GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170411
Downstream Processes

7th SEMESTER

Type of course: Professional Core Course

Prerequisite: Knowledge of Industrial Biotechnology and Chemical Engineering Fundamentals

Rationale: The objective of this course is to provide an overview of various aspects of recovery and processing of biological products.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	00	00	100

Contents:

Sr. No.	Topics	Teaching Hrs.
1	**INTRODUCTION TO BIOPRODUCTS AND BIOSEPERATIONS** Broad Classification of Bioproducts, Small Biomolecules, Macromolecule: Protein, Nucleic Acid and Oligonucleotides, Particulate Products, Introduction to Bioseperations	4
2	**Disruption of microbial cells:** Composition and structure of cell walls (Bacteria, yeast and other fungi), Analysis of Disruption (direct and indirect measurement), Laboratory scale disruption techniques (mechanical and non mechanical), large scale disruption techniques (High speed Ball Mills, High pressure homogenizers and others)	4

3	**PHYSICAL METHODS OF SEPERATION** Filtration Principles, Filter Media and Equipment, Membrane Fouling, Scale up and Design of Filtration Systems Sedimentation Principle, Methods and coefficients, Production Centrifuges, Ultracentrifugation, Flocculation and Sedimentation, Sedimentation at Low Accelerations, Centrifugal Elutriation	8
4	**ISOLATION OF PRODUCTS** Liquid-Liquid Extraction: Introduction, Principle, biochemical and technical aspects, Solvent selection, Extraction equipment selection, Process Considerations, Analytical applications Adsorption: Chemistry, Batch adsorption, Adsorption in continuous stirred tank, adsorption in fixed beds Precipitation:Principle, Precipitate formation phenomenon, Precipitation with a non solvent,precipitation with salts, precipitation with temperature, Design of precipitationsystems	11
5	**PRODUCT RESOLUTION** 1) Molecular sieve chromatography (Introduction, materials, equipment, theory, operations) 2) Ion Exchange chromatography (Introduction, materials, equipment, theory, operations) 3) Affinity Chromatography (Introduction, matrix, spacer arms, coupling procedures, adsorption, elution, regeneration, theoretical modeling, applications) 4) Hydrophobic chromatography (Introduction, structure and synthesis of	12

	hydrophobic matrices, theoretical aspects, applications and resolving power) 5) High Performance Liquid Chromatography (Introduction, theory and practice, instrumentation, gradient and scale up)	
6	**PRODUCT FINISHING** Crystallization: Principles, Batch Crystallizers, Process Crystallization of Proteins, Crystallizer Scale up and Design Drying : Drying Principles, Dryer Description and Operation, Scale up and Design of Drying Systems	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
5	**10**	**20**	**20**	**15**	**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. Roger G. Harrison, Paul Todd, Scott R. Rudge, Demetri P. Petrides, Bioseparations ScienceAnd Engineering, Oxford University Press 2003
2. P.A. Belter, E.L. Cusslerand Wei-Houhu – Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pub. (1988).
3. R.O. Jenkins, (Ed.) – Product Recovery in Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann (1992).
4. J.C. Jansonand L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.
5. R.K. Scopes – Protein Purification – Principles and Practice, Narosa Pub. (1994).

Course Outcome:

Sr.	**CO Statement**	**Marks %**

No.		Weightage
CO-1	Apprehend principles of various unit operations used in downstream process.	20%
CO-2	Integrate the individual unit operations in developing a process design	40%
CO-3	Choose correct hierarchy in selection of unit operations for recovery of bioproducts	40%

List of Open Source Software/learning website:

1) NPTEL / SWAYAM

2) free softwares / virtual labs etc.