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Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech.

SEM: V - THEORY EXAMINATION (2022 - 2023)

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. What is change in the concentration of any one of the reactants or products with time per unit volume? (CO1) 1

(a) Rate constant

(b) Rate of reaction

(c) mechanism of reaction

(d) None of these

1-b. What you call to any class of reaction that occurs in a different phase? (CO1) 1

(a) catalytic reactions

(b) Homogeneous reactions

(c) heterogeneous reactions

(d) none of these

1-c. The catalytic efficiency of two distinct enzymes can be compared based on which factor?(CO2) 1

(a) Km

(b) Product formation

(c) Size of the enzymes

(d) pH of optimum value

1-d. What is defined as the enzyme's binding efficiency with its appropriate substrate through optimized multiple non-covalent interactions? (CO2) 1

(a) Km

(b) Vmax

(c) [S]

(d) All of the above

1-e. What is the proportionality constant in the equation that expresses the relationship between the rate of a chemical reaction and the concentrations of the reacting substances?(CO3) 1

(a) Rate constant

(b) Rate of reaction

(c) Molecularity of the reaction

(d) Order of reaction

1-f. What describes the relationship between μ and residual growth limiting substrate? (CO3) 1

(a) Erying equation

(b) Van't hoff equation

(c) Monod equation

(d) Arrhenius equation

1-g. What is used with flocculating organisms in brewing and for the production of vinegar(CO4) 1

(a) FBRs

(b) PFRs

(c) Stirred tank bioreactors

(d) none of the above

1-h. What is the purpose of aeration? (CO4) 1

(a) Mixing

(b) Aeration

(c) supply of oxygen

(d) All of the above

1-i. On what does the biological treatment of waste waters depends? (CO5) 1

(a) complex mixture

(b) simple mixture

(c) pure culture

(d) Both (a) and (b)

1-j. symbiosis and mutualism are _____ 1

(a) same

(b) different

(c) neutral

(d) none of the above

2. Attempt all parts:-

2.a. What do you understand by the rate of reaction? (CO1) 2

2.b. Determine the equilibrium constant at 150°C when the free energy change is estimated to be -120Jmol-1 for the catalysis of sucrose? (CO2) 2

2.c. What do you understand by diauxic growth? (CO3) 2

2.d. What is the difference between bubble column and airlift bioreactor? (CO4) 2

2.e. What do you understand by parasitism? Give example (CO5) 2

SECTION B 30

3. Answer any five of the following:-

3-a. How the rate of reaction is determined? (CO1) 6

3-b. Differentiate between elementary and non-elementary reactions. (CO1) 6

3-c. Urease enzyme hydrolyzed urea at a concentration of 0.03 mmol/L with a Km value of around 0.06mmol/L. The initial velocity observed for urea hydrolysis was 1.5x10-3 mmol/L.min-1 . Calculate the maximum velocity of the enzymatic reaction. (CO2) 6

3-d. Urease enzyme hydrolyzed urea at [S]= 0.03 mmol/L with a Km value of around 0.06mmol/L. The initial velocity observed was 1.5x10-3 mmol/L.min-1 . Calculate the maximum velocity of the enzymatic reaction. (CO2) 6

3.e. Describe Line weaver burk plot. (CO3) 6

3.f. Write the major shortcoming associated with Solid state fermentation and the steps utilized to rectify the problems. (CO4) 6

3.g. What are the industrial applications of mixed cultures? (CO5) 6

SECTION C 50

4. Answer any one of the following:-

4-a. Discuss about first order reversible reactions in detail? (CO1) 10

4-b. Explain in detail about first order reversible reactions? (CO1) 10

5. Answer any one of the following:-

5-a. Invertase extracted from Aspergillus oryzae catalyzes the conversion of sucrose to glucose and fructose which is immobilised in porous resin particles of diameter 1.6 mm at a density of 0.1 μmol enzyme g-1. The effective diffusivity of sucrose in the resin is 1.3 * 10-11 m2 s-1. The resin is placed in a completely mixed bioreactor so that external mass-transfer effects are eliminated. the observed rate of conversion at a sucrose concentration of 0.85 kgm-3 is 1.25 * 10-3 kg s-1 m-3 resin. Km for the immobilised enzyme is 3.5 kg m-3. Determine the effectiveness factor and the true first-order reaction constant for immobilized invertase. (CO2) 10

5-b. Deduce an expression for solute concentration in an immobilized system for internal mass transfer following first order kinetics. (CO2) 10

6. Answer any one of the following:-

6-a. Derive an expression for mass transfer coefficient determination by oxygen balance method. (CO3) 10

6-b. A strain of Azotobacter vinelandii is cultured in a 15 m 3 stirred fermenter for alginate production. Under current operating conditions kLa is 0.17 s- 1. Oxygen solubility in the broth is approximately 8 x 10 -3 kg m -3.(a) The specific rate of oxygen uptake is 12.5 mmol g-1 h - 1 . What is the maximum possible cell concentration? (b) The bacteria suffer growth inhibition after copper sulphate is accidently added to the fermentation broth. This causes a reduction in oxygen uptake rate to 3 mmol g- 1 h - 1. What maximum cell concentration can now be supported by the fermenter? (CO3) 10

7. Answer any one of the following:-

7-a. Describe various bioreactor configurations. (CO4) 10

7-b. Sacharomyces cerevisiae was used to hydrolyse glucose to ethanol in a CSTR in 60m3 bioreactor wherein the feed concentration was found to be 12g/l and Ks for the organism as 0.2g/l under anaerobic conditions. The yield of biomass from substrate is 0.06 g g-1; YPX is 7.7 g g-1. The maintenance coefficient is 2.2 g g-1 h-1; the specific rate of product formation due to maintenance is 1.1 h-1. The maximum specific growth rate of Z. mobilis is approximately 0.3 h- 1. The feed contains 12 g 1-1
glucose; K s for the organism is 0.2 g l- 1. (CO4) 10
(a) What flow rate is required for a steady-state substrate concentration of 1.5 g l- 1 ?
(b) At the flow rate of (a), what is the cell density?
(c) At the flow rate of (a), what concentration of ethanol is produced?

8. Answer any one of the following:-

8-a.	Elaborate the competitive association between two microbial species with the help of mathematical relations. (CO5)	10
8-b.	Using mathematical relations, discuss the application of competitive association between two species. (CO5)	10