Code No: R09222301 **R09** **Set No. 2**

II B.Tech II Semester Examinations,April/May 2012
MASS TRANSFER OPERATIONS
Bio-Technology

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) What is differential distillation? Derive Rayleigh equation and mention the assumption involved during derivation.
   (b) Explain T-x-y diagram with neat sketch. [9+6]

2. What are the different types of membrane modules available? Explain each module. [15]

3. (a) What is meant by "specific oxygen uptake rate"?
   (b) What is the Sherwood number? How is it analogous to the Nusselt number?
   (c) What happens to the mass transfer coefficient when the temperature is changed? [5+5+5]

4. (a) Explain briefly various pressure driven membrane separation process.
   (b) Explain briefly separation process where surface phenomena is important with suitable examples. [9+6]

5. (a) Explain typical equilibrium diagrams used in leaching operation.
   (b) Define distribution coefficient.
   (c) What is a constant under flow? [6+5+4]

6. 1400 kg (bone dry) of granular solid is to be dried under constant drying conditions from a moisture content of 0.2 kg/kg of dry solid to a final moisture content of 0.02 kg/kg dry solid .The material has an effective area of 0.0615 m^2 /kg of solid. Under the same condition the following rates were previously known (data given below). Calculate the time required for drying.

X:	0.300	0.200	0.140	0.096	0.056	0.046	0.026	0.016
Y:	1.710	1.710	1.710	1.460	1.290	0.880	0.540	0.376

   Where X is kg/kg of dry solid and Y is in kg/ m^2 [15]

7. A mixture containing 40 weight percent acetone and 60 weight percent water is contacted with an equal amount of MIK.
   (a) What fraction of the acetone can be extracted in a single-stage process?
   (b) What fraction of the acetone could be extracted if the fresh solvent were divided into two parts and two successive extraction used?

Composition data (wt%)			Acetone distribution data (wt%)	
MIK	Acetone	Water	Water phase	MIK phase
98.0	0	2.00	2.5	4.5
93.2	4.6	2.33	5.5	10.0
77.3	18.95	3.86	7.5	13.5
71.0	24.4	4.66	10.0	17.5
65.5	28.9	5.53	12.5	21.3
54.7	37.6	7.82	15.5	25.5
46.2	43.2	10.7	17.5	28.2
12.4	42.7	45.0	20.0	31.2
5.01	30.9	64.2	22.5	34.0
3.23	20.9	75.8	25.0	36.5
2.12	3.73	94.2	26.0	37.5
2.20	0	97.8		

8. Calculate the extraction factor to facilitate the extraction of penicillin from the fermentation broth using amyl acetate. Fermentation broth contains 220 mg/l of penicillin at pH 3, volume of the feed solvent is 500 l/hr and extraction solvent is 40 l/hr, and the equilibrium constant K is 80. [15]

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Code No: R09222301 **R09** **Set No. 4**

II B.Tech II Semester Examinations,April/May 2012
MASS TRANSFER OPERATIONS
Bio-Technology

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. What are the advantages of membrane separation process? Also write some of its applications. [15]

2. (a) Define reflux and reflux ratio.
   (b) Explain the importance of reflux in a distillation column.
   (c) How will you calculate the optimum reflux ratio? [4+5+6]

3. (a) Write about the use of rectangular coordinates to describe the concentrations in ternary system.
   (b) Write short notes on triangular diagram. [8+7]

4. Estimate the liquid phase oxygen transfer coefficient from gas bubbles to the aqueous liquid phase in an airlift fermentor in which the aqueous liquid phase density is 1 g/ml, the aqueous liquid phase viscosity is 0.009 g/cm-sec, the diffusivity of oxygen is 2.5×10^{-5} cm^2/sec, the mean diameter of the bubbles is 1.3 mm, the gas flow rate is 1 volume of gas per volume of liquid per minute, and the pressure is 17 psia entering and 14.7 psia in the effluent. [15]

5. (a) While drying a solid from 33% to 1% moisture (dry basis), it is found that the constant rate drying time is the same as the falling rate drying time. The equilibrium moisture is negligible. If the falling drying rate is linear in the moisture content, what is the critical moisture content of the solid?
   (b) An indirect-heat rotary dryer (say a steam-tube rotary dryer) is often found to be more energy efficient than the direct heat dryer. How can this be explained? [8+7]

6. (a) Write the importance of pH for the extraction of penicillin.
   (b) Discuss Precipitation in crystallization and write the applications of these operations in citric acid production. [7+8]

7. Ammonia is diffusing through a stagnant mixture containing 1/3 N_2 and 2/3 H_2 by volume. The total pressure is 206kN/m^2 and temperature of 55^0C. Calculate the rate of diffusion of ammonia through a film of 0.5mm thickness when the concentrations of ammonia on either side of the film are 10% and 5% by volume.

