

Board of Studies Meeting Minutes
B.Tech Chemical Technology (Biochemical Engineering)
Department of Biochemical Engineering
School of Chemical Technology
HBTU, Kanpur

The Department of Biochemical Engineering, HBTU, Kanpur Board of Studies meeting was held on August 12, 2026 at 01:00 PM for B.Tech Chemical Technology (Biochemical Engineering) to review the course structure as per NEP 2020.

The following members were present during the meeting:

- | | | |
|-----|---|----------|
| 1. | Prof. Ajay Kumar Singh, HoD, Department of Biochemical Engineering | Chairman |
| 2. | Prof. A.S. Vidyarthi, Former Vice Chancellor, Bikaner Technical University | Member |
| 3. | Prof. C.B. Majumder, Professor, Department of Chemical Engineering, IIT Roorkee, Uttarakhand | Member |
| 4. | Prof. Ashok Kumar, Department of Bioscience & Bioengineering, IIT Kanpur | Member |
| 5. | Prof. Aradhana Srivastava, School of Chemical Technology, Guru Govind Singh Indraprastha University | Member |
| 6. | Mr. S.K. Singh, MD, Pollucon Technologies LTD. Noida | Member |
| 7. | Prof. Lalit Kumar Singh, Professor, Department of Biochemical Engineering | Member |
| 8. | Mr. Brajesh Singh, Associate Professor, Department of Biochemical Engineering | Member |
| 9. | Dr. Sachin Kumar, Associate Professor, Department of Biochemical Engineering | Member |
| 10. | Dr. Rajkamal Kushwaha, Assistant Professor, Department of Biochemical Engineering | Member |
| 11. | Dr. Roma Agrahari, Assistant Professor, Department of Biochemical Engineering | Member |
| 12. | Dr. Shravan Kumar, Assistant Professor, Department of Biochemical Engineering | Member |
| 13. | Mr. Vishal Bhadauria, Assistant Professor(C), Department of Biochemical Engineering | Member |

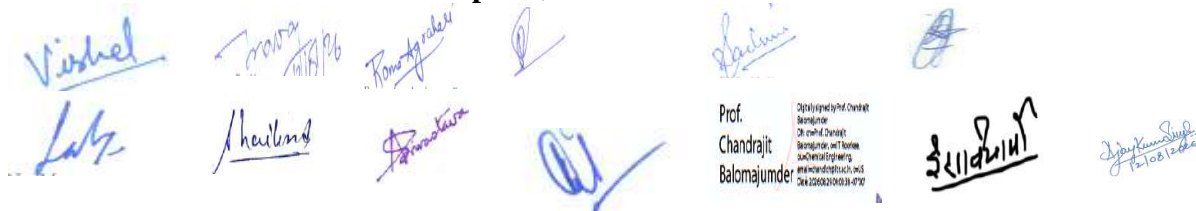
Chairman of BoS, Prof. Ajay Kumar Singh, HoD, BE welcome all the Board members, following agendas were taken up for discussion and decision.

1. Discussions and decisions on course structure of B.Tech, Chemical Technology (Biochemical Engineering)

The proposed B.Tech. Course structure was reviewed in accordance with the provision of NEP 2020, before the Board for detailed consideration. The members reviewed the distribution of courses across different semesters, credit requirements, core and elective courses, laboratory components, project work, internships, and other academic activities.

The Board discussed the revision of the four years VIII Semesters **B.Tech. course structure** and considered the following suggestions:

1. **Mr. S.K. Singh** suggested the inclusion of a **Digital Fabrication Workshop** in the *Manufacturing Practices* course to provide students with practical exposure to digital fabrication and modern manufacturing techniques. Prof. Singh had given greater emphasis to **equipment and process design**, along with relevant **instrumentation aspects**, in the course content.

