeate side may be assumed to be in atmospheric pressure. If spiral wound modules of 5 m^2 effective membrane area each is used, how many modules in parallel are required ? The osmotic pressure of 5% brine (linear in salt concentration) is 39.5 atm.
10. a) Discuss the detailed principles of iso-electric precipitation.
- b) The solubility of a protein is 15 g/dm^3 at ammonium sulphate concentration of 2.2 M and 0.25 g/dm^3 at 3.0 M. Calculate the solubility of the protein at 3.8 M of the salt.

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- c) In a chromatographic separation column use for the adsorption of solute A onto an adsorbent solid B, the atmospheric isotherm is given by

$C_s = k_1 C_L^3 = f(C_L)$, where the C_s is mg solute adsorbed/mg adsorbent C_L is the solute concentration in liquid medium (mg solute/ml liquid) and k_1 is constant and $k_1 = 0.2$ (mg solute adsorbed/mg adsorbent)/(mg solute/ml liquid)³. The porosity (void fraction) of the packed column $\varepsilon = 0.35$. The cross-sectional area of the column is 10 cm^2 and M is 5 gm adsorbent per 100 ml column volume. If the volume of the liquid added is $\Delta V = 250 \text{ ml}$,

- i) determine the position (ΔX) of the solute band in the column when the solute concentration in the liquid phase at equilibrium is

$$C_L = 5 \times 10^{-2} \text{ mg/ml.}$$

- ii) find the ratio of the travel distance of solute A (L_A) to that of solvent B in the column (R_f) when $C_L = 5 \times 10^{-2} \text{ mg/ml}$. 4 + 4 + 7

11. Write down a few applications of pervaporation process. What are the problems of pervaporation over other modern separation processes? Deduce the model equations for mass transport of pervaporation for a pure liquid (ideal case).

4 + 3 + 8

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