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Subject Code:- ABT0611

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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: VI - THEORY EXAMINATION (20 - 20.....)

Subject: Bioreactor Analysis and Design

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. Which of the following factors should be considered in bioreactor design? (CO1, K1) 1
- (a) Oxygen transfer rate
- (b) pH control
- (c) Heat transfer
- (d) All of the above
- 1-b. The equation for Del factor is _____ (CO1, K1) 1
- (a) $\nabla = \ln (N_0/N_t)$
- (b) $\nabla = \ln (N_t/N_0)$
- (c) $\nabla = \ln (N_0)$
- (d) $\nabla = \ln (N_0 N_t)$
- 1-c. _____ method involves the determination of the maximum rate of oxidation of sodium sulfite to sodium sulfate in the presence of CuSO₄ catalyst (CO2, K1) 1
- (a) Sulfite oxidation method
- (b) Oxygen balance method
- (c) Dynamic method
- (d) None of the above
- 1-d. Which of the following parameter of fluid flow does not affect reynolds number? (CO2, K1) 1

- (a) density
 - (b) fluid velocity
 - (c) temperature
 - (d) cross sectional area
- 1-e. The function of piping in a bioreactor system is to: (CO3, K2) 1
- (a) Contain the media
 - (b) Transfer gases
 - (c) Provide structural support
 - (d) Sampling
- 1-f. What type of valve allows flow in only one direction? (CO3, K2) 1
- (a) Gate valve
 - (b) Globe valve
 - (c) Check valve
 - (d) Ball valve
- 1-g. Which of the following is not an aspect in the context of scale-down? (CO4, K2) 1
- (a) Number of generations
 - (b) Oxygen Transfer rate
 - (c) Mixing
 - (d) Temperature
- 1-h. Packed bed reactors are best used for: (CO4, K2) 1
- (a) Suspended cells
 - (b) Immobilized cells
 - (c) Animal cells
 - (d) Plant cells
- 1-i. Maintaining constant gas flow rate per unit volume during scale-up ensures: (CO5, K2) 1
- (a) Similar oxygen availability
 - (b) Reduced shear stress
 - (c) Increased mixing time
 - (d) Decreased nutrient concentration
- 1-j. Shear-sensitive cells are most affected by: (CO5, K3) 1
- (a) High impeller tip speeds
 - (b) Low agitation rates
 - (c) Uniform mixing
 - (d) Constant temperature

2. Attempt all parts:-

- 2.a. What are the advantages and disadvantages of continuous sterilization? (CO1, K2) 2
- 2.b. Define residence time distribution in the context of chemical reactors. (CO2, K2) 2

- | | | |
|------|---|---|
| 2.c. | What do you understand by productivity for single cell protein? (CO3, K2) | 2 |
| 2.d. | List any two plant hormones commonly added to media. (CO4, K1) | 2 |
| 2.e. | How does cell density affect nutrient consumption rates? (CO5, K3) | 2 |

SECTION-B

30

3. Answer any five of the following:-

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|------|---|---|
| 3-a. | Discuss in detail about filter sterilization and sterilization by radiation? (CO1, K2) | 6 |
| 3-b. | Draw a flow diagram of bioprocessing steps? (CO1, K2) | 6 |
| 3-c. | Write short note on rheology of fermentative fluids. (CO2, K2) | 6 |
| 3-d. | Interpret the impact of different flow patterns (e.g., plug flow vs. mixed flow) on the RTD and how this influences reactor design and operation. (CO2, K4) | 6 |
| 3.e. | Write short note on controlling devices for environmental factors in a bioreactor (CO3, K2) | 6 |
| 3.f. | What are the effects of scale up on nutrient availability and supply? (CO4, K2) | 6 |
| 3.g. | What are some potential safety hazards associated with high impeller speeds in a bioreactor? (CO5, K2) | 6 |

SECTION-C

50

4. Answer any one of the following:-

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|------|--|----|
| 4-a. | Explain the role of temperature and pH control in bioreactor design. Discuss how these factors influence microbial growth and product formation. (CO1, K2, K3) | 10 |
| 4-b. | Explain the application of energy balance in controlling bioreactor temperature. Describe what happens if heat removal is not properly designed in an exothermic fermentation process. (CO1, K3) | 10 |

5. Answer any one of the following:-

- | | | |
|------|--|----|
| 5-a. | Describe various characteristics of oxygen uptake in cells and significance of critical oxygen tension. (CO2, K2) | 10 |
| 5-b. | Summarize the impact of fermentation broth viscosity on mass transfer processes, such as oxygen and nutrient diffusion, and the implications for microbial growth and product formation. (CO2, K3) | 10 |

6. Answer any one of the following:-

- | | | |
|------|--|----|
| 6-a. | Explain the principles, advantages, and disadvantages of various types of bioreactors employed in different industrial applications. (CO3, K2) | 10 |
| 6-b. | Compare bubble column and airlift bioreactors in terms of gas-liquid mass transfer. (CO3, K3) | 10 |

7. Answer any one of the following:-

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|------|--|----|
| 7-a. | How do correction factors come into play when applying geometric similarity to scale up a process? What are some common methods for evaluating correction factors, and how do they work? (CO4, K4) | 10 |
| 7-b. | Describe the advantages of using a continuous stirred-tank reactor (CSTR) for wastewater treatment in a sugar mill. (CO4, K3) | 10 |

8. Answer any one of the following:-

- 8-a. What are some challenges associated with temperature control in a bioreactor? 10
How can advances in temperature control technology impact bioprocesses? (CO5, K3)
- 8-b. Evaluate the effectiveness of scale-down models in predicting large-scale 10
performance. (CO5, K4)

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