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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: V - THEORY EXAMINATION (2025 - 2026)

Subject: Biochemical Reaction Engineering

Time: 3 Hours

Max. Marks: 100

General Instructions:

IMP: Verify that you have received the question paper with the correct course, code, branch etc.

1. This Question paper comprises of **three Sections -A, B, & C**. It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.

2. Maximum marks for each question are indicated on right -hand side of each question.

3. Illustrate your answers with neat sketches wherever necessary.

4. Assume suitable data if necessary.

5. Preferably, write the answers in sequential order.

6. No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.

SECTION-A

20

1. Attempt all parts:-

- 1-a. The collision theory of chemical kinetics states that the rate constant depends on: (CO1, K1) 1
- (a) The frequency of collisions and the energy of collisions
 - (b) The frequency of collisions
 - (c) The color and texture of the reactants
 - (d) The volume of the reaction container
- 1-b. A catalyst in a chemical reaction: (CO1, K1) 1
- (a) Increases the equilibrium constant of the reaction
 - (b) Decreases the equilibrium constant of the reaction
 - (c) Lowers the activation energy of the reaction
 - (d) Increases the activation energy of the reaction
- 1-c. Why are covalent bonds used in enzyme immobilization? (CO2, K1) 1
- (a) To increase enzyme-substrate affinity
 - (b) To enhance the stability of the enzyme
 - (c) To reduce the cost of enzyme immobilization
 - (d) To make the enzyme more flexible
- 1-d. Blocking of enzyme action by blocking its active site is called as: (CO2, K1) 1
- (a) Allosteric inhibition
 - (b) Competitive inhibition
 - (c) Non-competitive inhibition
 - (d) Feedback inhibition

- 1-e. What does "lag phase" in microbial growth represent? (CO3, K1) 1
- (a) Maximum growth
 - (b) Adaptation period
 - (c) Death phase
 - (d) Substrate inhibition
- 1-f. Which type of bubble has a higher surface-to-volume ratio? (CO3, K1) 1
- (a) Larger bubbles
 - (b) Smaller bubbles
 - (c) Irregular bubbles
 - (d) None of these
- 1-g. Which technique is commonly used to measure k_La in bioreactors? (CO4, K1) 1
- (a) Gas chromatography
 - (b) Dynamic gassing-out method
 - (c) Spectrophotometry
 - (d) Chromatographic analysis
- 1-h. Which bioreactor provides better gas-liquid mass transfer? (CO4, K1) 1
- (a) CSTR
 - (b) Bubble column
 - (c) Airlift reactor
 - (d) Packed bed reactor
- 1-i. Which interaction is essential for biogas production in mixed cultures? (CO5, K1) 1
- (a) Antagonism
 - (b) Parasitism
 - (c) Syntrophy
 - (d) Neutralism
- 1-j. Which factor is most critical for achieving balance in mixed cultures? (CO5, K1) 1
- (a) Medium color
 - (b) Product type
 - (c) Operating pressure
 - (d) Nutrient availability

2. Attempt all parts:-

- 2.a. Write down the distinct characteristics of ideal reactors? (CO1, K1) 2
- 2.b. What is Thiele's modulus? (CO2, K1) 2
- 2.c. How does the lag phase benefit microbial populations during initial growth? (CO3, K1) 2
- 2.d. What do you understand by chemostat? (CO4, K1) 2
- 2.e. How does temperature affect the metabolic activity of mixed cultures? (CO5, K1) 2

SECTION-B

30

3. Attempt all parts:-

3.a. Answer any one of the following:-

- 3.a.(i) Can you explain how the Arrhenius equation helps us understand how reaction rates change with temperature? (CO1, K2) 6
- 3.a.(ii) Derive the expression for autocatalytic Reactions in constant volume reactors? (CO1, K3) 6
- 3.b. Answer any one of the following:-
- 3.b.(i) How does pH affect the stability and activity of enzymes in free and immobilized states? (CO2, K3) 6
- 3.b.(ii) Derive an equation for Lineweaver Burk plot using Michaelis-Menten equation? (CO2, K3) 6
- 3.c. Answer any one of the following:-
- 3.c.(i) Explain the role of transport phenomena in ensuring efficient nutrient and oxygen delivery in bioreactors? (CO3, K2) 6
- 3.c.(ii) Discuss in detail about six phases of growth cycle for microbial fermentations? (CO3, K2) 6
- 3.d. Answer any one of the following:-
- 3.d.(i) How do microbial interactions influence substrate utilization in mixed cultures? Discuss? (CO4, K2) 6
- 3.d.(ii) How are mathematical models like Monod or Lotka-Volterra used to study mixed-culture systems? (CO4, K3) 6
- 3.e. Answer any one of the following:-
- 3.e.(i) List four different kinds of interactions where microbes survive in association with one or more species? (CO5, K1) 6
- 3.e.(ii) How does the mixed populations stay benefitted in presence of each other? Discuss with example? (CO5, K2) 6

SECTION-C 50

4. Answer any one of the following:-
- 4-a. Derive an equation for second order bimolecular irreversible reaction in constant volume bioreactor? (CO1, K3) 10
- 4-b. Describe Arrhenius law. Find out the activation energy of a reaction, given that the rate constant of the reaction at 600K is $8.0 \times 10^3 \text{ s}^{-1}$ and the rate constant at 300K is $4.0 \times 10^2 \text{ s}^{-1}$. (CO1, K3) 10
5. Answer any one of the following:-
- 5-a. Deduce an expression for solute concentration in an immobilized system for internal mass transfer following first order kinetics? (CO2, K4) 10
- 5-b. How will you derive the equation for Line weaver Burk plot from Michaelis Menten equation? (CO2, K3) 10
6. Answer any one of the following:-
- 6-a. How will you deduce an expression for effective mass transfer coefficient in Liquid-gas mass transfer? (CO3, K4) 10
- 6-b. Discuss various resistance steps for transfer of oxygen from gas bubbles to cells? (CO3, K2) 10
7. Answer any one of the following:-

- 7-a. Define residence time distribution? Also, with the help of suitable diagram discuss the working principle of CSTR? (CO4, K2) 10
- 7-b. Derive expressions for the determination of biomass, product and substrate concentration for continuous stirred tank bioreactor? (CO4, K3) 10
8. Answer any one of the following:-
- 8-a. Discuss the Lotka-Volterra model in terms of microbial interaction? Also write any five industrial applications of mixed culture model? (CO5, K2) 10
- 8-b. Elucidate the competitive association between two microbial species with the help of mathematical relations? (CO5, K2) 10

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