   Diffusivity of NH_3 in N_2 at 25 ^{0} C = 1.32×10^{-5} m^2/sec.
   Diffusivity of NH_3 in H_2 at 25 ^{0}C = 4.1×10^{-5} m^2/sec. [15]

8. (a) Discuss about integral heat of adsorption.

(b) Differentiate between adsorbent and adsorbate?

(c) An aqueous solution colored by small amount of impurities which can he removed by adsorption on carbon. A series of laboratory tests yield the equilibrium data represented by the equation. $y = 8.91^{0}10^{-5}\ x^{1.66}$, where y = equilibrium color units/kg solution and x is units of color adsorbed/kg carbon. It is desired to reduce the color of the solution from 9.6 units to10% of the value. Determine the quantity of fresh carbon required per 1000kg of solution for a single stage operation. [4+4+7]

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Code No: R09222301 **R09** **Set No. 1**

II B.Tech II Semester Examinations,April/May 2012
MASS TRANSFER OPERATIONS
Bio-Technology

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
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1. (a) Write the advantages of membrane separation processes over the conventional separation process.
   (b) Describe the industrial applications of membrane gas separation. [8+7]

2. (a) Write the role and importance of crystallization for production of penicillin.
   (b) Write the importance of crystallization temperature for isolation of citric acid and also write the problems associated during crystallization. [7+8]

3. (a) Explain the step-by-step procedure for the calculation of theoretical number of plates of a distillation column by McCabe-Thiele method. Mention the assumption made and its limitations.
   (b) Explain about 'steam distillation'. [9+6]

4. A gas mixture A-air is fed into an absorption tower where absorption of component A in water is taking place at 298 K and 2 std atm. Given that k_L = 0.122 kmol A/(hr.m^2) (mol A/m^3). KG = 1.32 k mol A / hr.m^2.atm the equilibrium partial pressure of gas A over dilute solution of A in the water is given $p_{A,i} = 0.28(c_{A,i})$ is in atm while $c_{A,I}$ is expressed in terms of mol A/m^3. Determine the values of the following mass transfer coefficients.
   (a) k_y
   (b) k_c for gas film
   (c) K_L. [15]

5. (a) Consider diffusion of A in non-diffusing B through a constant area from z = z_1, $p_A = p_{A1}$ to z = z_2, $p_A = p_{A2}$ ($p_{A1} \leq p_{A2}$). At which point in the diffusion path is the magnitude of the partial pressure gradient maximum?
   (b) Calculate the rate of diffusion of 'A' through non-diffusing 'B' at 25^{0}C and 101 kN/m^2 pressure $D_{AB} = 6.6 \times 10^{-5}$m^2/s. The diffusional path is 5 mm long and the concentration of 'A' at the two ends of the path in terms of partial pressure is 12 kN/m^2 and 8.4 kN/m^2 respectively. [7+8]

6. (a) Explain typical equilibrium diagrams used in leaching operation.
   (b) What is constant underflow? [11+4]

7. It is planned to extract diphenyl hexane (DPH) from a solution in docosane (A) using 'pure' furfural (B) as the solvent. The feed enters the cross current cascade

at a rate of 2000 kg/h with 45% DPH (C) that has to be reduced to 4% in the final raffinate. The solvent rate is 700 kg/h in each stage. Determine the number of theoretical stages required. Extraction is to be carried out at 45^0C. Several compositions at 45^0C are given below. [15]

Equilibrium data

A:	96.0	84.0	67.0	52.5	32.6	21.3	13.2	7.7	4.4	2.6	2.6	1.5	1.0	0.7
B:	4.0	5.0	7.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	70.0	80.0	90.0	99.3
C:	0	11.0	26.0	37.5	47.4	48.7	46.8	42.3	35.6	27.4	27.4	18.5	9.0	0.0

Tie-line data

Raffinate (Docosane) phase, mass%

A	B	C
85.2	4.8	10.0
69.0	6.5	24.5
43.9	13.3	42.6

Extract (Furfural) phase, mass%

A	B	C
1.1	89.1	9.8
2.2	73.6	24.2
6.8	52.3	40.9

8. (a) A plant wishes to dry a certain type of fiber board in sheets 1.2m × 2m × 12mm. To determine the drying characteristics a 0.3mx0.3mx12mm sample of the board with the edges sealed so that drying took place from the two large faces only, was suspended from a balance in a laboratory cabinet drier and exposed to a current of hot dry air. The initial moisture content was 75%. The sheets lost weight at the constant rate of 1×10^{-4}kg/sec. Until the moisture content fell to 60% where upon the drying rate fell. Measurements of the rate of drying were discontinued, but after a long period of exposure to the air it was established that the equilibrium moisture content was 10%. The dry mass of the sample was 0.9kg.All moisture content on the wet basis. Determine the time for drying the large sheets from 75 to 20% moisture under the same drying conditions.

