University of Ruhuna- Faculty of Technology

Bachelor of Biosystems Technology Honours Degree
Level 2 (Semester I) Examination, June/July 2026
Academic year 2024/2025

Course Unit: BST2152-Bio separation processes (old) (Written)

Duration: 1 & ½ hours

INSTRUCTIONS:

- Answer any three (3) out of the four questions provided.
- Use a separate answer booklet for your answers.
- Each question must begin on a new page.
- If more than three questions are answered, only the **first three** will be marked.

1) Liquid-liquid extraction is an important operation in downstream processing where the separation of one or more of the components from a liquid mixture is required.

   a) Write five (05) properties to be considered when selecting a suitable solvent for liquid-liquid extraction. (20 marks)

   b) Briefly explain the main steps of liquid-liquid extraction process. (30 marks)

   c) Penicillin is extracted from a fermentation broth using isoamyl acetate as the organic solvent. The volumes of the organic (I) and aqueous (H) phases are 10 L and 100 L, respectively. The distribution coefficient (K_D) of penicillin between the organic and aqueous phases at pH = 3, is 50.

      i) If the penicillin concentration in the feed solution is 20 g/L, calculate the Penicillin concentration in the raffinate. (40 marks)

      ii) Write the strategy that you implement to reduce the penicillin concentration to 0.1 g/L in the raffinate. (10 marks)

(Total- 100 marks)

2) Activated carbon is a highly porous, adsorptive material that is widely employed in the purification, decolorization, and deodorization of liquid and gaseous streams across the food, pharmaceutical, and chemical industries.

a) Write three (3) examples of raw materials for activated carbon and explain the synthesis process of activated carbon starting from the raw material.

(30 marks)

b) The cleaning frequency of the fixed bed system depends on the breakthrough time. Explain the parameters that affect on the cleaning frequency of the system.

(30 marks)

c) C-phycocyanin is a natural blue dye extracted from *Spirulina platensis*. C-phycocyanin is adsorbed onto Streamline QXL adsorbent resin. The C-phycocyanin adsorption isotherm is represented by the following Freundlich model.

$$q_{\text{C-phycocyanin}} = K_f (C_{\text{C-phycocyanin}})^{1/n}$$

$q_{\text{C-phycocyanin}}$ = C-phycocyanin concentration of solid phase in mg/g

$C_{\text{C-phycocyanin}}$ = C-phycocyanin concentration of mobile phase mg/L

Kf = 35.94

n = 2.5

If the concentration of C-phycocyanin in extract is 22.94 mg/L and the equilibrium concentration of C-phycocyanin in the aqueous phase is 0.21 mg/L, calculate the Streamline QXL adsorbent mass required to purify of 1 L of the *Spirulina platensis* extract.

(40 marks)

(Total- 100 marks)

3) Pressure-driven membrane filtration technologies, including reverse osmosis, are extensively utilized in the food and beverage industry for clarification and concentration applications.

a) Compare dead end filtration and cross filtration techniques. (20 marks)

b) Explain why reverse osmosis (RO) is suitable for concentrating tea extract before spray drying. Also, discuss the main problems you may face with RO and its benefits when compared to thermal (heat-based) concentration techniques.

(30 marks)

c) An RO system processes 1500 L/h of fruit juice with 14 °Brix. The permeate flow rate is 900 L/h with 0.3 °Brix, and the concentrate flow rate is 600 L/h. The total membrane area is 25 m^2.

i) Calculate the recovery rate (%) and Brix of the concentrate. (20 marks)

ii) Determine the solute rejection coefficient. (10 marks)

iii) If the same system has a membrane area of 20 m^2, Calculate the permeate flux in $L/m^2 \cdot h$. (10 marks)

iv) Write two modifications to double the flux and justify their feasibility.

(10 marks)

(Total- 100 marks)

4) Supercritical fluid extraction (SFE) is an advanced, modern separation technique that has been extensively adopted for the recovery of bioactive phytochemicals from herbs, spices, aromatic plants, and medicinal flora.

a) Write the advantages of using carbon dioxide in supercritical fluid extraction.

(20 marks)

b) Gallic acid is a polar compound present in tea leaves. Briefly discuss the parameters that optimize for increase efficiency of gallic acid extraction by supercritical fluid extraction with CO_2.

(30 marks)

c) Provide a brief overview of the large-scale commercial and industrial applications of supercritical fluid extraction technology. (50 marks)

(Total- 100 marks)

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