The block contains several handwritten signatures in blue ink. From left to right, the signatures are: 'Vishal', 'Lok', 'Rajkamal', 'Roma', 'Sachin', 'Ashok', 'Aradhana', 'S.K. Singh', 'Lalit', 'Brajesh', 'Dr. Sachin', 'Dr. Rajkamal', 'Dr. Roma', 'Dr. Shravan', 'Vishal Bhadauria', and a circular stamp of Prof. Chandrajit Balomajumder. The stamp text includes: 'Prof. Chandrajit Balomajumder', 'Department of Chemical Engineering', 'HBTU, Kanpur', '2008-2010', '2010-2012', '2012-2014', '2014-2016', '2016-2018', '2018-2020', '2020-2022', '2022-2024', '2024-2026', '2026-2028', '2028-2030', '2030-2032', '2032-2034', '2034-2036', '2036-2038', '2038-2040', '2040-2042', '2042-2044', '2044-2046', '2046-2048', '2048-2050', '2050-2052', '2052-2054', '2054-2056', '2056-2058', '2058-2060', '2060-2062', '2062-2064', '2064-2066', '2066-2068', '2068-2070', '2070-2072', '2072-2074', '2074-2076', '2076-2078', '2078-2080', '2080-2082', '2082-2084', '2084-2086', '2086-2088', '2088-2090', '2090-2092', '2092-2094', '2094-2096', '2096-2098', '2098-2100'.

2. **Prof. C.B. Majumder** suggested the inclusion of **equipment design, process design, and supplementary design components** in the *Bioprocess Design* course.
3. **Prof. A.S.Vidhyarthi** suggested appropriate mapping of AI-ML courses with **Biochemical Engineering core courses** and inclusion of relevant **Bioinformatics and AI/ML components** in the B.Tech. curriculum.
4. **Prof. Aradhana Srivastava** suggested the inclusion of **case studies in the Pre-Ph.D. course work** to enhance research-oriented and analytical learning among Ph.D. scholars.
5. **Prof. Ashok Kumar** discussed whether the University has a provision for pursuing a one year M.Tech. programme after completion of the B.Tech. programme by earning additional 22 credits during the B.Tech. programme and completing the remaining required credits of M.Tech. Integrated programme. Prof. Lalit Kumar Singh clarified the Board that such a provision is available in the University.

During discussion feedbacks of all stakeholders have also been considered. Board Members agreed to maintain an appropriate balance between fundamental sciences, engineering fundamentals, core biochemical engineering subjects, and emerging areas. Provide adequate emphasis on laboratory-based learning, hands-on training, computational skills, and project-based learning. Strengthen industry-oriented courses, internships, industrial visits, and interaction with professionals. Provide sufficient opportunities for electives, multidisciplinary learning, innovation, startup management skills, entrepreneurship, and research. Incorporate emerging areas relevant to the discipline to enhance students' employability and preparedness for higher studies. All suggestion and modification incorporated in the programme structure and thereafter approved by the committee.

2. Discussions/modification/ improvement in the name of courses offered for B.Tech. Chemical Technology (Biochemical Engineering).

The title names of various courses and practical laboratory works were discussed and the approved titles were incorporated.(ANNXURE-I).

I Semester: Multidisciplinary – Chemistry, Basic Electronics Engineering, Basic Engineering Mechanics; Value Added Course – Environmental Science and Engineering; Skill Enhancement – Digital Fabrication/Workshop/Manufacturing Practices; Ability Enhancement – Communication Skills; Core – Introduction to Biochemical Engineering; Mandatory Course – NSS/Physical Activities/Meditation & Yoga/Photography/Nature Club.

II Semester: Multidisciplinary – Mathematics-I, Physics, Programming for Problem Solving, Basic Electrical Engineering; Skill Enhancement – Engineering Graphics & Design; Value Added Course – Universal Human Values; Ability Enhancement – DHS 202; Mandatory Course – Induction Program.

Handwritten signatures and stamps are present at the bottom of the page, including names like Vishal, Lab, Hailind, Rajendra, Prof. Chandrajit Balomajumder, A, S. K. Singh, and Prof. Kumar Singh.

IV Semester: Multidisciplinary – Computer Oriented Numerical Methods; Core – Modern Analytical Techniques, Heat Transfer Operation, Chemical Engineering Thermodynamics, Industrial Biotechnology; Skill Enhancement (Branch Specific) – Bioprocess Principles; Ability Enhancement - Seminar; Mandatory Course – NSS/Physical Activities/Meditation & Yoga/Photography/Nature Club

VI Semester: Core – Instrumentation & Process Control, Environmental Biotechnology, Downstream Techniques in Bioprocesses, Fermentation Technology; Skill Enhancement – Environmental and Fermentation Technology Laboratory; Professional Elective-I – CHED; Professional Elective-II – Molecular Biology, Bioinformatics-II, Genetic Engineering; Mandatory Course – NSS/Physical Activities/Meditation & Yoga/Photography/Nature Club.

VIII Semester: Major Project–Major Project; Open Elective-I–NPTEL/MOOC/SWAYAM; Open Elective-II – NPTEL/MOOC/SWAYAM.

