

**TRANSFER OPERATIONS – II**  
**(BTC3104)**

**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) Diffusion coefficient in a binary gas mixture at low pressure varies  
(a) Directly with P (b) Inversely with P  
(c) Directly with P<sup>2</sup> (d) Independent of P
- (ii) Packed columns are  
(a) differential contact plant (b) stage contact plant  
(c) gas-liquid contact plant (d) solid-liquid contact plant
- (iii) When the boiling temperature is plotted against the liquid composition, then it is called  
(a) Cooling Curve (b) Heating Curve  
(c) Bubble point curve (d) Volatility Phase Diagram
- (iv) As the reflux ratio in a distillation column is increased from the minimum, the  
(a) slope of the operating line in stripping section increases  
(b) number of plates decreases very slowly first and then more and more rapidly  
(c) total cost first decreases  
(d) liquid flow increases while the vapor flow decreases for a system.
- (v) Which of the following is not separated through distillation process?  
(a) Acetone and water (b) Aniline and chloroform  
(c) Impurities in Sea water (d) Milk and water
- (vi) For estimating the drier size it is necessary to know \_\_\_\_\_  
(a) Time of drying (b) Heat of drying  
(c) Speed of drying (d) All of the mentioned
- (vii) Solvent extraction is more effective when the extraction is repeated with:  
(a) Extra solvent (b) Large solvent  
(c) Small solvent (d) No solvent

- (viii) What is meant by crystallization?  
 (a) Concentration of atoms into a highly structured form  
 (b) Solidification of atoms into a highly structured form  
 (c) Solidification of solution  
 (d) Concentration of solution
- (ix) Which of the following is a pressure driven membrane separation process?  
 (a) Dialysis (b) Osmosis  
 (c) Electrodialysis (d) Reverse Osmosis
- (x) Diffusion coefficient in a binary gas mixture varies with temperature  
 (a) Directly with T (b) Inversely with P  
 (c) Directly with  $P^{3/2}$  (d) Independent of T

*Fill in the blanks with the correct word*

- (xi) The relationship between the temperature of saturated liquid feed and bubble point is \_\_\_\_ .
- (xii) Mole fraction of MVC in distillate is always \_\_\_\_ than mole fraction of MVC in feed.
- (xiii) Absorption is a \_\_\_\_ process.
- (xiv) The most important application of reverse osmosis is \_\_\_\_ .
- (xv) Extraction factor is related to distribution coefficient by the relation \_\_\_\_

### Group - B

2. (a) Differentiate between steady state one way diffusion and pseudo steady state one way diffusion. [[CO1](Remember, Differentiate/LOCQ)]
- (b) Give a practical example for each type of diffusion from your everyday life. [[CO1](Remember/LOCQ)]
- (c) Derive a mathematical expression for measuring diffusion flux in pseudo steady state one way diffusion. [[CO2](Apply/IOCQ)]
- 3 + 3 + 6 = 12**

3. An air-ammonia mixture containing 20%(mole)  $\text{NH}_3$  is scrubbed with water in a counter current packed tower to remove 95% ammonia in the entering gas. The gas enters the column at  $1000\text{kg/h.m}^2$  and the column is operated at 308K and 101.3kPa. Pure water is admitted at a rate 1.5 times the minimum rate. The equilibrium relation is  $y=0.75x$  where x and y are mole fractions. The mass transfer coefficient ( $K_y a=34\text{kmol/h.m}^3$ ). Find the height of the tower. [[CO2](Apply/HOCQ)]
- 12**

### Group - C

4. (a) Derive the Raleigh equation for batch distillation. [[CO3](Analyse/HOCQ)]
- (b) Write short note on extractive distillation? [[CO4](Remember/LOCQ)]
- 6 + 6 = 12**

5. A mixture of n-heptane and n-octane containing 40 mol% n-heptane is subjected to simple distillation at 101.3 KPa. Equilibrium data is given below:

X	0	0.157	0.312	0.487	0.655	1
Y	0	0.279	0.492	0.674	0.810	1

- (i) Determine the composition of the residue and distillate if half of the feed is distilled off.  
(ii) Determine the composition of the residue and moles of the distillate product, if it is desired that the distillate product has an average composition of 57 mol% n-heptane and waste product generated is to be of 77 kmol, when 100 kmol of feed is introduced.

[[CO3](Analyse/HOCQ)]

**(9 + 3) = 12**

### Group - D

6. (a) What is adsorption isotherms? Name and explain any two isotherms applicable for adsorption process.  
(b) Define Relative humidity and Percentage humidity.

[[CO5](Understand/LOCQ)]

[[CO4](Remember/LOCQ)]

**(2 + 6) + (2 + 2) = 12**

7. Data on the drying curve of a particular solid is given below. The weight of the dry material in the solid is 48.0 kg/m<sup>2</sup>. Calculate the time required to dry the material from 20% to 8% moisture.

X	0.30	0.20	0.18	0.15	0.14	0.11	0.07	0.05
N	1.22	1.22	1.14	0.90	0.80	0.56	0.22	0.05

[[CO5](Analyse/HOCQ)]

**12**

### Group - E

8. (a) What are the working principles of ultra-filtration, electro dialysis and reverse osmosis?  
(b) Where can you apply the above unit operations in the field of biotechnology.

[[CO6](Calculate/IOCQ)]

[[CO6](Understand/LOCQ)]

**6 + 6 = 12**

9. In a cross flow ultra filtration system for separation of protein from the fermentation broth, the flow rate of liquid through a tube of diameter d=2cm and length L= 50cm is Q= 2L/min. The flow regime is turbulent, f=0.0005, and C<sub>4</sub>= 2[atm(s/cm)<sup>2</sup>]. The inlet pressure is P<sub>i</sub>= 2 atm. Protein concentration in the solution and on gel film are C<sub>B</sub>= 30mg/L and C<sub>G</sub> =100 mg/L, respectively. Determine:

(i) The transmembrane pressure drop.

(ii) If the mass transfer coefficient (k) for protein flux is k= 5cm/s, determine the flux of liquid through the UF membrane.

[[CO6](Analyse/IOCQ)]

**12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	37.5	18.75	43.75

