Printed page: 4 **Subject Code: BBT0501**

Roll No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: V - THEORY EXAMINATION (2025-2026)

Subject: Bioprocess Engineering

Time: 3 Hours **Max. Marks:100**

General Instructions:

IMP: Verify that you have received question paper with 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 growth rate constant (μ) is defined as (CO1, K2) 1

(a) ln X / t

(b) (dX/dt)/X

(c) X × t

(d) t/X

1-b. A batch culture shows a linear increase in biomass with time after the exponential phase. Which factor most likely limits growth in this phase? (CO1, K4) 1

(a) Enzyme denaturation

(b) Nutrient depletion

(c) Oxygen inhibition

(d) Temperature drop

1-c. Design an experimental setup to compare the performance of immobilized vs. free enzymes in a continuous bioreactor. Which metric is most relevant? (CO2, K6) 1

(a) Reaction temperature

(b) Enzyme turnover number

(c) Product yield per unit time

(d) Reactor volume

1-d. Immobilization of enzymes improves (CO2, K4) 1

(a) Specific activity

(b) Reusability and stability

(c) Km value

(d) All of these

1-e. Evaluate why scale-up often fails despite identical geometries. (CO3, K5) 1

(a) Power input / volume ratio changes

(b) Shear stress differences

(c) Non-uniform mixing

(d) All of these

1-f. Which control parameter is adjusted to maintain dissolved oxygen? (CO3, K3) 1

(a) Feed rate

(b) Agitator speed

(c) pH

(d) Temperature

1-g. Aroma compounds in bioprocessing are typically produced by (CO4, K1) 1

(a) Bacteria

(b) Yeast

(c) Algae

(d) None of the above

1-h. Compare the downstream processing needs of recombinant insulin vs. natural insulin. (CO4, K4) 1

(a) Recombinant insulin requires additional refolding steps

(b) Both have identical purification schemes

(c) Natural insulin is easier to purify

(d) Recombinant insulin does not require chromatographic purification

1-i. Propose a mathematical model to predict biomass growth under variable pH and temperature conditions. Which approach is most suitable? (CO5, K6) 1

(a) Empirical polynomial regression

(b) Monod model

(c) Neural network model

(d) Lineweaver-Burk equation

1-j.	Evaluate which modelling approach best describes bioprocess kinetics. (CO5, K5) (a) Empirical (b) Mechanistic (c) Hybrid (d) All depending on data	1

2. Attempt all parts:-

2.a.	Define yield coefficient and give its types. (CO1, K1)	2
2.b.	Mention two advantages of immobilized enzyme systems. (CO2, K2)	2
2.c.	Evaluate the challenges in scale-up from laboratory to industrial bioreactors. (CO3, K5)	2
2.d.	Distinguish between microbial and enzymatic production of bioethanol. (CO4, K4)	2
2.e.	Apply the concept of optimization to improve ethanol yield in fermentation. (CO5, K3)	2

SECTION – B 30

3. Attempt all parts:-

3.a. Answer any <u>one</u> of the following-

3-a.i	Evaluate the significance of stoichiometric analysis in predicting microbial product formation efficiency. (CO1, K5)	6
3-a.ii	Discuss the effect of environmental factors on microbial growth kinetics. (CO1, K2)	6

3.b. Answer any <u>one</u> of the following-

3-b.i	Differentiate between batch, fed-batch, and continuous bioreactors in terms of productivity and control. (CO2, K4)	6
3-b.ii	List different types of enzyme immobilization techniques with suitable examples. (CO2, K1)	6

3.c. Answer any <u>one</u> of the following-

3-c.i	Define solid-state fermentation and list its key parameters. (CO3, K1)	6
3-c.ii	Critically evaluate the suitability of batch, fed-batch, and continuous bioreactor operations for large-scale production using immobilized enzyme or immobilized cell systems. (CO3, K5)	6

3.d. Answer any <u>one</u> of the following-

3-d.i	Develop a process flow diagram for the production of Xantham Gum using a microbial fermentation system. (CO4, K6)	6
3-d.ii	Develop a schematic diagram showing the process flow for human insulin production via microbial fermentation. (CO4, K6)	6

3.e. Answer any <u>one</u> of the following-

3-e.i	Apply the principles of optimization to improve product yield in a fermentation process. (CO5, K3)	6

3-e.ii	Evaluate how the integration of advanced process monitoring tools with mathematical models can enhance prediction accuracy and control efficiency in industrial-scale bioprocesses (CO5, K5)	6

SECTION – C 50

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

4-a.	Critically evaluate direct and indirect methods for quantitative analysis of microbial growth and determine which is more suitable for large-scale fermentation (CO1, K5)	10
4-b.	Discuss how substrate utilization affects biomass production in batch culture. (CO1, K2)	10

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

5-a.	Explain Michaelis-Menten kinetics and the significance of Km and Vmax. (CO2, K2)	10
5-b.	Analyze how enzyme inhibition affects reaction kinetics and reactor productivity. (CO2, K4)	10

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

6-a.	Identify various control variables used in bioreactor operation. (CO3, K1)	10
6-b.	Discuss the role of agitation and aeration in maintaining optimal microbial growth conditions. (CO3, K2)	10

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

7-a.	Analyze the process differences between antibiotic and protein production. (CO4, K4)	10
7-b.	Define the term “bioprocess significance” and its industrial importance. (CO4, K1)	10

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

8-a.	Discuss different types of sterilization used in bioprocesses. (CO5, K1)	10
8-b.	Compare empirical and mechanistic models for predicting bioprocess performance. (CO5, K4)	10