4. Review of Vision and Mission of the Department








Vishal
 Rohan
 Romya
 Prof. Chandrajit Balomajumder
 Prof. Chandrajit Balomajumder
 Prof. Chandrajit Balomajumder

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20/03/2020

After detailed discussion, the Board recommended that the Vision and Mission should clearly reflect the Department's commitment towards:

Excellence in teaching and learning. Advancement of research, innovation, and entrepreneurship. Development of competent and industry-ready professionals. Promotion of multidisciplinary and interdisciplinary learning. Sustainable and socially responsible technological development. Collaboration with industry, academia, research organizations, and other stakeholders. Addressing contemporary challenges in biochemical engineering and allied sectors. The Board recommended the proposed Vision and Mission statements for adoption, subject to incorporation of the suggestions discussed during the departmental meeting. (ANNXURE-III)

5. Pre-Ph.D. courses were also discussed in the meeting

It was suggested that case studies should be incorporated in the Pre-Ph.D. courses to strengthen analytical and research-oriented learning. It was also suggested that “Introduce” be replaced by “Review” wherever applicable in the syllabus of the course. After discussion in length a consensus decision was taken. (ANNXURE-IV)

6. Panel/list of External Examiner

The panel/list of External Examiners for the B.Tech. and M.Tech. programmes was placed before the Board for consideration. After due deliberation, the Board approved the proposed list of External Examiners for the respective programmes (ANNXURE-V)

The meeting concluded with a formal vote of thanks to the Chairperson and all distinguished members of the Board for their valuable observations, constructive suggestions, and active participation in strengthening the academic framework of the B.Tech. programme.

Mr. Vishal Bhadauria
(Member)

Dr. Shravan Kumar
(Member)

Dr. Roma Agrahari
(Member)

Dr. Rajkamal Kushwaha
(Member)

Dr. Sachin Kumar
(Member)

Mr. Brajesh Singh
(Member)

Prof. Lalit Kumar Singh
(Member)

Mr. S.K. Singh
(Member)

Prof. Aradhana Srivastava
(Member)

Prof. Ashok Kumar
(Member)

Prof.
Chandrajit
Balomajumder

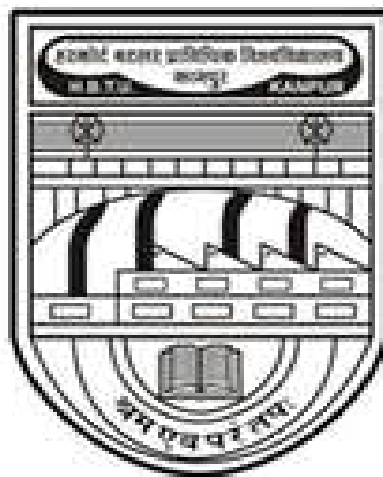
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Prof. C.B. Majumder
(Member)

Prof. A.S. Vidyarthi
(Member)

Prof. Ajay Kumar Singh
(Chairman)

**B. Tech. Chemical Technology
(Biochemical Engineering)**
(Effective from the session 2026-27 for new entrants)



HARCOURT BUTLER TECHNICAL UNIVERSITY
KANPUR-208002(UP)-INDIA

Vishel
Labz

Shaitand

Romaygrahesi

Armatuwa



Lactone

Prof.
Chandrajit
Balomajumder

इलाहाबाद

Hardeep Singh
12/08/2022

HARCOURT BULTER TECHNICAL UNIVERSITY KANPUR
SCHOOL OF CHEMICAL TECHNOLOGY
B.TECH - BIOCHEMICAL ENGINEERING
(Academic Session 2026-2027)
(For New Entrants)

I - SEMESTER (TECHNOLOGY)														
Sr. No.	Course Type	Category	Subject Code	Course Title	L	T	P	Credits	MSE	LAB	TA	Total	ESE	Total Marks
1	BSC	Multidisciplinary	DCY 101	Chemistry	3	0	2	4	15	15	20	50	50	100
2	ESC	Multidisciplinary	DET 101	Basic Electronics Engineering	2	1	0	3	30	-	20	50	50	100
3	ESC	Multidisciplinary	DME 101	Basic Engineering Mechanics	3	1	0	4	30	-	20	50	50	100
4	ESC	Value Added Course	DCE 101	Environmental Science and Engineering	2	1	0	3	30	-	20	50	50	100
5	SEC	Skill Enhancement	DME 102	Digital Fabrication/ Workshop/Manufacturing Practices	0	0	4	2	-	30	20	50	50	100
6	HSMC	Ability Enhancement	DHS 103	Communication Skills	2	0	2	3	15	15	20	50	50	100
7	PCC	Core	DBE 101	Introduction to Biochemical Engineering	3	0	0	3	30	-	20	50	50	100
8	MC	Mandatory Course	MC 101	NSS/ Physical Activities / Meditation & Yoga / Photography/ Nature Club	0	0	0	0						
Total Credits								22						700

