



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 × 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

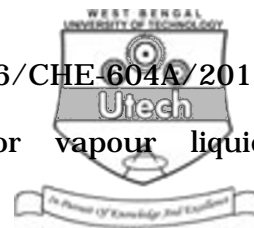
- a)  $r ( T/M_A )$                       b)  $r ( T/M_A )^{1/2}$   
c)  $r \times T/M_A$                       d)  $r ( T/M_A )^{3/2} .$

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.  $3 \times 5 = 15$

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.  $3 \times 15 = 45$

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.  $2 + 5 + 5 + 3$



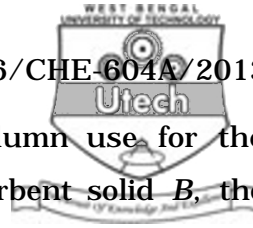
8. What is ultra-filtration ? Explain 'Concentration Polarization' for UF system with a neat sketch. Briefly explain two applications of UF system in industry. What are the limitations of UF system ?

2 + 5 + 5 + 3

9. An RO module is to be designed for production of 1000 cm<sup>3</sup>/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<sup>3</sup>/m<sup>2</sup>. 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<sup>2</sup> 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<sup>3</sup> at ammonium sulphate concentration of 2.2 M and 0.25 g/dm<sup>3</sup> 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)<sup>3</sup>. The porosity (void fraction) of the packed column  $\varepsilon = 0.35$ . The cross-sectional area of the column is  $10 \text{ cm}^2$  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 ( $\Delta X$ ) 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 ( $Rf$ ) 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

