Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–I(New course)• EXAMINATION – WINTER- 2015

Subject Code: 2713011 **Date: 04/01/2016**

Subject Name: Membrane Separation Processes

Time:2:30 pm to 5:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1	**(a)**	State various methods of manufacturing of polymeric membranes and discuss any one in details.	**07**
	(b)	Answer the following questions to the point: i] Name a membrane process in which phase change takes place. ii] Arrange the following membrane processes in ascending order of solute particle size: RO,UF, NF, MF iii] Which membrane process may be suitable for the recovery of proteins from whey? iv] How does temperature affect solvent flux and solute rejection in RO? v] What is the driving force in dialysis? vi] What is the difference between liquid-liquid extraction and liquid membrane separation? vii] The ideal separation factor of B and A for diffusion through a polymer film is α^*_{BA} = 4.5. The permeability of A (P'_A) = 3 barrer, what is the permeability of B?	**07**
Q.2	**(a)**	Compare Kedem-Katchalsky and Spiegler-Kedem model of solvent and solute transport by reverse osmosis. Discuss briefly the Solution-diffusion models of solute transport in reverse osmosis.	**07**
	(b)	Explain concentration polarization in ultrafiltration process with a schematic diagram. How can the effect of concentration polarization be reduced in pressure driven membrane processes?	**07**
		OR	
	(b)	Discuss the effect of various parameters on the performance of nanofiltration process. State few industrial applications of nanofiltration	**07**
Q.3	**(a)**	Discuss solvent and solute transport mechanism in nanofiltration	**07**
	(b)	Discuss fundamental mechanisms of gas transport with special mention of dual sorption model.	**07**
		OR	
Q.3	**(a)**	Derive the design equation for the separation of binary gas mixture using a complete mixing model. State the assumptions clearly.	**07**

(b) A membrane is to be used to separate gaseous mixture of 'A' & 'B' whose feed flow rate is 1×10^4 cm^3(STP)/s and feed composition of A, x_f = 0.50 mole fraction. The desired composition of the reject x_o= 0.25, the membrane thickness 2.54×10^{-3} cm, the pressure on the feed side 80 cm Hg and on permeate side 20 cm Hg. Permeabilities of A and B are 50×10^{-10} and 5×10^{-10} cm^3 (STP).cm/(s.cm^2. cm-Hg) respectively. Assuming complete mixing model, calculate the permeate composition, fraction permeated and the membrane area. **07**

Given:

$$a = 1 - \alpha^*$$

$$b = \frac{p_h}{p_l}(1 - x_o) - 1 + \alpha^* \frac{p_h}{p_l} x_o + \alpha^*$$

$$c = \alpha * \frac{p_h}{p_l} x_o$$

Q.4 **(a)** State the basic principle of pervaporation. Discuss critically the phenomenon of temperature-drop at the membrane surface during pervaporation. **14**

State various industrial applications of pervaporation and discuss any one application with a schematic diagram.

OR

(b) Derive various mass transfer resistances in a dialysis process with a schematic diagram. **14**

A dialysis process is being designed to recover a certain solute from a dilute solution having solute concentration 2.0×10^{-2} kg mol/m^3 through a membrane to a solution having solute concentration 0.3×10^{-2} kg mol/m^3. The membrane is 1.59×10^{-5} m thick. The distribution coefficient is 0.75; diffusivity of solute through membrane is 3.5×10^{-11} m^2/s. The mass transfer coefficients in the upstream and downstream are 3.5×10^{-5} m/s and 2.1×10^{-5} m/s respectively. Calculate

(i) The individual resistances, total resistance and the total percent resistance of the two films.

(ii) The flux at steady state and the total area in m^2 for a transfer of 0.01 kg mol solute/h.

Q.5 **(a)** Explain the working principles of various types of liquid membranes with schematic diagrams. **07**

(b) What are the applications of liquid membrane technology? **07**

OR

Q.5 **(a)** Discuss various configuration and mechanism of membrane distillation. State the characteristics of membranes used in membrane distillation? **07**

(b) Write a short note on recycle membrane bioreactor. **07**

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