Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - VII EXAMINATION - WINTER 2025

Subject Code: 3170407 **Date: 24-11-2025**

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)**	Explain the terms law of conservation of mass, steady state and equillibrium	**03**
	(b)	A continuous process is set up for treatment of wastewater. Each day, 10^5 kg cellulose and 10^3 kg bacteria enter in the feed stream, while 10^4 kg cellulose and 1.5 x 10^4 kg bacteria leave in the effluent. The rate of cellulose digestion by the bacteria is 7 x 10^4 kg d^{-1}. The rate of bacterial growth is 2 x 10^4 kg d^{-1}; the rate of cell death by lysis is 5 x 10^2 kg d^{-1}. Write balances for cellulose and bacteria in the system.	**04**
	(c)	Give classification of fluids based on their rheological behaviour.	**07**
Q.2	**(a)**	Explain Reynolds number for pipes and stirred vessels.	**03**
	(b)	Define Viscosity. Explain different factors affecting viscosity of a fluid in a bioprocess.	**04**
	(c)	A fermentation slurry containing Streptomyces kanamyceticus cells is filtered using a continuous rotary vacuum filter. 120 kg h^{-1} slurry is fed to the filter; 1 kg slurry contains 60 g cell solids. To improve filtration rates, particles of diatomaceous-earth filter aid are added at a rate of 10 kg h^{-1}. The concentration of kanamycin in the slurry is 0.05% by weight. Liquid filtrate is collected at a rate of 112 kg h^{-1}; the concentration of kanamycin in the filtrate is 0.045% (w/w). Filter cake containing cells and filter aid is continuously removed from the filter cloth. (a) What percentage liquid is the filter cake? (b) If the concentration of kanamycin in the filter-cake liquid is the same as in the filtrate, how much kanamycin is absorbed per kg filter aid?	**07**
		OR	
	(c)	Acetobacter aceti bacteria convert ethanol to acetic acid under aerobic conditions. A continuous fermentation process for vinegar production is proposed using non-viable A. aceti cells immobilised on the surface of gelatin beads. The production target is 2 kg h^{-1} acetic acid; however the maximum acetic acid concentration tolerated by the cells is 12%. Air is pumped into the fermenter at a rate of 200 gmol h^{-1}. (a) What minimum amount of ethanol is required? (b) What minimum amount of water must be used to dilute the ethanol to avoid acid inhibition? (c) What is the composition of the fermenter off-gas?	**07**
Q.3	**(a)**	Explain the terms kinetic energy, potential energy and internal energy	**03**

	(b)	Explain radial flow and axial flow impellers.	**04**
	(c)	Explain film theory in detail.	**07**
		OR	
	(a)	Explain the terms enthalpy, sensible heat and latent heat.	**03**
	(b)	Explain mechanism of mixing.	**04**
	(c)	Explain the steps of oxygen transfer from a gas bubble to inside a cell with a neat diagram.	**07**
Q.4	**(a)**	Explain Lineweaver-Burk Plot.	**03**
	(b)	Glucose isomerase is used extensively in the USA for production of high-fructose syrup. The reaction is: glucose ↔ fructose. ΔH^{o}_{rxn} for this reaction is 5.73 kJ $gmol^{-1}$ $K^{-1;}$ ΔS^{o}_{rxn} is 0.0176 kJ $gmol^{-1}$ K^{-1}. (a) Calculate the equilibrium constants at 50 ^{o}C and 75^{o}C (b) A company aims to develop a sweeter mixture of sugars, i.e. one with a higher concentration of fructose. Considering equilibrium only, would it be more desirable to operate the reaction at 50^{o}C and 75^{o}C?	**04**
	(c)	Explain Michaelis-Menten Kinetics in detail.	**07**
		OR	
	(a)	Explain Langmuir Plot	**03**
	(b)	Draw a neat diagram of stirred tank reactor with proper annotations and explain functions of its components.	**04**
	(c)	Derive the equation for total time in a batch reaction cycle.	**07**
Q.5	**(a)**	Explain principle of Flow injection analysis.	**03**
	(b)	Explain feedback control and programmed control of a bioprocess.	**04**
	(c)	Describe immunosensors and DNA biosensors — include their principle, design, and applications in disease detection.	**07**
		OR	
	(a)	Describe any two cost-cutting strategies commonly used in industrial bioprocessing.	**03**
	(b)	Differentiate between deterministic and stochastic models in bioprocess simulations.	**04**
	(c)	Elaborate on the role of modelling and simulation in scale-up and process design of industrial fermentations.	**07**

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