Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI EXAMINATION – SUMMER 2025

Subject Code:3160512 Date:30-05-2025

Subject Name:Biochemical Engineering

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Distinguish between bioprocess engineering and biochemical engineering.	**03**
	(b)	For animal and plant cells, mention the following differences: 1. Cell wall 2. Chloroplast 3. Vacuoles 4. Endoplasmic reticulum	**04**
	(c)	List out procedures involved in the separation and purification of intracellular enzymes. Tabulate the unit operations and their range for recovery and purification of products based on: 1. Size 2. Diffusivity 3. Surface activity 4. Density.	**07**
Q.2	**(a)**	State the role of chelator, buffer and antifoam in the microbiological process.	**03**
	(b)	Classify protein based on its structure. What is the function of transport protein?	**04**
	(c)	Define and write chemical reactions for the synthesis of: 1. Fat 2. Sucrose 3. Amylose	**07**
		OR	
	(c)	What is the denaturation of protein? List out the five major biological functions of proteins.	**07**
Q.3	**(a)**	List out physical methods adopted for immobilization of enzymes. What are the advantages and disadvantages of it compared to free enzyme?	**03**
	(b)	What is the effect of temperature, pH and concentration of substrate on enzyme activity?	**04**
	(c)	A substrate is converted to a product by the catalytic action of an enzyme. Assume that the Michaelis-Menten kinetic parameters for this enzyme reaction are: K_M = 0.03 mol/L r_{max} = 13 mol/L.min a. What should be the size of a steady-state CSTR to convert 95% of incoming substrate C_{S0}=10 mol/L) with a flow rate of 10L/hr? b. What should be the size of the reactor if a plug flow reactor is used instead of the CSTR in part (a)?	**07**
		OR	
Q.3	**(a)**	Write assumptions involved in enzyme kinetics for the Michaelis-Menten approach.	**03**
	(b)	Differentiate between competitive and noncompetitive inhibition of enzymes.	**04**

(c) The initial reaction rate of hydrolysis of acetylcholine (substrate) by dog serum (source of enzyme) and obtained the following data: **07**

Substate Concentration, mol/L	Initial Reaction Rate, mol/L.min
0.0032	0.111
0.0049	0.148
0.0062	0.143
0.0080	0.166
0.0095	0.200

Evaluate the Michaelis-Menten kinetic parameters by employing
(a) the Langmuir plot
(b) the Lineweaver-Burk plot
(c) the Eadie-Hofstee plot

Q.4 **(a)** Define the following: **03**

1. Cultivation
2. Inoculation
3. Sterilization

(b) Discuss the use of a valve and steam trap in the fermentation unit. **04**

(c) Aerobic degradation of benzoic acid by a mixed culture of microorganisms can be represented by **07**

$$\underset{\text{(substrate)}}{C_6H_5COOH} + a\,O_2 + b\,NH_3 \longrightarrow \underset{\text{(bacteria)}}{c\,C_5H_7NO_2} + d\,H_2O + e\,CO_2$$

a. Determine *a*, *b*, *c*, *d*, and *e* if respiratory quotient RQ = 0.9.
b. Determine the yield coefficients, $Y_{X/S}$ and $Y_{X/O2}$.

OR

Q.4 **(a)** How mass transfer limitations in bioreactors are prevented? List out the variant of it. **03**

(b) What are the limitations of batch reactors for microbial growth? How fed-batch reactor is advantageous for it? **04**

(c) Disuses sodium sulfite method for oxygen absorption rate. A fermenter was filled with 10 L of 0.5 M sodium sulfite solution containing 0.003 M Cu^{++} ion and the air sparger was turned on. After 10 minutes, the airflow stopped and a 10 mL sample was taken and titrated. The concentration of the sodium sulfite in the sample was found to be 0.21 mol/L. The experiment was carried out at 25°C and 1 atm. Calculate the oxygen uptake and K_La. **07**

Q.5 **(a)** What is foaming in a bioreactor? What are the adverse impacts of it? How it can be prevented? **03**

(b) List out the source of probable contamination generation in a bioreactor. How can it be prevented? **04**

(c) Sketch a single stirred tank reactor and write a cell and substrate mass balance. Derive an expression for dilution rate. **07**

OR

Q.5 **(a)** List out the methods used for the separation of soluble products. **03**

(b) Write about ultrafiltration and microfiltration methods. **04**

(c) What is Chromatography? Discuss the various types of chromatography methods used for product separation and recovery. **07**

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