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Shailendra

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Prof.
Chandrajit
Bakamajumder

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II - SEMESTER (TECHNOLOGY)

Sr. No.	Course Type	Category	Subject Code	Course Title	L	T	P	Credits	MSE	LAB	TA	Total	ESM	Total Marks
1	BSC	Multidisciplinary	DMA201	Mathematics-I	3	1	0	4	30	-	20	50	50	100
2	BSC	Multidisciplinary	DPH 201	Physics	3	0	2	4	15	15	20	50	50	100
3	ESC	Multidisciplinary	DCS 201	Programming for Problem Solving	3	1	0	4	15	15	20	50	50	100
4	ESC	Multidisciplinary	DEE 201	Basic Electrical Engineering	3	0	2	4	15	15	20	50	50	100
5	SEC	Skill Enhancement	DCE 201	Engineering Graphics & Design	0	0	4	2	-	30	20	50	50	100
6	HSMC	Value Added Course	DHS 201	Universal Human Values	2	0	0	2	15	15	20	50	50	100
7	HSMC	Ability Enhancement	DHS 202					2						100
8	MC	Mandatory Course	MC 201	Induction Program	0	0	0	0						
Total Credits								22						700

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Praveen
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Romesh Chandra
Prasad

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Prof.
Chandrajit
Belomajumder

12/10/2022

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III - SEMESTER (TECHNOLOGY)														
Sr. No.	Course Type	Category	Subject Code	Course Title	L	T	P	Credits	MSE	LAB	TA	Total	ESE	Total Marks
1	BSC	Multidisciplinary	DMA 301	Mathematics-II	3	1	0	4	30	-	20	50	50	100
2	PCC	Core	DBE 301	Fundamental of Life Processes	3	1	0	4	30	-	20	50	50	100
3	PCC	Core		Chemical Process Calculations	3	0	0	3	30	-	20	50	50	100
4	PCC	Core		Fluid Mechanics & Mechanical Operations	3	0	2	4	15	15	20	50	50	100
5	PCC	Core	DBE 302	Biochemistry	3	0	0	3	30	-	20	50	50	100
6	PCC	Skill Enhancement (Branch Specific)	DBE 303	Microbial and Biochemical Techniques Laboratory	0	0	4	2	-	30	20	50	50	100
7	HSMC	Value Added Course Basket		Humanities Subject	2	0	0	2	30	-	20	50	50	100
8	MC	Mandatory Course	MC 301	NSS/ Physical Activities / Meditation & Yoga / Photography/ Nature Club	0	0	0	0						
Total Credits								22						

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Srivastava

Q

Prof.
Chandrajit
Bakomajunder

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Sybil Kumar Singh
12/08/2022

IV - SEMESTER (TECHNOLOGY)

Sr. No.	Course Type	Category	Subject Code	Course Title					MSE	LAB	TA	Total	ESM	Total Marks
1	BSC	Multidisciplinary	DMA 401	Computer Oriented Numerical Methods	3	0	2	4	15	15	20	50	50	100
2	PCC	Core		Modern Analytical Techniques	3	1	0	4	30	-	20	50	50	100
3	PCC	Core		Heat Transfer Operation	3	0	0	3	30	-	20	50	50	100
4	PCC	Core		Chemical Engineering Thermodynamics	3	0	0	3	30	-	20	50	50	100
5	PCC	Core	DBE 401	Industrial Biotechnology	3	0	0	3	30	-	20	50	50	100
6	PCC	Skill Enhancement (Branch Specific)	DBE 402	Bioprocess Principles	2	0	2	3	15	15	20	50	50	100
7	PCC	Ability Enhancement	DBE 471	Seminar	0	0	4	2	-	30	20	50	50	100
8	MC	Mandatory Course	MC 401	NSS/ Physical Activities / Meditation & Yoga / Photography/ Nature Club	0	0	0	0						
Total Credits								22						

