

**Department of Biochemical Engineering & Biotechnology**

BBL 445: Membrane Applications in Biotechnology

**Make up Minor Test**

**May 9, 2018**

**M.M.: 20**

**1 hour**

1. (i) Make a sketch of each UF module where Taylor vortices and Dean's vortices are produced. Can these modules be scaled up to industrial size? If the answer is yes, explain how? If the answer is no, explain why not? **(2+2)**

(ii) In bubble point test of a microfiltration (MF) membrane, the pressure 215 psig gives the string of bubbles. What size pore of MF membrane this bubble point pressure corresponds to? Make a brief comment on your answer. **(1+1)**

2. Consider the series of experiments for UF of a protein solution at room temperature. The experiments were carried out on a totally protein retentive membrane for different feed concentration of the protein and the corresponding limiting volumetric flux was measured. The following data was obtained. Can you find out the mass transfer coefficient (k) and the protein saturation concentration at membrane wall from this data? **(7)**

Feed concentration of Protein (g/l)	2	5	10	20	25	32
Limiting Volumetric Flux (m/s) x 10 <sup>-5</sup>	18.2	14.9	12.1	9.1	8.4	7.3

or

2. Make a block flow diagram and briefly explain the typical biorefinery operations using all important key words namely, (i) Lignocellulosic biomass (ii) Enzyme complex (iii) Pretreatment (iv) Lignin & hemicellulosic rich fraction (v) Cellulose rich solids (vi) Enzymatic hydrolysate (vii) Fermentation (viii) Detoxification (ix) Xylose (x) Glucose & (xi) Inhibitors (xii) Microfiltration (xiii) Ultrafiltration & (xiv) Nanofiltration. **(5+2)**

3. For a UF tubular module the linear velocity in the tube is to be kept at 4.5 m/s. The internal diameter of the tube is 10 mm and the length is 2.5 m. The pressure drop across each tube is 2 bar. In the module there are 19 tubes and 5 modules are used in parallel. (a) Calculate the pump motor rating required for UF assuming motor efficiency is 50%. (b) Calculate the energy required per unit permeate volume if the average permeate rate was 25 LMH. (c) Calculate power requirement per unit area of the membrane. Give all your answers in SI units. **(3+2+2)**

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