



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3160512

Semester – VI

Subject Name: Biochemical Engineering

Type of course: Professional elective

Prerequisite: Basic Concepts of chemistry and unit operations.

Rationale: This course is intended to familiarize the students of chemical engineering with the key aspects associated with biochemical processes. Students will be exposed to the concepts which constitute biochemical engineering including its scope, applications and advantages over conventional processes. Students will also learn the principles and practice of cell culture including sterilization techniques, bioreactor design, and some of the common unit processes of the downstream processing of biological products.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Biochemical engineering as an interdisciplinary course, comparison of chemical and biochemical processes, Integrated bioprocess systems, Unit Operations in Bioprocess, microbiology fundamentals, Prokaryotic and Eukaryotic cells and their comparison; important features.	6
2	Chemicals of life: carbohydrates- types and functions, proteins- functions, elemental composition and types of proteins, basic idea about primary, secondary and tertiary structure of proteins, protein denaturation. Lipids- classifications and functions.	7
3	Properties of enzymatic reactions, Various models for enzyme-substrate complex formation, factors affecting enzyme activity, Michaelis-Menten equation: derivation and graphical evaluation of kinetic parameters, Enzyme inhibition, Enzyme immobilization, different methods of immobilization, Industrial enzymes and their applications.	7
4	Sterilization and media preparation, different types of solid media, cell death kinetics, Air sterilization, steam sterilization, batch and continuous sterilization. Stoichiometry of microbial growth and product formation, elemental balances, degree of reduction, yield coefficient, respiratory quotients. Oxygen uptake rate, Biomass production in cell cultures, phases of microbial growth, measurement of microbial growth by various methods, Monod growth kinetics, Evaluation of kinetic parameters, substrate and product	7



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	inhibition, maintenance energy, environmental factors affecting microbial growth.	
5	Growth of organisms in batch reactor, continuous culture of organism, comparison between batch and continuous biomass culture, Stirred tank reactor in series and stirred tank reactor with recycle of biomass. Fed batch reactor, plug flow reactor.	6
6.	Design of Fermentor, Basic Functions, Body construction, Maintenance of aseptic conditions, Control of parameters, Valves and steam traps, Variants of fermentation vessels, Oxygen requirement in fermentations, Aeration and Agitation, Determination of K_{La} values, Fluid rheology, Factors affecting K_{La} values	6
7.	Product recovery operations, applications of filtration, cell disruption, centrifugation, liquid-liquid extraction, micro and ultrafiltration, chromatography, electrophoresis, isoelectric focusing in downstream processing.	6

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	26	23	7		

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Bioprocess Engineering: Basic concepts, 2nd Edition, by Michael L Shuler & Fikret Kargi, PHI, New Delhi.
2. Introduction to Biochemical Engineering by D. G. Rao, Tata McGraw-Hill Education, 2005.
3. Biochemical Engineering Fundamentals by James Bailey & David F Oillis, Second Edition, McGraw Hill Publications.
4. Principles of Fermentation Technology, by Whitaker, Peter F Stanbury, S. Hall and A. Whitaker, Publisher: Butterworth-Heinemann; 2nd edition
5. Biochemical Engineering, Harvey W Blanch and Douglas S Clark, CRC Press

Course Outcomes: At the end of the course, the students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	To understand basic features of a biochemical reaction and its stoichiometry	15



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CO-2	To develop an elementary idea of the basic features of common microorganisms and their growth and functions of selected biochemical.	20
CO-3	To identify and explain the basic design features of bioreactors	25
CO-4	To understand the principles of the various downstream processing of bio-products	20
CO-5	To understand the basics of enzyme kinetics and features of enzymes with few applications	20

List of Open Source Software/learning website:

Preparation of power-point slides, which include videos, animations, Pictures, graphics for better understanding theory – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus of Biochemical engineering is covered.

Suggested list of experiments to be performed (8 to 10 experiments are to be given)

1. Preparation of aqueous culture medium for microbial growth and steam sterilization of the medium in autoclave.
2. Preparation of solid medium (on agar): Slant, stab, petridish and inoculation of microbial culture in laminar hood cabinet.
3. Analytical Estimation of Glucose from aqueous solution by DNS method using spectrophotometer.
4. Estimation of total sugar, reducing and non-reducing sugar from jaggery sample by Cole's Method.
5. Estimation of Protein by Folin-Lowry method
6. To study the Growth kinetic of any microorganism by using Monod Equation
7. Determination of dissolved oxygen concentration from a sample of water.
8. Determination of oxygen transfer rate and K_{La} value
9. Determination of iodine value of the given sample of vegetable oil.
10. Determination of free CO_2 in a given sample of tap-water.
11. Determination of BOD-5 for a given sample of waste water
12. To perform column chromatography
13. To perform drying operation on any biomass/biological materials and construct the drying rate plot.

List of Open Source Software/learning website: Software:

Students can refer to video lectures available on the websites including NPTEL, Students can refer to the CDs which are available with some reference books for the solution of problems using software.

Students can develop their own programs for the solutions of problems.