Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER-1 (NEW) EXAMINATION – WINTER 2016

Subject Code: 2713011 **Date:06/01/2017**

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)** Explain briefly the advantages and disadvantages of membrane separation processes. How do you classify membrane processes? **07**

(b) What are the different modules of membrane? Explain their relative features along with advantages. **07**

Q.2 **(a)** Discuss Kedem-Katchalsky and Solution diffusion model for membrane transport by reverse osmosis. Is there any demerit of the above models? **07**

(b) Answer as directed: **07**

i] Give two examples of naturally occurring semipermeable membrane.

ii] Which of the following type of membrane module is having maximum packing density (m^2/m^3)?

(a) Plate and frame (b) Spiral wound (c) Tubular (d) Hollow fibre

iii] In pervaporation, the permeate side is usually under a vacuum. Explain why?

iv] Which amongst RO, NF, UF and MF requires less applied pressure and why?

v] How does the selectivity of separation change with the increasing membrane thickness?

vi] The ideal separation factor of B and A for diffusion through a polymer film is $\alpha^*_{BA} = 4.5$. The permeability of A is 3 barrer, what is the permeability of B?

vii] Name the impurities of blood that can be removed by dialysis.

OR

(b) A dialyser unit has to be designed, the area of which is 1.2 m^2. There are a total of 5000 fibres having diameter 300 m. The overall mass transfer coefficient $K_L = 1.3 \times 10^{-6}$ m/s. The wall thickness of the fibres is rather small, and the flow rate of the dialysate is much larger than that of blood. If an extraction ratio of 0.85 is achieved in the dialyser, calculate its HTU. **07**

Q.3 **(a)** Derive the design equations for the complete mixing model of gas transport with a schematic. State the assumptions clearly **07**

	(b)	Explain transport mechanism in nanofiltration membranes. State and explain various parameters affecting the performance of nanofiltration process.	**07**

OR

Q.3	**(a)**	Discuss various mechanism of membrane gas transport. State important industrial applications of membrane gas transport.	**07**
	(b)	A mixture of oxygen and nitrogen is being separated by a gas separation membrane module using a silicone rubber membrane. The membrane module is perfectly mixed. Inlet gas is 21 mol% O_2. We desire a permeate product which is 27 mol% O_2. Membrane has a selectivity $\alpha_{AB} = P_A/P_B = 2.1$. Pressure ratio is $P_l/P_h = 0.35$. Treat the gases as ideal gases. What cut fraction must be used?	**07**
Q.4	**(a)**	Calculate the rate of removal of urea in g/h from blood in a cellophane membrane dialyzer at 37ºC. The membrane is 0.025 mm thick and having an area of 2.0 m^2. The mass transfer coefficient on the blood side is 1.25×10^{-5} m/s and that on the aqueous side is 3.33×10^{-5} m/s. The membrane permeability is 8.73×10^{-6} m/s. the concentration of urea in blood is 0.02 g urea per 100 ml and that in the dialyzing fluid can be assumed zero.	**07**
	(b)	Explain the phenomena of concentration polarization in ultrafiltration. State various methods to reduce concentration polarization	**07**

OR

Q.4	**(a)**	Write short notes on miceller-enhanced and affinity ultrafiltration.	**07**
	(b)	Discuss types and working of liquid membrane. Discuss their industrial applications.	**07**
Q.5	**(a)**	Discuss various factors affecting pervaporation "Temperature drop at the membrane surface in a drawback in pervaporation" Justify. How do you get rid of such problem?	**07**
	(b)	State and elaborate important applications of pervaporation with special reference to its use in combination with a distillation unit.	**07**

OR

Q.5	**(a)**	State and explain various mechanisms of facilitated transport.	**07**
	(b)	Explain with diagrams three general types of membrane reactor. Write a note on membrane bioreactor.	**07**

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