GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3150406
METABOLIC ENGINEERING

5TH SEMESTER

Type of course: Open Elective

Prerequisite: Basic Knowledge of Biochemistry and Bioenergetics

Rationale: The objectives of this subject is primarily to identify specific genetic and environmental manipulations that lead to enhancement of yield and productivity of biotechnological process, or the overall improvement of cellular properties.

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)	
3	1	0	4	70	30	0	0	100

Contents:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**The Essence of Metabolic Engineering:** Basic Concepts of metabolism and importance	4	9%
2	**Review of Cellular Metabolism** An overview, Transport Processes, Different types of cellular reaction and growth energetics	5	11 %
3	**Comprehensive models of Cellular Reactions** Stoichiometry of Cellular Reactions, Reaction Rates, Dynamic Mass Balances, Yield Coefficients and Linear Rate Equations	10	22%
4	**Regulation of Metabolic Pathways and Metabolic pathway synthesis Algorith** Regulation of Enzymatic Activity, Regulation of Enzyme Concentration, Global Control and Regulation of Metabolic Networks. Overview of Algorithm.	10	22%

5	**Metabolic Flux Analysis and its determination by Isotope Labeling** Theory of MFA, Over determined and Underdetermined Systems, Sensitivity Analysis, Methods to Determine Flux with case studies.	9	20%
6	**Metabolic Control Analysis** Fundamentals of MCA, Determination of Flux Control Coefficients, MCA for Linear and Branched Pathways.	7	16%

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
05	**5**	**20**	**20**	**20**	**0**

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

Reference Books:

1. Gregory Stephanopoulos, Aristos Aristidou, Jens Nielsen (2006) Metabolic Engineering: Principles and Methodologies, Elsevier Science (USA).
2. John Villadsen (2016), Fundamental Bioengineering, Published by Wiley – VCH
3. Christoph Wittmann, Sang Yup Lee, Systems Metabolic Engineering, by Springer Publication
4. Christina Smolke, The Metabolic Pathway Engineering Handbook Tools and Applications, 2017 CRC Press

Course Outcome:

Students will be

Sr. No.	**CO Statement**	**Marks % Weightage**
CO-1	To integrate techniques of molecular biology with the tools of mathematical analysis.	10%
CO-2	To integrate many different parts of overall metabolism.	20%
CO-3	To suggest alternative pathways for the biosynthesis of specific products.	20%

CO-4	To describe metabolic networks computationally as stoichiometric and kinetic models.	10%
CO-5	To describe how metabolism is constrained and how biological and physical constraints can be applied for simulating metabolism.	10%

LIST OF TUTORIALS:

1. Enhancement of Product Yield and Productivity – Case Study of Ethanol/Amino acids
2. Extension of Substrate Range – with Case Study
3. Extension of Product Spectrum and Novel Products – with Case Study
4. Improvement of Cellular properties – with Case study
5. Xenobiotic Degradation – with Case study
6. Application of Metabolic Pathway Synthesis Algorith with case study
7. Metabolic Flux Analysis of Lysine Biosynthetic Network in *C.glutamicum*

List of Open Source Software/learning website:

1) NPTEL

2) MIT Open course lecture