GUJARAT TECHNOLOGICAL UNIVERSITY
Integrated Master of Science (Biotechnology)
Semester: 3
Subject Name: Enzyme Technology
Subject Code: 1320403

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	8	8	70	30	30	20	150

Prerequisite:
Students must study the biochemistry in previous classes. They must have knowledge about the fundaments of kinetics and protein structures.

Rationale:
This course will enable students to understand concepts in enzymology and enzyme techniques. The course will provide an overview of the use of enzymes in large scale industrial processes. An overview of industrial scale protein production will be presented, including an introduction to applicable microbial expression hosts, downstream processing and purification methods, and enzyme optimization through enzyme discovery and engineering.

Course Content:

Unit No.	Content	No. of Hours	Weightage (%)
1	**Introduction to enzymes** Historical development of enzymology, Enzymes vs Chemical catalyst, structure and properties of enzymes, Cofactors and coenzymes. Enzyme nomenclature and classification (rationale, overview and specific examples) Nature of enzymes, other forms of enzymes: Abzymes, Ribozymes, Synzymes, Extremozymes; Classification of enzymes with examples, Concept of Holoenzymes, cofactors and coenzymes; Enzyme mechanism and activation, various models of enzyme specificity. Zymogens and their activation (Proteases and Prothrombin). Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Units of activity	12	20
2	**Enzyme kinetics** Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy. Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibiton	12	20

3	**Structure and Regulation of enzymes** Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase, Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency Techniques for studying mechanisms of action specific examples-: chymotrypsin, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feedback control, covalent modification. Structure function relationship in enzymes, structural motifs and enzyme evolution.	12	20
4	**Large scale production and technological aspects of enzymes** Enzyme industry in India, scope for entrepreneurship in enzyme industry, Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Improvement of enzymes, Thermal stability and catalytic efficiency of enzyme, introduction to enzyme engineering site directed mutagenesis and enzyme engineering– selected examples. Applications of enzymes: Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes.	12	20
5	**Metabolic Engineering** Importance of metabolic engineering; Need for pathway synthesis (bioproduction), Scope and future of metabolic engineering; Methods for metabolic characterization: genome, transcriptome, proteome, metabolome, fluxome. Regulation of enzyme activity versus regulation of enzyme concentration; Regulation of metabolic networks; Regulation of at the whole cell level; Metabolic control analysis, The theory of flux balances (Cell Capability Analysis, Genome Scale Flux Analysis),Examples of applications of flux analysis, Experimental Determination Method of Flux Distribution with Isotope Labeling	12	20
	Total Hours:	60	

Textbook:

1. Principles of Enzyme Technology (2015) by M. Y. Khan and Farha Khan
2. Enzyme Technology: Pacemaker of Biotechnology (2011) by Prasad N.K

Reference Books:

1. Enzyme Technology (2012) by S. Shanmugam and T. Sathish kumar
2. Biocatalysts and Enzyme Technology (2012) by Klaus Buchholz and Volker Kasche
3. Enzyme Technology (2009) by Anusha Bhaskar and V. G. Vidhya

Course Outcomes:

No.	Course Outcomes	RBT Level*
1	Understanding of the structures and functions of enzymes its classification and parameters associated with enzyme activity	UN,RM,AP,AN
2	Carry out basic research in purifying and characterizing enzymes to establish an application in industry or research	UN,RM,AP,AN
3	Work in industries related to enzymes	UN,RM,AP,AN
4	Understand the large scale production of enzymes and their purification	UN,RM,AP,AN
5	Understand the kinetics of enzyme reactions and reaction stoichiometry, mass balances, basic modeling of enzyme mediated bioprocesses	UN,RM,AP,AN

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Suggested Course Practical List:

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).

List of Laboratory/Learning Resources Required

1. https://onlinecourses.swayam2.ac.in/cec20_bt20/preview
2. https://archive.nptel.ac.in/courses/102/102/102102033/