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V - SEMESTER

Sr. No.	Course Type	Category	Subject Code	Course Title	L	T	P	Credits	MSE	LAB	TA	Total	ESE	Total Marks
1	PCC	Core		Mass Transfer Operations	3	0	0	3	30	-	20	50	50	100
2	PCC	Core		Chemical Reaction Engineering	3	0	0	3	30	-	20	50	50	100
3	PCC	Core	DBE 501	Process Equipment Design	3	0	0	3	30	-	20	50	50	100
4	PCC	Core	DBE 502	Bioprocess Engineering	3	1	0	4	30	-	20	50	50	100
5	PCC	Core	DBE 503	Bioinformatics & Computational Biology	3	0	2	4	15	15	20	50	50	100
6	PCC	Core	DBE 504	Enzyme Engineering & Technology	3	0	0	3	30	-	20	50	50	100
7	PCC	Skill Enhancement (Branch Specific)	DBE 505	Bioprocess Engineering Lab	0	0	4	2	-	30	20	50	50	100
8	MC	Mandatory Course	MC 501	NSS/ Physical Activities / Meditation & Yoga / Photography/ Nature Club	0	0	0	0						
Total Credits								22						

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Chandrajit
Balomajumder

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12/08/2022

VI – SEMESTER

Sr. No.	Course Type	Category	Subject Code	Course Title					MSE	LAB	TA	Total	ESM	Total Marks
1	PCC	Core		Instrumentation & Process Control	3	0	2	4	15	15	20	50	50	100
2	PCC	Core	DBE 601	Environmental Biotechnology	3	0	0	3	30	-	20	50	50	100
3	PCC	Core	DBE 602	Downstream Techniques in Bioprocesses	3	0	0	3	30	-	20	50	50	100
4	PCC	Core	DBE 603	Fermentation Technology	3	0	0	3	30	-	20	50	50	100
5	PCC	Skill Enhancement	DBE 604	Environmental and Fermentation Technology Laboratory	0	0	6	3	-	30	20	50	50	100
6	PEC-I	Professional Elective		CHED	3	0	0	3	30	-	20	50	50	100
7	PEC-II	Professional Elective	DBE 621 DBE 622 DBE 623	Molecular Biology Bioinformatics-II Genetic Engineering	3	0	0	3	30	-	20	50	50	100
8	MC	Mandatory Course	MC 601	NSS/ Physical Activities / Meditation & Yoga / Photography/ Nature Club	0	0	0	0						
Total Credits								22						

Vishel
Lok

Shailendra

Ramkrishna

Q1

Prof.
Chandrajit
Balomajumder

Shilpa

Shilpa

VII - SEMESTER

Sr. No.	Course Type	Category	Subject Code	Course Title	L	T	P	Credits	MSE	LAB	TA	Total	ESE	Total Marks
1	PCC	Core	DBE 701	Biorefinery & Sustainability	3	1	0	4	30	-	20	50	50	100
2	PCC	Core	DBE 702	Biosafety Regulations	3	1	0	4	30	-	20	50	50	100
3	PEC-III	Professional Elective	DBE 731 DBE 732 DBE 733	Plant Cell Biotechnology Food Biotechnology Animal Cell Biotechnology	3	1	0	4	30	-	20	50	50	100
4	PEC-IV	Professional Elective	DBE 741 DBE 742 DBE 743	Nanobiotechnology IPR & Biosafety Regulations Biomaterial Science & Engineering	3	1	0	4	30	-	20	50	50	100
5	PCC	MINI /MINOR PROJECT	DBE 791	MINI /MINOR PROJECT	0	0	8	4	-	30	20	50	50	100
6	PCC	SEMINAR & INTERNSHIP	DBE 781	SUMMER INTERNSHIP / INDUSTRIAL TRAINING COMPREHENSIVE SEMINAR	0	0	4	2	-	30	20	50	50	100
Total Credits								22						

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Balomajumder
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VIII - SEMESTER (TECHNOLOGY)

Sr. No.	Course Type	Category	Subject Code	Course Title	L	T	P	Credits	MSE	LAB	TA	Total	ESM	Total Marks
1	PCC	MAJOR PROJECT	DBE 891	MAJOR PROJECT	0	0	24	12	-	30	20	50	50	100
2	PCC	OEC-I	ODBE 811	NPTEL / MOOC/ SWYAM	3	0	0	3						
3	PCC	OEC-II	ODBE 821	NPTEL / MOOC/ SWYAM	3	0	0	3						
Total Credits								18						

