UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF CHEMICAL AND BIO-ENGINEERING TECHNOLOGY

FINAL EXAMINATION

OCTOBER 2025 SEMESTER

COURSE CODE	:	CBB20503
COURSE TITLE	:	PRINCIPLES OF BIOPROCESS TECHNOLOGY
PROGRAMME NAME	:	BACHELOR OF CHEMICAL ENGINEERING TECHNOLOGY (BIOPROCESS) WITH HONOURS
DATE	:	30 JANUARY 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. 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

Bioprocess technology applies biological systems to manufacture useful products.

(a) Define the term bioprocess technology with TWO (2) examples of biocatalysts used in industrial bioprocesses.

(4 marks)

(b) A general bioprocess can be divided into upstream processing, bioreaction, and downstream processing. Describe the scope of each section with illustration using a simple process flow showing typical unit operations.

(6 marks)

Question 2

Fermentation processes can be operated in different modes.

(a) State FOUR (4) characteristics of batch fermentation as an operation mode.

(4 marks)

(b) Differentiate TWO (2) characteristics between fed-batch, and continuous fermentation modes with illustration.

(6 marks)

Question 3

In industrial fermentation, inoculum development is a critical upstream activity that affects fermentation start-up, process stability, and final product yield.

(a) List FOUR (4) reasons why inoculum development is important in industrial fermentation.

(4 marks)

(b) Explain the key criteria of a "good inoculum" that influences fermentation performance.

(6 marks)

Question 4

Cell culture is an important platform in bioprocess technology to produces products such a biopharmaceuticals.

(a) Give definitions for the terms cell line and primary culture.

(4 marks)

(b) Describe the isolation process of cell lines in animal cell culture.

(6 marks)

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

A batch fermentation of a microorganism on glucose produced the following data:
Refer Below - Table1 : Batch fermentation data .

Table 1: Batch fermentation data

Time (h)	Biomass, X (g/L)
0	0.20
2	0.30
4	0.48
6	0.78
8	1.25
10	1.70
12	1.85
16	1.89
24	1.891

(a) Determine the interval of microbial growth phases by plotting ln X versus time.

(10 marks)

(b) Justify the most appropriate time interval for μ_{max} using the plot in (a) by stating the μ_{max} and the doubling time for that interval.

(10 marks)

Question 2

A company plans to produce an extracellular enzyme using an aerobic bacterium at pilot scale.

(a) Assess a suitable pilot-scale bioreactor configuration for aerobic production of an extracellular enzyme by specifying EIGHT (8) essential design features and function of each feature.

(10 marks)

(b) Justify the suitable impeller type, sparger and baffle combination to maximise mixing and k_La in an aerobic bioreactor.

(10 marks)

Question 3

Oxygen transfer rate (OTR) is the rate at which oxygen moves from the gas bubbles into the liquid culture that is characterized by volumetric mass transfer rate (k_La).

(a) Assess the differences between the static gassing out and dynamic gassing out techniques for the estimation of k_La.

(10 marks)

(b) In an aerobic fermentation, the dissolved oxygen (DO) starts to drop below the set point. You want to increase oxygen supply without causing excessive shear. Recommend the suitable adjustment of aeration rate and agitation speed to improve k_La and OTR.

(10 marks)

Question 4

A fermentation broth is heated from 100°C to 121°C in 30 min and cooled from 121°C to 100°C in 17 min. The required lethality is $\nabla_{overall} = 40$.

(a) Justify the killing effect contributions from the heating and cooling stages by calculating $\nabla_{heating}$ and $\nabla_{cooling}$ using Richard's method.
Refer Below - Table2 : Table of Del Factors .

(10 marks)

Table 2: Table of Del Factors

T (°C)	k (min^{-1})	∇
100	0.019	—
101	0.025	0.044
102	0.032	0.076
103	0.040	0.116
104	0.051	0.168
105	0.065	0.233
106	0.083	0.316
107	0.105	0.420
108	0.133	0.553
109	0.168	0.720
110	0.212	0.932
111	0.267	1.199
112	0.336	1.535
113	0.423	1.957
114	0.531	2.488
115	0.666	3.154
116	0.835	3.989
117	1.045	5.034
118	1.307	6.341
119	1.633	7.973
120	2.037	10.010
121	2.538	12.549
122	3.160	15.708
123	3.929	19.638
124	4.881	24.518
125	6.056	30.574
126	7.506	38.080
127	9.293	47.373
128	11.494	58.867
129	14.200	73.067
130	17.524	90.591

(b) Given $\nabla_{overall} = 40$, justify the required holding time at 121°C by determining the minimum holding time needed at 121°C to meet $\nabla_{overall}$.

(10 marks)

END OF EXAMINATION PAPER