GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Science (Industrial Biotechnology)

Level: PG

Course / Subject Code: IB02001031

Course / Subject Name : Enzyme Engineering

1. Learning Outcomes

Learning Outcome Component	Learning Outcome (Learner will be able to)
Theoretical and practical understanding of Enzyme Engineering	• To learn the factors involved in and factors affecting the enzyme activity.
Application of enzymes- clinical diagnosis and industries	• To know the catalytic activity of enzymes and its regulation. • To learn the enzyme used in clinical diagnosis and industries.
Mechanism of reaction catalysed by enzymes	• To learn the kinetics of single and multi enzyme substrate enzyme catalysed reaction.
Effective Communication	• Communicate concepts and ideas effectively.
Professional & Ethical Behaviour	• Transparency, honesty and ethical reasoning in handling biomolecules and product processing.

LO – PO Mapping: Correlation Levels:

1 = Slight (Low); 2 = Moderate (Medium); 3 = Substantial (High), "-"= no correlation

Sub Code: 1320103	PO1	PO2	PO3	PO4	PO5	PO6	PO7
LO1: Theoretical and practical understanding of Enzyme Engineering	3	2	3	2	2	3	1
LO2: Application of enzymes- clinical diagnosis and industries	3	3	3	2	2	3	2
LO3: Mechanism of reaction catalysed by enzymes	2	2	2	3	3	2	2
LO4: Effective communication	2	3	2	2	3	3	2
LO5: Professional & Ethical Behaviour	2	2	3	2	3	2	3

2. Course Duration: The course duration is of 45 sessions of 60 minutes each.

3. Course Contents:

Module No:	Module Content	No. of Sessions	70 Marks (External Evaluation)
1	**Introduction to enzymes**	6	10

	What are enzymes, Brief history of enzymes, Nomenclature and classification of enzymes, Properties of enzymes, Structure of enzymes, Active site of enzymes, Factors influencing enzyme activity, Enzyme assays.		
2	**Specificity and mechanism of enzyme action** Types of specificity, Koshland "induced fit" hypothesis, Strain or transition – state stabilization hypothesis; Mechanism of catalysis, Mechanism of reaction catalyzed by enzyme without cofactors, Metal-activated enzyme and metalloenzyme, Coenzymes in enzyme catalyzed reactions.	6	10
3	**Enzyme Kinetics** Kinetics of enzyme-catalyzed reaction, Methods for investigating kinetics of enzyme catalyzed reactions, Interpretation of Km, Vmax, Turnover number and Kcat, Specific activity of enzymes, Enzyme units, Inhibition of enzyme activity, Regulation of enzyme activity.	6	10
4	**Immobilization of enzymes** Concept, Methods of immobilization, Kinetics of immobilized enzymes, Effects of immobilization on enzymes, Use of immobilized enzymes, Bioreactors using immobilized enzymes.	4	10
5	**Industrial application of enzymes** Industrial enzymes: Sales value of industrial enzymes, Traditional (non-recombinant) sources of industrial enzymes, Impact of genetic engineering on enzyme production, Engineered enzymes, Extremophiles: hyperthermophiles, Enzymes from hyperthermophiles, Enzymes from additional extremophiles, Enzymes in organic solvents.	6	10

6	**Industrial enzymes** Proteases and Carbohydrases, Proteolytic enzymes: Carbohydrases, Lignocellulose degrading enzymes, Pectin and Pectic enzymes.	6	10
7	**Additional industrial enzymes:** Lipases, Penicillin acylase, Amino acylase and Amino acid production, Cyclodextrins and cyclodextrin glycosyltransferase, Enzymes in animal nutrition, Enzymes in molecular biology; Clinical applications of enzymes.	6	5
8	**Enzyme Engineering** Prediction of enzyme structure, Design and construction of novel enzymes.	5	5
9	**Practicals** 1. Purification of enzyme by Ion Exchange (anion and cation), gel filtration and Hydrophobic Interaction Chromatography. 2. Immobilization by entrapment and surface immobilization. 3. Running of immobilization energy column. 4. Estimation of mass transfer effect (diffusion control reaction, Enzyme pellet efficiency, comparison with free enzyme system). 5. Estimation of stability of enzyme (thermal, operational and pH).	-	(30 marks)

4. Pedagogy:

- ICT enabled Classroom teaching
- Practical / live assignment
- Interactive classroom discussions

5. Evaluation:

Students shall be evaluated on the following components:

Internal Evaluation	**(Internal Assessment – 20 Marks)**
• Assignments	10 marks
• Class Presence	5 marks
• Record maintenance	5 marks
Mid-Semester Examination	**(Internal assessment-30 Marks)**
End-Semester Examination	**(External assessment-70 Marks)**

6. Reference Books:

No	Author	Name of the Book	Publisher	Year of Publication / Edition
1	T. Palmer and P.L. Bonner	Enzymes: Biochemistry, Biotechnology and Clinical Chemistry	Woodhead publishing limited	Latest Edition
2	Wolfgang Aehle	Enzymes in Industry: Production and Applications	Wiley-VCH Verlag GmbH & Co. KGaA	Latest Edition
3	Branden and Tooze	Introduction to Proteins Structure	Garland Publishing Group	Latest Edition
4	Gary Walsh	Proteins: Biochemistry and Biotechnology	John Wiley & Sons Ltd.	Latest Edition

Note: Wherever the standard books are not available for the topic appropriate print and online resources, journals and books published by different authors may be prescribed.

7. List of Journals/Periodicals/Magazines/Newspapers / Web resources, etc

- https://www.longdom.org/enzyme-engineering.html
- https://www.sciencedirect.com/journal/enzyme-and-microbial-technology
- https://infinitabiotech.com/blog/application-of-enzyme-engineering/

Course Outcomes:

On completion of this course, students should be able to:

- Gain clear understanding in isolation, purification and characterization of enzymes.
- Understand enzyme engineering technologies.