   (b) Differentiate between bound and unbound moisture. [11+4]

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Code No: R09222301 **R09** **Set No. 3**

II B.Tech II Semester Examinations,April/May 2012
MASS TRANSFER OPERATIONS
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Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
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1. (a) A binary mixture of A and B components the following temperature and vapour pressure characteristics (vapour pressure in mm Hg)

T^0C	38.5	42	46	50	54	58	62
Vapour pressure A	400	458	532	615	708	812	948
Vapour pressure B	160	185	217	254	295	342	400

Calculate the T-x-y diagrams for the above system at 400 mm of Hg total pressure and also compute the average relative volatility.

(b) Explain the principles of flash vaporization. [9+6]

2. (a) Write the equations for calculating water flux, solute flux and rejection coefficient in reverse osmosis process.

(b) Write short notes on effect of operating parameters on flux and rejection coefficient in reverse osmosis. [8+7]

3. (a) Make a sketch to show typical concentration profiles of the solute during mass transfer across an interface. Qualitatively explain the concentration profiles.

(b) Write short notes on equilibrium. [8+7]

4. A solute is recovered from an aqueous solution containing 20% of the solute by weight using kerosene as the solvent. The distribution of the solute in water and kerosene may be described by $x' = 6045y'$ where x' is the kg of solute per kg of water and y' is the kg of solute per kg of kerosene. Calculate the final concentration in the final raffinate if the extractions done in 3 simple equilibrium contacts using 5kg solvent per kg of initial solution in each stage. [15]

5. (a) What is the oldest separation method used for the removal of final 4 to 5% of water present in the ethanol. Explain.

(b) Explain briefly vacuum crystallization of citric acid with neat sketch. [6+9]

6. Ammonia gas and Nitrogen gas are diffusing in counter current through diffusion from a straight glass tube 0.61 m long with an inside diameter of 24.4 mm at 298 K and 101.32 KPa. Both ends of the tube are connected to large mixed chambers at 101.32 KPa. The partial pressure of NH_3 in one chamber is constant at 20 KPa and 6.666 KPa in the other chamber. The diffusivity at 298K and 101.32 KPa is 2.30×10^{-5} m^2 /sec.

(a) Calculate the rate of diffusion of NH_3 in kg mol/s.

(b) Calculate the rate of diffusion of N_2.

(c) Calculate the partial pressure at a point 0.305 m in the tube and plot p_A, p_B and p_t verses distance z. [15]

7. (a) The equilibrium adsorption of acetone vapour on activated carbon at 30^0 C is given by

gm adsorbed/ gm carbon	0	0.1	0.2	0.3	0.35
partial pressure of acetone, mm Hg	0	2.0	12.0	42.0	92.0

A litre flask contains air and acetone vapour at 1 atm. and 30^0C with partial pressure of acetone 100mm Hg. Two grams of fresh activated carbon is introduced into the flask and it is sealed. Compute the final vapour concentration at 30^0C and pressure inside the flask. Neglect the absorption of air.

(b) Write short notes on applications of leaching? [9+6]

8. In order to test the feasibility of drying a certain foodstuff, drying data were obtained in a tray dryer with air flow over the top exposed surface having an area of 0.186 m^2. The bone-dry sample weight was 3.765 kg dry solid. At equilibrium after a long period, the wet sample weight was 3.955 kg H_2 O + solid. Hence, 3.955 - 3.765, or equilibrium moisture was present. The following sample weights versus time were obtained in the drying test.

Time(h)	Weight(kg)	Time(h)	Weight(kg)	Time(h)	Weight(kg)
0	4.944	2.2	4.554	7.0	4.019
0.4	4.885	3.0	4.404	9.0	3.978
0.8	4.808	4.2	4.241	12.0	3.955
1.4	4.699	5.0	4.150		

(a) Calculate the free moisture content and plot X versus t.

(b) Construct the rate drying curve.

(c) Predict the total time required to dry the sample from X =0.2 to 0.04. [15]

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