

National Exams December 2019

16-Chem-B4, Biochemical Engineering

3 hours duration

NOTES:

- 1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.**
- 2. This is a CLOSED BOOK EXAM. A Casio or Sharp approved calculator is permitted.**
- 3. FIVE (5) questions constitute a complete exam paper. ANSWER ALL FIVE QUESTIONS.**
- 4. Each question is of equal value.**
- 5. Most questions require an answer in short essay format. Clarity and organization of the answer are important.**

Question 1 (20 marks)

Explain briefly what is an enzyme? How many classes of enzymes are there? Derive the Michaelis-Menten equation using first principles and state all assumptions.

Question 2 (20 marks)

The following is the design equation for an Michaelis-Menten enzyme reaction in a CSTR:
$$K_m(X/(1-X)) + S_0X = v_{max}\tau$$

- (i) Show how this equation is obtained from a mass balance on the CSTR. Explain all terms and state any assumptions
- (ii) The enzymatic isomerization of glucose to fructose follows the Michaelis-Menten kinetics. If the feed substrate (glucose) concentration is 100 g/L and the desired conversion is 40%, what volume of the reactor will be needed. The kinetic constants are: $K_m=0.26$ g/L, $V_{max}=10$ g/L.h. The feed flow rate is 100 L/h.

Question 3 (20 marks)

Explain briefly (i) the principles of the Air On-Air Off method for experimental determination of mass transfer coefficient in bioreactors; (ii) Principles of continuous sterilization of liquid media

Question 4 (20 marks)

Explain: (i) Growth associated and non growth associated products; (ii) why the dilution rate should not exceed the maximum specific growth rate of a microorganism in a chemostat; (iii) cell maintenance coefficient and the Pirt equation; (iv) major nutritional requirements for the cultivation of microorganisms.

Question 5 (20 marks)

What is enzyme and cell immobilization? What are common approaches applied to immobilize cells and enzymes? What are the specific advantages and limitations of enzyme and cell immobilization? Provide one example of industrial applications for immobilized enzymes.