Printed Page:-04 **Subject Code**:- **ABT0611**

Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: VI - THEORY EXAMINATION (2023 - 2024)

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 parameter is crucial for maintaining optimal growth of microorganisms in a bioreactor? (CO1) 1

(a) Carbon dioxide concentration

(b) Nitrogen concentration

(c) Oxygen concentration

(d) Methane concentration

1-b. How is energy balance typically expressed in a bioreactor? (CO1) 1

(a) Heat transfer coefficient (W/m^2K)

(b) Temperature (°C)

(c) Power consumption (W)

(d) Enthalpy (J/g)

1-c. The dynamic method for measuring kLa is based on _____ (CO2) 1

(a) an unsteady-state mass balance for oxygen

(b) a steady-state mass balance for oxygen

(c) None of the above

(d) Both (a) and (b)

1-d. Oxygen balance method is based on ____ (CO2) 1

(a) no assumptions

(b) few assumptions

(c) too many assumptions
(d) None of the above

1-e. Safety valves are used for ____ (CO3) 1

(a) release of pressure when excess pressure builds
(b) release of volume when volume increases
(c) None of the above
(d) Both (a) and (b)

1-f. Feed ports allow ____ (CO3) 1

(a) media or ingredients to be passed through them
(b) transfer air through them
(c) transfer of alkali
(d) transfer of acid

1-g. After the fermentation is over, ethanol is recovered by (CO4) 1

(a) centrifugation
(b) distillation
(c) filtration
(d) cell disintegration

1-h. Which of the following is an upstream process? (CO4) 1

(a) Product recovery
(b) Product purification
(c) Media formulation
(d) Cell lysis

1-i. What is the ideal pH range for most aquatic organisms? (CO5) 1

(a) 0 to 2
(b) 2 to 4
(c) 6 to 8
(d) 10 to 12

1-j. Which of the following is a common method for temperature control in bioreactor? (CO5) 1

(a) Constant cooling
(b) Constant heating
(c) On-off control
(d) PID control

2. Attempt all parts:-

2.a. Discuss the importance of agitation and aeration in aerobic fermentation? (CO1) 2

2.b. What do you understand by cryptic growth? (CO2) 2

2.c. What is the importance of stirrer glands? (CO3) 2

2.d. What do you mean by scale down of bioreactor? (CO4) 2

2.e.	What do you understand by feedback and feedforward control in a bioreactor ? (CO5)	2

SECTION-B 30

3. Answer any five of the following:-

3-a.	How bioreactor operation involves mass and energy balance calculations? (CO1)	6
3-b.	Discuss in detail about the physical and chemical methods of sterilization? (CO1)	6
3-c.	Discuss in detail about the film theory for mass transfer? (CO2)	6
3-d.	Discuss various fluid flow regimes and map their importance with the help of Reynold's number? (CO2)	6
3.e.	With the help of labelled diagram, explain photobioreactors in detail? (CO3)	6
3.f.	How does geometric similarity helps in the optimization of mixing and oxygen transfer in bioreactors? (CO4)	6
3.g.	How monitoring and controlling dissolved oxygen levels in a bioreactor is advantageous? (CO5)	6

SECTION-C 50

4. Answer any one of the following:-

4-a.	Draw a schematic diagram of continuous steam injector and explain their working mechanism? Also write its advantages? (CO1)	10
4-b.	With the help of graph, discuss about the batch heat sterilization of liquids in detail? (CO1)	10

5. Answer any one of the following:-

5-a.	Derive an expression for mass transfer coefficient of gas-liquid mass transfer? (CO2)	10
5-b.	Derive an expression for the determination of mass transfer coefficient by oxygen balance method? (CO2)	10

6. Answer any one of the following:-

6-a.	Explain the concept of scale-up in bioreactor design and the challenges involved in transitioning from lab-scale to large-scale production? (CO3)	10
6-b.	Explain the principle and applications of immobilized cell bioreactor in bioprocess engineering? (CO3)	10

7. Answer any one of the following:-

7-a.	Consider the scale up of a fermentation from 10L to 10000L vessel. The small fermenter has a height to diameter ratio of 4. The impeller diameter is 30% of the tank diameter and air is sparged at 1VVM. Agitator speed is 500rpm and three Rushton turbine impellers are used. Determine the dimensions of the large fermenter and agitator speed for constant impeller tip speed? (CO4)	10
7-b.	A laboratory-scale bioreactor with a working volume of 1 L and an agitation speed of 300 rpm is producing a PHB at a rate of 10 g/L/hr with a yield of 95%. What would be the expected yield and production rate of PHB in an pilot-scale bioreactor with a working volume of 100 L and an agitation speed of 150 rpm?	10

Assume constant P/V is maintained between the two reactors? (CO4)

8. Answer any <u>one</u> of the following:-

8-a.	Explain the working principle of common temperature measurement techniques used in bioreactors, such as thermocouples, resistance temperature detectors (RTDs), and thermistors. Compare and contrast these techniques in terms of accuracy, response time, and application suitability. (CO5)	10
8-b.	Discuss the importance of pH measurement and control in a bioreactor? Also explain how pH affects microbial growth, enzymatic activity, and product formation? (CO5)	10