



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: Post Graduate Degree

Branch: Chemical Engineering

Course/Subject Code: ME01000121

Course/Subject Name: Bio Process Engineering

w.e.f. Academic Year:	A.Y. 2024-25
Semester:	1 <sup>st</sup> Semester
Category of the Course:	PEC

<b>Prerequisite:</b>	Basic Concepts of Transport Phenomena, Mass transfer and Reaction kinetics
<b>Rationale:</b>	This subject is an integration of chemical engineering with biological systems. It deals with kinetics of biological reactions, mass and heat transfer concepts and transport phenomena occurring within biological reactors.

## Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes
01	Understand the different cells and their use in biochemical processes
02	Understand the role of enzymes in kinetic analysis of biochemical reaction
03	Analyze bioreactors, upstream and downstream processes in production of bio products
04	Apply the concepts of various unit operations in downstream processes of biological products

## Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial/ Practical		
				ESE (E)	PA/ CA (M)	PA/CA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

## Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	<b>Kinetics of Enzyme Catalyzed Reaction</b> The Enzyme Substrate Complex and Enzyme Action, Simple Enzyme kinetics with one and two substrates, Determination of Elementary Step Rate Constants, Other patterns of substrate concentration dependence, Modulation and	9	19



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	Regulation of Enzymatic Activity, Other Influences on enzyme activity, Enzyme deactivation, Enzyme reactions in Heterogeneous systems		
2.	Kinetics of Substrate Utilization, Product Formation, Biomass Production in Cell Cultures Ideal Reactors for kinetics measurements, Stoichiometry and kinetics of Balanced Growth, Transient growth kinetics, structured kinetic models, product formation kinetics, Segregated kinetic models of Growth and Product Formation, Thermal Death kinetics of Cells and Spores.	9	19
3.	<b>Transport Phenomena in Bioprocess Systems</b> Gas Liquid Mass transfer in cellular systems, determination of oxygen transfer rates, mass transfer for freely rising or falling bodies, forced convection mass transfer, overall K <sub>L</sub> a estimates and power requirements for sparged and agitated vessels, Mass transfer across free surfaces, other factors affecting K <sub>L</sub> a, Scaling of Mass transfer equipment, Heat Transfer, Sterilization of Gases and liquids	9	19
4.	<b>Design and Analysis of Biological Reactors:</b> Ideal reactors, reactor dynamics, reactors with non-ideal mixing, sterilization reactors, immobilized biocatalysts, multiple bioreactors, Fermentation Technology, animal and plant cell reactor technology.	8	19
5.	<b>Product Recovery Operations</b> Recovery of particulates – cells and solid particles by Filtration, Centrifugation, Flocculation, Cell Disruption, Production isolation by Liquid Liquid extraction, Precipitation, Chromatography and Fixed Bed Adsorption, Dialysis, Membrane Separation, Electrophoresis, Crystallization and Drying	10	25
	<b>Total</b>	<b>45</b>	<b>100</b>

## Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	28	28	7	0	0

Where R:Remember; U:Understanding; A:Application, N:Analyze and E:Evaluate C:Create(as per Revised Bloom's Taxonomy)



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## **References/Suggested Learning Resources:**

### **(a) Books:**

- 1) Shuler, M. L., Kargi, F., Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. India: Prentice Hall.
- 2) Doran P.M (1995) Bioprocess Engineering Principles, Elsevier Science and Technology Publishers
- 3) Bailey, J. E., Ollis, D. F. (1986). Biochemical engineering fundamentals. Singapore: McGraw-Hill.
- 4) Stanbury, P. F., Whitaker, A., Hall, S. J. (2013). Principles of Fermentation Technology. United Kingdom: Elsevier Science.

### **(b) Open source software and 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 Bioprocess and Biochemical Engineering is covered.

## **Suggested Course Practical List: List of lab experiments:**

- 1 Estimation of Iodine Value of Fats and Oils
- 2 Estimation of Saponification Value of Fats/Oils
- 3 Bioreactor- Basics
- 4 Estimation of growth kinetic parameters in batch fermentation
- 5 Determination of Volumetric Mass Transfer Co-efficient (Dynamic method)
- 6 Determination of Volumetric Mass Transfer Co-efficient (Oxygen balance method)
- 7 Batch Microbial Cultivation
- 8 Fed-Batch Microbial Cultivation
- 9 Continuous Microbial Cultivation
- 10 Study of Enzyme Kinetics
- 11 Immobilization of whole cells

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