Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech/CHE/NEW/SEM-6/CHE-604A/2013

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 : $10 \times 1 = 10$

   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.

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.

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.

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.

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

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 cm^3/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 m^3/m^2. day. 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.

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 ε = 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 ΔV = 250 ml,

i) determine the position (ΔX) of the solute band in the column when the solute concentration in the liquid phase at equilibrium is
$C_L = 5 \times 10^{-2}$ mg/ml.

ii) find the ratio of the travel distance of solute *A* (L_A) to that of solvent *B* in the column (*Rf*) when $C_L = 5 \times 10^{-2}$ 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