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National Institute of Technology Hamirpur
Department of Chemical Engineering
End Semester Examination, May 2023
Branch: Chemical Engineering **Course Code:** CH-443
Course Title: Novel Separation Processes
Class: B. Tech. | **Semester:** VIII | **Full Marks:** 50 | **Time:** 3 hours

Instructions:

- Answer all the questions. All parts (a, b, c) of any question must be answered in same place.
- Calculator is allowed but exchange of the same is not permitted.
- Missing data may suitably be assumed, if any.

1. a) Explain phase inversion method for membrane casting. (3)
   b) A feed solution having 100 kg/m^3 solute concentration and 400 L/h flow rate is subjected to ultrafiltration at 25°C. During the process, gel concentration is estimated to be 350 kg/m^3. The permeate concentration is to be maintained at 20 kg/m^3. The system is operated at steady state and mass transfer coefficient is 10^{-5} m/s. The densities of feed, retentate and permeate are 1100, 1200 and 1000 kg/m^3, respectively. If the retentate concentration does not exceed 132.55 kg/m^3, calculate: (7)
      i) Mass flow rates of retentate and permeate.
      ii) Solvent mass flux.
      iii) Minimum membrane area required.

2. a) Explain type-II facilitated transport mechanism in emulsion liquid membrane. (3)
   b) A dialysis process is being designed to recover a certain solute from a feed solution having solute concentration 2×10^{-2} kmol/m^3 through a membrane to a dialysate having solute concentration 3×10^{-3} kmol/m^3. The membrane is 1.59×10^{-5} m thick. The distribution coefficient is 0.75, and diffusivity of solute through membrane is 3.5×10^{-11} m^2/s. The mass transfer coefficients in the feed and dialysate sides are 3.5×10^{-5} and 2.1×10^{-5} m/s, respectively. Calculate: (7)
      i) Overall mass transfer coefficient.
      ii) Steady state solute flux.
      iii) Membrane area required to transfer 0.01 kmol solute per h.

3. a) From the thermodynamics, derive the Vant-Hoff's osmotic pressure equation. State the assumptions clearly, if any. (4)
   b) Phenol is removed from SDS micellar solution of 10 kg/m^3. Feed concentration of phenol is 20 mg/L. Solubilization of phenol in micelle, S = 2.34 mg/g. The solubilization isotherm is given as: (6)

$$S = \frac{QbC_p}{1 + QbC_p}$$

   Where, S is in mg/mg, Q = 0.1 mg/mg, and b = 9×10^{-2} L/mg.
   If gel concentration of SDS is 280 kg/m^3 and mass transfer coefficient is 2.0×10^{-5} m/s, calculate:
      i) The permeate flux.
      ii) Observed retention of phenol.
      iii) CMC of SDS.

P.T.O.

4. a) What is normal and reverse phase chromatography? (3)
   b) Explain the principle of ion exchange chromatography. (3)
   c) What are the reasons behind the broadening of peak in chromatography? Explain any one of them. (4)

5. a) Write a short note on: (6)
      i) SDS-PAGE electrophoresis.
      ii) Foam fractionation method.
   b) Explain supercritical fluid extraction. Why is CO_2 most widely used as supercritical fluid? (4)

********** *All the Best* **********