Vishel
Lah

Prerna
12/11/2026

Romansh
Pravara

Q

Prof.
Chandrajit
Balomajumder

A

Dr. Anil Kumar Singh
12/10/2026

Course Title: Introduction to Biochemical Engineering

Subject Code	Credits	L	T	P	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab.	Total		
DBE 101	3	3	0	0	30	20	-	50	50	100

Module	Title	Course Contents
Module I	Fundamentals of Biology and Microbiology	Scope of biochemical engineering; basics of biology and microbiology; microbial diversity and classification; structure and functions of microbial cells; cell constituents, cell wall and cell membrane; comparison of prokaryotic and eukaryotic cells
Module II	Microbial Growth and Fermentation	Microbial growth and growth kinetics; substrate utilization and product formation; yield concepts; fundamentals of fermentation; batch, continuous and fed-batch processes; basic bioreactor operation; mixing, aeration and monitoring of bioreactor parameters.
Module III	Sterilization and Fermentation Media	Principles and methods of sterilization; preparation and sterilization of fermentation media; batch and continuous sterilization; basic concepts of sterilization of air, equipment and process streams.
Module IV	Downstream Processing and Bioseparation	Introduction to downstream processing; principles of solid-liquid separation; filtration, ultrafiltration and centrifugation; product recovery and purification; precipitation; chromatography; electrophoresis; membrane-based separation processes.
Module V	Biological Waste Treatment	Characteristics of biological wastes and wastewater; qualitative and quantitative assessment of wastes; fundamentals of biological treatment; aerobic and anaerobic wastewater treatment processes; basic principles and applications of biological waste treatment.



Objective: - This course introduces the basic aspects of biochemical engineering and bioprocess technology and their commercial implications to the students from various

disciplines. **Course Outcome (CO) :-** On successful completion of the course student will be able to –

COs	Course Outcome	Bloom's Level
CO1	Remember and understand the fundamentals of biology, microbiology, microbial cell structure, microbial growth, fermentation, and bioreactor technology.	Remember, Understand
CO2	Understand and apply the principles of microbial growth kinetics, substrate utilization, product formation, mass and energy balances, and yield concepts to bioreactor systems.	Understand, Apply
CO3	Analyze and apply the principles of sterilization, fermentation media preparation, and bioreactor operation, including mixing, aeration, monitoring, and control of important process parameters.	Analyze, Apply
CO4	Understand, analyze, and apply the principles of downstream processing and bioseparation techniques, including filtration, centrifugation, ultrafiltration, precipitation, chromatography, electrophoresis, and membrane separation, for product recovery and purification.	Understand, Analyze, Apply
CO5	Analyze and apply the principles of aerobic and anaerobic biological waste treatment to evaluate biological wastes and select suitable treatment processes based on process requirements and operating constraints.	Analyze, Apply

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												3	3
CO2	3	3	1										3	3
CO3	3	2	1										3	3
CO4	3	3	2				1						3	3
CO5	3	3	2			1	3						3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put “-“

Suggested Reference Books:

1. **Bioprocess Engineering: Basic Concepts** — Michael L. Shuler & Fikret Kargi
2. **Bioprocess Engineering Principles** — Pauline M. Doran
3. **Principles of Fermentation Technology** — Peter F. Stanbury, Allan Whitaker & S. J. Hall







Vision

Harcourt Butler Technical University

Vision statement clarifies the values, beliefs, and governing principles of the organization. In order to achieve the goal to become center of excellence with focus on Research & Development, Incubation in the fields of Engineering, Technology, Basic and Applied Science, Humanities, Social Science & Management and other professional courses and Innovation in emerging areas of higher technical education, HBTU, Kanpur specified its Vision which is as follows:-

**“To achieve excellence in technical education,
research and innovation”**

Mission

The mission statements of the University are aligned to the vision and they communicate the purpose of the University to all its stakeholders, develop the measurable goals and objectives in order to gauge the success of University's strategic plan. The Mission statements are as follows:-

- ✓ *Imparting Knowledge to develop analytical ability in science and technology to serve the industry and society at large.*
- ✓ *Equip and enable students with conceptual, technical and managerial skills to transform the organization and society.*
- ✓ *Inculcating entrepreneurial philosophy and innovative thinking to promote research, consultancy and institutional social responsibility.*
- ✓ *Serving people, society and nation with utmost professionalism, values and ethics to make development sustainable and quality of life.*

Vision

Department of Biochemical Engineering

The department of Biochemical Engineering aspires to be globally recognized center to develop professionals with technical knowledge and skills, leadership qualities and strong ethical values for successful career in Biochemical and allied industries, research and development organizations.

