

JK LAKSHMIPAT UNIVERSITY, JAIPUR
INSTITUTE OF ENGINEERING AND TECHNOLOGY
 End Term Examination (Regular/Backlog), November 2017
 B. Tech/ M. Tech (as applicable) in Chemical Engineering, Semester Seventh

Roll No.....

COURSE CODE: CHE722

Time: 3 hours

Max. Marks: 100

COURSE TITLE: Advanced Separation Processes

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1A	Objective type multiple choice questions (10 questions @ 1 mark)	10
i.	How much pressure on feed side for high pressure Reverse Osmosis (a) >100 bar (b) >120 bar (c) >150 bar (d) >200 bar	
ii.	What is the outer diameter range of the hollow fiber membrane module is (a) 25-250 μm (b) 10-100 μm (c) 50-250 μm (d) None of above	
iii.	What is the wall thickness range of the hollow fiber membrane module is (a) 5-50 μm (b) 1-50 μm (c) 25-75 μm (d) none of above	
iv.	How much the packing density range in spiral wound module (a) 300 to 1000 m^3/m^2 (b) 30 to 100 m^3/m^2 (c) 3 to 10 m^3/m^2 (d) None of above	
v.	Which pore size membrane are used in reverse osmosis process (a) <2 nm (b) >2 nm (c) = 2 nm (d) <0.2 nm	
vi.	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 Fiber	
vii.	Which of the following techniques yields a membrane of narrow pore size distribution? (a) Film Stretching (b) Phase inversion (c) Track etching (d) None of above	
viii.	How does solute rejection change with rise in pressure (a) Decreases (b) increases (c) remains same (d) none of above	
ix.	An asymmetric cellulose acetate membrane is to be cast from a solution of the polymer in acetone. Which of the following liquids may be used as a non-solvent during membrane preparation by phase inversion? (a) Water (b) Diethylformamide (c) Acetic acid (d) None of above	
x.	Arrange the following membrane processing in ascending order of solute particle size. (a) Reverse osmosis (b) Ultra filtration (c) Nano filtration (d) Micro Filtration	

Q.2	Short answer type questions (4 questions @ 2.5 marks)	10
A.	Discuss the basic principle of microfiltration.	
B.	Write the basic information on dialysis process.	
C.	Write the salient features of tortuous pore membrane.	
D.	What are the fundamental mechanism of gas transport?	

Q.3A	Derive the correlation for membrane plunging and throughput in microfiltration process.	5
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Q.3B	An experiment is being carried out to study the microbial population characteristics of water using microfiltration. Polyamide membrane having a thickness of 80 micrometer and average porosity of 0.35 is used. Pure water flux through the membrane is $30 \text{ m}^3/\text{m}^2\text{h}$ at a pressure drop of 1.2 bar at 25°C . The average pore size is estimated to be 1 micrometer. Calculate the tortuosity factor of the pores and the resistance to flow offered by the membrane. The viscosity of the water at 25°C is 0.9 cP.	5
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Q.4A	Derive the correlation for mass transfer in dialysis with suitable diagram.	5
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Q.4B	A dialyzer unit has to be designed, the area of which is 1.2 m^2 . There are a total of 5000 fibers having diameter 300 m. the overall mass transfer coefficient is $1.3 \times 10^{-6} \text{ m/s}$. the wall thickness of the fibers is rather small, and the flow rate of the dialysate is much larger than that of blood. If an extraction ration of 0.85 is achieved in the dialyzer, calculate its height of transfer unit (HTU).	5
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Q.5A	Write the advantages and disadvantages of diffusion dialysis.	5
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Q.5B	Write the application of pervaporation for removal of volatile organic compounds from water with suitable diagram.	5
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Q.6A	What are the principle of the pervaporation explain it with suitable diagram.	5
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Q.6B1	A dialysis process is being designed to recover a certain solute from a dilute having solute concentration $2.0 \times 10^{-2} \text{ kgmol/m}^3$ through a membrane to a solution having solute concentration $0.3 \times 10^{-2} \text{ kgmol/m}^3$. The membrane is $1.59 \times 10^{-5} \text{ m}$ thick. The distribution coefficient is 0.75; diffusivity of solute through the membrane is $3.5 \times 10^{-11} \text{ m}^2/\text{s}$. the mass transfer coefficients in the upstream and downstream are $3.5 \times 10^{-5} \text{ m/s}$ and $2.1 \times 10^{-5} \text{ m/s}$, 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.	5
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OR

Q.6B2	A membrane of thickness of $2 \times 10^{-3} \text{ cm}$, a permeability is $400 \times 10^{-10} \text{ cm}^3 \cdot \text{cm}/\text{s} \cdot \text{cm}^2 \cdot \text{cmHg}$ and separation factor of 10 is to be used to separate a gas mixture of A and B. the feed flow rate is $2 \times 10^3 \text{ cm}^3/\text{s}$ and its compositions is 0.413. The feed side pressure is 80 cmHg and the permeate side pressure is 20 cmHg. The reject compositions is to be 0.30. Calculate the permeate composition, the fraction of feed permeated, and the membrane are using complete mixing model.	5
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Q.7A	Explain in details about the mass transfer in pervaporation.	5
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Q.7B1	A stream containing 4% ammonia, 72% hydrogen, and 25% nitrogen at 135 atm pressure and 35°C temperature is being recycled to an ammonia synthesis reactor. It is required to pass this stream through an ammonia-selective hollow	5
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	fibre module to recover 90% of ammonia. If fibre diameter 320μm, void fraction is 0.50, membrane permeability 1×10^{-4} cm²/s and membrane thickness 2.3μm, what should be resistance time of gas in the module? OR	
Q.7B2	Write the operating parameter which affecting the performance of the pervaporation.	5
Q.8A	It is required to remove water from n-butanol using cellulose 2.5 acetate membrane. The feed is 90 mole% n-butanol. Feed is at 70°C. Selectivity is 43 and flux is 0.2 lb/ft² h. maximum permissible temperature drop 40°C. Find out the cut fraction and the permeate and liquid mole fractions. If the feed rate is 100 lb/h, find out the membrane area. Given $\lambda_{Bu\ tanol} = 141.6 \text{ cal} / \text{gm}$, $\lambda_{Water} = 9.72 \text{ Kcal} / \text{gmole}$; $C_{p,Bu\ tanol} (45^{\circ} \text{C}) = 0.625 \text{ cal} / \text{g}^{\circ} \text{C}$, $C_{p,Water} (45^{\circ} \text{C}) = 1.0 \text{ cal} / \text{g}^{\circ} \text{C}$	10
Q.9A	Write the eight applications of the microfiltration processes in details.	10
Q.9B1	Derive the correlation for determining the membrane area in gas separation for complete mixing model with suitable diagram.	10
	OR	
Q.9B2	A membrane module uses silicone-polycarbonate copolymer membrane to separate 200 m ³ of air per hour to produce a permeate stream containing 25% oxygen. The stage cut is 40% and 50% of permeate is to be recycled into the feed stream. Permeability of nitrogen in the 0.1 μ m thick dense layer of the membrane is 32 barrer. The ideal separation factor is 5.5. The feed side pressure is 50 bar; that on the permeate side is 5 bar. Calculate the membrane area if both the feed and permeate sides are well mixed.	10

*****Good Luck*****