

**CONFIDENTIAL**



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2022/2023**

COURSE NAME : FERMENTATION ENGINEERING  
TECHNOLOGY

COURSE CODE : BNN 30304

PROGRAMME CODE : BNN

EXAMINATION DATE : JULY/AUGUST 2023

DURATION : 3 HOURS

INSTRUCTION : 1. ANSWER ALL QUESTIONS.

2. THIS FINAL EXAMINATION IS  
CONDUCTED VIA **CLOSED BOOK**.

3. STUDENTS ARE **PROHIBITED** TO  
CONSULT THEIR OWN MATERIAL OR  
ANY EXTERNAL RESOURCES DURING  
THE EXAMINATION CONDUCTED VIA  
CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

**TERBUKA**

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- Q1** Fermentation is a biochemical change caused by anaerobic oxidation of carbohydrates by microorganisms or by enzymes. In order to run a fermentation process, bioreactor plays a vital role by providing a controlled environment for the growth of a microorganism to obtain a desired product.
- (a) Classify **TWO (2)** types of fermentation and differentiate their process. (8 marks)
- (b) As a consultant engineer/technologist, propose a complete set up of a suitable 10 L bioreactor for the fermentation of *Saccharomyces cerevisiae* that will be used in a laboratory for research and development purpose.  
(You are required to label all the components of sketched bioreactor) (8 marks)
- (c) Referring to the sketched components in **Q1(b)**, briefly explain on how a complete aeration and agitation could be achieved during fermentation process. (3 marks)
- (d) From 10 L vessel you designed in **Q1(b)**, you are considering in scaling up a fermentation to 10000L vessel. Please be noted that, the small fermenter has a height-to-diameter ratio of 3. The impeller diameter is 30% of the tank diameter. Agitator speed is 500 rpm and three Rushton impellers are used. Determine the dimensions of the large fermenter and agitator speed for P/V. (6 marks)
- Q2** Oxygen is usually introduced to fermentation broth by sparging air through the broth. In aerobic fermentation, oxygen molecules must overcome a series of transport resistance before being utilized by the cells.
- (a) Illustrate and briefly describe **EIGHT (8)** mass-transfer steps involved in transport of oxygen from the interior of gas bubbles to the site of intracellular reaction (8 marks)
- (b) The dissolved oxygen concentration reflects the balance between the supply of dissolved oxygen by the fermenter and the oxygen demand of the organism. From **Figure Q2(b)**, calculate the  $K_{La}$  value from *dynamic method*. Also, if the cell dry weight has been measured as 2 g/l, evaluate the specific respiration rate of the culture. (8 marks)
- (c) The optimum oxygen concentration in solution throughout fermentation process should be maintained for product formation. Interpret the effect of  $K_{La}$  value on the aeration capacity of the fermentation system. (9 marks)

- Q3** Enzymes are macromolecular biological catalysts that catalyze chemical reactions. While enzyme immobilization is a powerful tool for the design of green and sustainable production processes.
- (a) Enzyme stability is a crucial factor to determine whether application of biocatalysis will be commercially successful. Identify **THREE (3)** primary approaches pursued in research to improve the stability of enzymes. (3 marks)
- (b) The technology of enzyme immobilization provides an effective means to circumvent these concerns by enhancing enzyme catalytic properties and simplifying downstream processing and improve operational stability. Illustrate and describe **FOUR (4)** methods utilized in industry for immobilizing enzymes. (20 marks)
- (c) The demand for lactose-free milk is increasing, leading to extensive studies in lactose-free milk production. At present, soluble enzyme is widely used to remove lactose in the milk. However, the downstream process to remove free enzyme in the product is time-consuming. How would you solve this problem and why is the chosen method considered more cost effective in obtaining purified lactose-free milk. (2 marks)
- Q4** Fermentation engineering is a discipline used to solve the engineering problems of industrial production according to fermentation technology.
- (a) In any industrial process, the primary aim is to achieve maximum profitability. Determine **SIX (6)** critical factors necessary to attain this goal. (6 marks)
- (b) Analyze the prospects of fermentation engineering technology in the future. (7 marks)
- (c) As a researcher involved in producing a COVID-19 Coronavirus vaccine, which Class of Biological Safety Cabinet (BSC) would be appropriate for you to employ. Sketch the air flow of the BSC to support your answer and explanation. (12 marks)

-END OF QUESTIONS -

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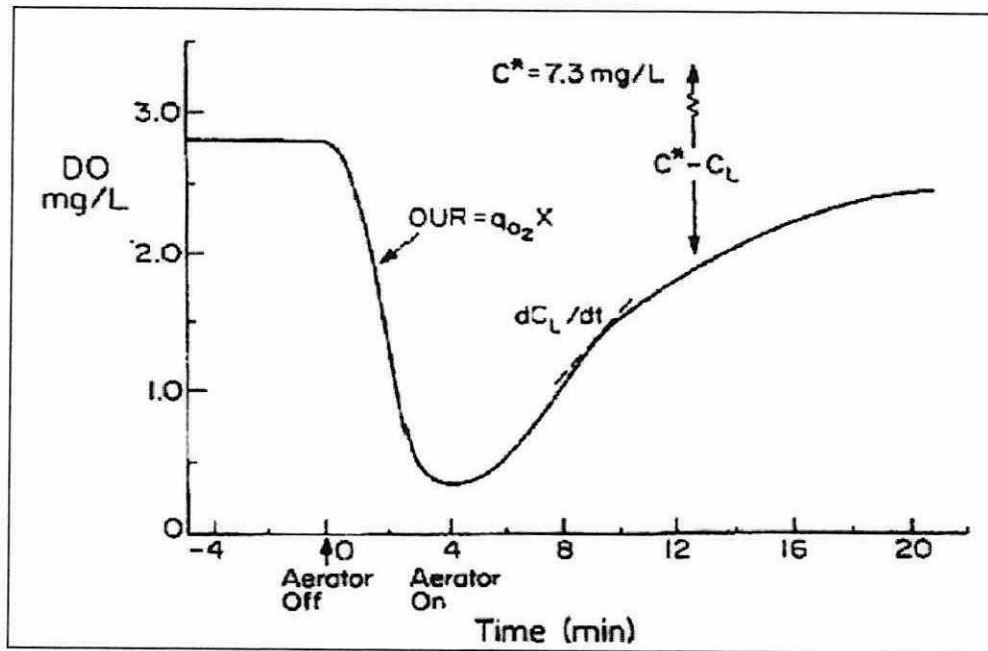


Figure Q2(b)

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FORMULA:

1.  $V = \pi r^2 H$
2.  $Re = \frac{ND^2 \rho}{\mu}$
3.  $N = \frac{P}{\rho N^3 D^5}$
4.  $P = k_1 \mu N^2 D^3$
5.  $P = N_p \rho N^3 D^5$
6.  $OTR = k_L a (C^* - C_L)$
7.  $OUR = q_{O_2} X$