Mission

The mission of the Department of Chemical Technology-Biochemical Engineering

- M1:** *To develop state-of-the-art facilities to impart technical knowledge and skill to the graduate and post graduate students for Biochemical and allied industries and research organizations.*
- M2:** *To be a center of research and development for betterment of society in sustainable manner.*
- M3:** *To develop state-of-art the technologies for testing and consultancy for industry and society.*
- M4:** *To cultivate strong ethical values to be a successful professionals and to become life-long learners.*

Program Educational objectives (PEOs)

B.Tech. Chemical Technology- Biochemical Engineering

- PEO1:** *To produce globally competent technical manpower in the field of Biochemical processing, product formation and in the allied areas to cater the need of the country.*
- PEO2:** *To impart knowledge for development of innovative designs, production materials and processes for sustainable development of society.*
- PEO3:** *To serve the industry to meet the challenges in terms of quality assurance and standardization to withstand the global competitiveness.*
- PEO4:** *To be able to discharge duties with professional attitudes and ethics.*

Program Specific outcome (PSOs)

B.Tech. Chemical Technology- Biochemical Engineering

Graduate students of B.Tech Chemical Technology- Biochemical Engineering Programm will be able

- PSO1:** *To apply practical skills, technical knowledge in major stream such as biology, manufacturing, processing and application areas of engineering and technology in Biochemical Engineering and allied industries.*
- PSO1:** *To apply practical skills, technical knowledge in major stream such as biology, manufacturing, processing and application areas of engineering and technology in Biochemical Engineering and allied industries*

Course Title: ANALYTICAL METHODS IN BIOPROCESSES

Evaluation Scheme:

Course Type	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
			L	T	P	MSE	TA	Lab.	Total		
Pre Ph.D	PDBE701	4	3	1	0	30	20	-	50	50	100

Course Objective: To develop the ability to analyze the principles, instrumentation, applications, selection criteria, and limitations of analytical and bioseparation techniques used for the characterization and separation of biomolecules in bioprocesses.

Course outcome:- On successful completion of the course student will be able to –

CO1	Analyze and select appropriate microscopic techniques for characterization of biological samples based on their principles, applications, and limitations.	Analyze
CO2	Analyze and select appropriate chromatographic techniques for separation and purification of biomolecules based on their physicochemical properties.	Analyze
CO3	Analyze the principles, instrumentation, applications, and limitations of spectroscopic and mass-spectrometric techniques used in bioprocess analysis.	Analyze
CO4	Analyze centrifugation principles and operating parameters to select appropriate centrifugation techniques for separation and characterization of biomolecules.	Analyze
CO5	Analyze the principles and operating factors of electrophoretic techniques and select appropriate methods for separation and characterization of biomolecules.	Analyze

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	2	2	-	-	-	-	-	1	3	2	-
CO2	3	2	-	2	2	-	-	-	-	-	1	3	2	-
CO3	3	2	-	2	3	-	-	-	-	-	1	3	2	-
CO4	3	2	-	3	2	-	-	-	-	-	1	3	2	-
CO5	3	2	-	2	2	-	-	-	-	-	1	3	2	-
Total	3	2	-	2	2	-	-	-	-	-	1	3	2	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put “-”

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Balomajumder
Department of Chemical Engineering
Indian Institute of Technology
Kharagpur, India
Date: 20/08/2022

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Syllabus

Unit I

Nature and properties of biochemical metabolites. Basic principles and applications of light microscopy: bright-field, and dark-field.

Electron microscopy: transmission electron microscopy (TEM) and scanning electron microscopy (SEM).

Unit II

Principle and application of Chromatography. Working principle, instrumentation, and application of: Paper Chromatography, Thin Layer Chromatography, Column Chromatography (Affinity Chromatography, Ion-exchange Chromatography, Gel filtration Chromatography or Exclusion Chromatography)

Unit III

Basic principles and applications of Beer-Lambert law; spectrophotometric and spectroscopic techniques including UV-visible spectroscopy, infrared spectroscopy, and atomic absorption spectroscopy (AAS); introduction to mass spectrometry and its applications in bioprocess analysis.

