UNIVERSITI KUALA LUMPUR

MALAYSIAN INSTITUTE OF CHEMICAL AND BIO-ENGINEERING TECHNOLOGY

FINAL EXAMINATION

OCTOBER 2025 SEMESTER

COURSE CODE	:	CBB30204
COURSE TITLE	:	BIOSEPARATIONS ENGINEERING TECHNOLOGY
PROGRAMME NAME	:	BACHELOR OF CHEMICAL ENGINEERING TECHNOLOGY (BIOPROCESS) WITH HONOURS
DATE	:	02 FEBRUARY 2026
TIME	:	2:00PM - 5:00PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of TWO sections.
4. Answer ALL questions for Section A.
5. Section B consist of four questions. Answer THREE (3) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet. ☐ *Tick if applicable*
9. Refer to the attached Formula/ Appendies. ☐ *Tick if applicable*

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

Question 1

Bioseparation refers to the steps taken after fermentation.

(a) Define bioseparation and explain its importance in bioprocessing.

(6 marks)

(b) Describe TWO (2) factors affecting the selection of techniques in bioseparation.

(4 marks)

Question 2

Membrane filtration separates microorganisms and contaminants from liquids allowing only desirable substances to pass according to pore size.

(a) Arrange FOUR (4) types of membrane filtration process based on increasing separation selectivity.

(2 marks)

(b) Identify the pore size and ONE (1) typical application of each membrane process stated in (a).

(8 marks)

Question 3

Chromatography is commonly used as a separation process for biologics, fine and specialty chemicals.

(a) Describe the TWO (2) phases that determine the separation of mixtures in chromatography.

(4 marks)

(b) Explain the mechanism of elution chromatography for separating solutes mixture with support of suitable chromatogram.

(6 marks)

Question 4

A pharmaceutical company uses crystallization to purify an active ingredient from an aqueous solution

(a) Differentiate between crystallization and precipitation.

(6 marks)

(b) Explain why industrial crystallization is usually operated in the metastable zone.

(4 marks)

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

Answer the following questions.

(a) In a filtration of suspended cells under full vacuum using a Buchner funnel (10 cm radius), the following data is collected. The concentration of cells was 100g/L (mass of dry cake solids per volume of filtrate), and the viscosity of the filtrate was 1.0 cp. By referring to the equation below, determine the filter medium resistance (R_m) and specific cake resistance (α). (Given 1 atm = 1.013 x 10^6 $gcm^{-1}s^{-2}$)

$$\frac{t}{V/A} = \frac{\alpha\mu\rho}{2\Delta p}\left(\frac{V}{A}\right) + \frac{\mu R_m}{\Delta p}$$

Refer Below - Table1 : Filtration Data .

(10 marks)

Table 1: Filtration Data

Time (min)	Filtrate volume (L)
20	4
30	5
40	6.5
50	7
60	7.5
70	7.8

(b) Precipitate formation is controlled by a series of steps that occur in sequence.

i. Explain the steps involved in the precipitate formation.

(6 marks)

ii. Describe ONE (1) typical method for precipitation of protein.

(4 marks)

Question 2

Liquid-liquid extraction involves the separation of a substance from one liquid into another liquid based on differing solubilities.

(a) Multistage countercurrent extraction is a widely used liquid-liquid extraction technique.

i. Explain the principle of multistage countercurrent extraction process with the aid of suitable diagram.

(8 marks)

ii. Write the material balance on the solute around the feed end of the cascade down to stage n-1.

(2 marks)

(b) Aqueous two-phase extraction (ATPE) is a commonly used technique for extracting proteins.

i. Describe TWO (2) factors that affect protein partitioning.

(4 marks)

ii. Justify the suitability of ATPE for protein recovery in comparison to traditional organic solvent extraction methods.

(6 marks)

Question 3

Liquid chromatography and adsorption processes are based on the differential affinity of various soluble molecules for specific types of solids.

(a) Discuss the principles of the following modes of chromatography.

i. Size exclusion chromatography

(5 marks)

ii. Affinity chromatography

(5 marks)

(b) A fixed-bed adsorber packed with activated carbon is used to remove a solute (i) from an aqueous stream. The feed enters the column at a constant concentration (c_{i0}) and flows upward through the bed at a constant flow rate. The effluent concentration (c_i) is monitored as a function of time, producing a typical breakthrough curve.

i. Define breakpoint time (t_b) and the ideal adsorption time (t^*).

(2 marks)

ii. Sketch the breakthrough curve showing the breakpoint time (t_b) and the ideal adsorption time (t^*).

(4 marks)

iii. Explain how Length of Unused Bed (LUB) can be determined from the breakthrough curve.

(4 marks)

Question 4

Drying is an effective method for preserving biological products.

(a) Drying involves lowering water activity by water elimination.

i. Discuss the significance of water activity towards bioproduct stability.

(4 marks)

ii. Explain the principle of freeze drying (lyophilization) and state one advantage over conventional drying methods.

(6 marks)

(b) A biotechnology company intends to convert a liquid protein formulation into a free-flowing powder.

i. Propose a suitable drying technique and justify your selection.

(4 marks)

ii. Describe the working principle of the drying technique specified in (i).

(6 marks)

END OF EXAMINATION PAPER

APPENDIX

FACTORS FOR UNIT CONVERSIONS

Quantity	Equivalent Values
Mass	1 kg = 1000 g = 0.001 metric ton = 2.20462 lb_m = 35.27392 oz 1 lb_m = 16 oz = 5 x 10^{-4} ton = 453.593 g = 0.453593 kg
Length	1 m = 100 cm = 1000 mm = 10^6 microns (μm) = 10^{10} angstroms ($\overset{0}{A}$) = 39.37 in = 3.2808 ft = 1.0936 yd = 0.0006214 mile 1 ft = 12 in = 1/3 yd = 0.3048 m = 30.48 cm
Volume	1 m^3 = 1000 liters = 10^6 cm^3 = 10^6 ml = 35.3145 ft^3 = 220.83 imperial gallons = 264.17 gal = 1056.68 qt 1ft^3 = 1728 in^3 = 7.4805 gal = 0.028317 m^3 = 28.317 liters = 28 317 cm^3
Force	1 N = 1 kg.m/s^2 = 10^5 dynes = 10^5 g.cm/s^2 = 0.22481 lb_f 1 lb_f = 32.174 lb_m.ft/s^2 = 4.4482 N = 4.4482 x 10^5 dynes
Pressure	1 atm = 1.01325 x 10^5 N/m^2 (Pa) = 101.325 kPa = 1.01325 bars = 1.01325 x 10^6 dynes/cm^2 = 760 mm Hg at 0°C (torr) = 10.333 m H_2O at 4°C = 14.696 lb_f/in^2 (psi) = 33.9 ft H_2O at 4°C = 29.921 in Hg at 0°C
Energy	1 J = 1 N.m = 10^7 ergs = 10^7 dyne.cm = 2.778 x 10^{-7}kW.h = 0.23901 cal = 0.7376 ft-lb_f = 9.486 x 10^{-4} Btu
Power	1 W = 1 J/s = 0.23901 cal/s = 0.7376 ft.lb_f/s = 9.486 x 10^{-4} Btu/s = 1.341 x 10^{-3} hp
Viscosity	1 cP = 0.01 poise = 0.01 g/cm.s = 0.01 dyne s/cm = 10^{-3}Pa.s = 10^{-3} N.s/m2 = 10^{-3} kg/ms = 6.7197 x $10^{-4}$$lb_m$/ft.s = 2.0886 x $10^{-5}$$lb_f$.s/$ft^2$