SEMESTER S8

ADVANCED BIO SEPARATION ENGINEERING

Course Code	PEBBT865	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. This course will allow students to recognize the basis for various steps in bio separations and their economics, to design a strategy for the purification of a product

SYLLABUS

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Module No.	Syllabus Description	Contact Hours
1	**Selection of operations in separation processes:** Defining final product objective, characterization of starting material, selection of separation sequence, purification process and unit operations, selection of purification operations, protein purification and handling, use of protein properties in selection of purification operations. **Cell disruption methods:** Cell disruption by homogenizer-mechanism, process design considerations, enzyme release applications; Bead mill disruption-mechanism and design considerations, operational parameters and mixing characteristics; Enzymatic cell lysis and product release- Basic theory and models, methods and design, applications.	9
2	**Concentration and separation operations:** Membrane systems -Process description, theory of dialysis, reverse osmosis, ultrafiltration and crossflow filtration, batch continuous and diafiltration modes, applications**;** Ion-exchange processes- Physical description, separation mechanisms, equipment and applications, Aqueous-two phase separations- Theory,	9

	methods and applications, Precipitation- Theory, design/methods, applications.	
3	**Purification operations:** Ion-exchange in purification-Ion-exchange equilibria of biochemicals, chromatographic processes; Process affinity chromatography-Theoretical and practical considerations, affinity adsorbents, process affinity chromatography in operation, applications; Reversed-phase and hydrophobic interaction chromatography of peptides and proteins-Theory, applications, preparative separations; Electrically-driven separation processes-Analytical techniques, Theory of electrophoresis, modes of electrophoresis, sources of dispersion, continuous electrophoresis.	**9**
4	**Design of separation processes:** Synthesis of downstream processes-Separation processes involved, process synthesis, mathematical programming techniques, heuristics, artificial intelligence/expert systems, evolutionary methods; Downstream processing plant and equipment-Overview of bioprocess plants, downstream process equipment requirement, general factors affecting facility size and layout, DSP flowsheets; Downstream process economics- Commercialization and scaling-up of biotechnology, Case study-Production of human insulin using recombinant E. coli- Capital cost and operating cost estimation, return on investment-sensitivity analysis, cash flow analysis.	**9**

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Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain the rationale for selection of operations for separation and purification of bio-products.	**K2**
CO2	Illustrate the design of various processes for cell disruption, concentration and purification of bio-products.	**K3**
CO3	Explain the design and scale-up of downstream process plant and equipment.	**K3**
CO4	Discuss the economics of downstream processing, in the back drop of suitable case studies.	**K3, K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

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CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2	3	3	3	2								
CO3	3	3	3	2								
CO4	3	3	3	2	3						3	

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Separation processes in Biotechnology	Juan A Asenjo	CRC Press	1st ed. 1990
2	Bioseparations Science and Engineering	Roger G Harrison, Paul Todd, Scott R Rudge, Demetri P Petrides	Oxford University Press	2nd ed. 2015
3	Bioseparations Engineering: principles, practice and economics	Michael R Ladisch	John Wiley and Sons	1st ed. 2001

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Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Handbook of Downstream Processing	Elliott Goldberg	Blackie Academic and Professional	1st ed. 1997
2	Engineering Processes for Bioseparations	Laurence R Weatherley	Elsevier	1st ed. 2013
3	Handbook of Bioseparations	Satinder Ahuja	Elsevier	1st ed. 2000

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	NPTEL: Principles of downstream techniques in bioprocesses https://youtu.be/jsVnQYxQDdk

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