UNIVERSITI KUALA LUMPUR

MALAYSIAN INSTITUTE OF CHEMICAL AND BIO-ENGINEERING TECHNOLOGY

FINAL EXAMINATION

OCTOBER 2025 SEMESTER

COURSE CODE	:	CBD22003
COURSE TITLE	:	INTRODUCTION TO BIOPROCESS TECHNOLOGY
PROGRAMME NAME	:	DIPLOMA IN CHEMICAL ENGINEERING TECHNOLOGY
DATE	:	02 FEBRUARY 2026
TIME	:	9:00AM - 12:00PM
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. Section A consist total of 60 marks. Answer ALL questions.
5. Section B consist of three questions. Answer TWO (2) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Refer to the attached Formula/ Appendies. ☐ *Tick if applicable*

THERE ARE 7 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 60 marks)

Answer ALL questions.

Please use the answer booklet provided.

Question 1

Fermentation allows for the production of a variety of valuable products.

(a) Define fermentation.

(2 marks)

(b) Differentiate between solid-state and submerged fermentation. Give an example for each.

(4 marks)

(c) Explain the typical analysis to determine cell growth and substrate concentration of a fermentation process.

(4 marks)

Question 2

Microbial cells use nutrients for growth, energy production and product formation.

(a) Distinguish between growth associated and non-growth associated products in batch culture with the support of illustration.

(6 marks)

(b) Monod equation describes the relationship between growth rate and the residual growth-limiting substrate.Write the Monod equation and define each term.

(4 marks)

Question 3

Batch, fed batch and continuous are three primary modes of fermentation.

(a) Differentiate these THREE (3) modes of fermentation.

(6 marks)

(b) Discuss the steady state condition in continuous culture system.

(4 marks)

Question 4

A bioreactor typically consists of several key components in order to provide a controlled environment for the growth of a microorganism.

(a) Draw a schematic diagram of a stirred tank bioreactor with complete labeling of the major components.

(6 marks)

(b) Describe TWO (2) distinct functions of impellers.

(4 marks)

Question 5

Bioreactor control involves monitoring and automatically adjusting critical parameters to maintain optimal conditions for cell growth and product formation.

(a) Illustrate and explain the feedback control loop of a bioreactor.

(6 marks)

(b) Explain the pH control system of a bioreactor.

(4 marks)

Question 6

Efficient oxygen (O_2) transfer is critical in aerobic fermentation.

(a) The oxygen (O_2) mass transfer pathway involves the transfer of O_2 from a gas bubble to the microbial cell. Explain how O_2 and carbon dioxide (CO_2) concentrations affect the diffusion of O_2 across the gas liquid interface.

(5 marks)

(b) Explain the flooded impeller phenomenon in a stirred tank bioreactor.

(5 marks)

SECTION B (Total: 40 marks)

Answer TWO (2) questions only.

Please use the answer booklet provided.

Question 1

Answer the following questions.

(a) With the aid of a labeled sketch, describe the main components of an air-lift fermenter.

(6 marks)

(b) Shake flasks are frequently used for small scale cell cultivation. Suggest TWO (2) approaches to maximize the oxygen transfer rate in shake flask

(6 marks)

(c) Aerobic degradation of an organic compound by a mixed culture of organisms in wastewater can be represented by the following reaction.

$$C_3H_6O_3 + aO_2 + bNH_3 \rightarrow cC_5H_7NO_2 + dH_2O + eCO_2$$

Determine the stoichiometric coefficients if $Y_{X/S}$ = 0.4 gX/gS.

(8 marks)

Question 2

Sterilization is crucial for preventing contamination by unwanted microbes in bioprocesses.

(a) Explain the sterilization procedures required prior to fermentation in a 2L bioreactor.

(5 marks)

(b) A fermentation medium contains heat-sensitive vitamins and proteins. Give reasons why steam sterilization may not be suitable.

(5 marks)

(c) Differentiate between batch and continuous sterilization processes. Support your explanation with an illustration that shows temperature change during batch and continuous sterilization.

(10 marks)

Question 3

Volumetric oxygen transfer rate, kLa is an important parameter in the design and operation of bioreactor.

(a) Examine how the design of the impeller and sparger affects the size of air bubbles in stirred tank reactors.

(6 marks)

(b) Elaborate the steps to determine k_La value by using the non-fermentative dynamic gassing out method. Include the equation and graph used to determine k_La value.

(8 marks)

(c) An antifoam agent is added to control excessive foaming during fermentation. Analyze the effect of foaming and antifoam addition on the k_La value.

(6 marks)

END OF EXAMINATION PAPER