Unit IV

Principles of centrifugation; differential and density-gradient centrifugation; ultracentrifugation; preparative and analytical centrifuges; sedimentation analysis; relative centrifugal force (RCF); selection of centrifugation conditions for biomolecule separation and characterization.

Unit V

Principles of electrophoresis and factors affecting electrophoretic separation, including pH, voltage, and supporting media such as agar, polyacrylamide, and dextran. Agarose gel electrophoresis, polyacrylamide gel electrophoresis (PAGE), SDS-PAGE, and isoelectric focusing; selection and application of electrophoretic methods for biomolecule separation and characterization.

References:

1. H-P Schmauder, M Schweizer and L M Schweizer., Methods in Biotechnology, (eds), Taylor & Francis Publishers, 2002.
2. K. Wilson & J. Walker, Practical Biochemistry: Principles and Techniques. (eds) Cambridge University Press, New York, 1995.
3. Douglas A. Skoog and James J. Leary, Principles of Instrumental Analysis. 4th Edition. Saunders College Publishing, 1992.
4. Methods in Modern Biophysics, B Notting, Springer Verlag Berlin Heidelberg New York, 2003

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5. Principles and Techniques of Biochemistry and Molecular Biology, 6th edition, K Wilson and J Walker (ed.), Cambridge University Press, 2007
6. Bioinstrumentation, J G Webster, John Wiley & Sons Inc. 2004
7. Essentials of Biophysics, P Narayanan, New Age Int. Pub. New Delhi. 2000
8. Spectroscopy for the Biological Sciences, G G Hames, John Wiley & Sons Inc. 20

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Course Title: ADVANCES IN ENVIRONMENTAL BIOTECHNOLOGY

Evaluation Scheme:

Course Type	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
			L	T	P	MSE	TA	Lab.	Total		
Pre-Ph.D.	BPHD703	4	3	1	0	30	20	0	50	50	100

Course Objective: To develop the ability to analyze the microbial, molecular and engineering principles that govern advanced environmental biotechnological processes, and to evaluate and design bioprocesses for pollution abatement, biological nutrient removal, bioremediation of contaminants, and recovery of energy and value-added products from waste streams.

Course outcome:- On successful completion of the course student will be able to –

CO1	Analyze the stoichiometry, bioenergetics and growth kinetics of environmental microbial processes and estimate kinetic parameters required for bioreactor design.	Analyze
CO2	Analyze molecular microbial ecology and monitoring of microbial communities in engineered environmental systems.	Analyze
CO3	Evaluate and design advanced biological nitrogen and phosphorus removal processes and high-rate bioreactor configurations for wastewater treatment.	Evaluate
CO4	Evaluate biotechnological strategies for bioremediation of organic and inorganic pollutants and for the treatment of emerging contaminants.	Evaluate
CO5	Design bioprocesses for resource recovery, bioenergy generation and value-added product formation from waste streams within a circular bioeconomy framework.	Create

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	2	-	2	-	-	-	1	3	3	2
CO2	3	3	2	3	3	-	2	-	-	-	1	3	3	2
CO3	3	3	3	2	2	2	3	-	-	-	2	3	3	3
CO4	3	3	2	3	2	3	3	1	-	-	1	3	2	3
CO5	3	3	3	2	2	3	3	1	-	-	2	3	3	3
Total	3	3	2	3	2	3	3	1	1	1	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) If there is no correlation, put “-”
























































































































Syllabus

Unit I

Microbial metabolism and diversity relevant to environmental processes; catabolism, anabolism and electron flow; redox couples, electron tower and Gibbs free energy of half reactions. Electron-equivalent (half-reaction) approach to stoichiometry of microbial reactions; partitioning of electrons between energy generation and cell synthesis; true and observed cell yield. Microbial growth kinetics: microbial growth models, maximum specific growth rate, half-saturation constant, endogenous decay and maintenance; substrate inhibition (Haldane) kinetics; experimental estimation of kinetic parameters. Mass balances for batch, continuous stirred tank and plug-flow bioreactors; solids retention time, washout and steady-state design equations; biofilm kinetics, substrate diffusion, penetration depth and effectiveness factor.

Unit II

Structure, function and dynamics of microbial communities in engineered environmental systems; microbial ecology of activated sludge, biofilms, granules and anaerobic digesters; syntrophy, interspecies electron transfer and quorum sensing. bioreporters, biomarkers and biosensors for environmental monitoring; design and application of engineered and synthetic microbial consortia. Bio-filters to mitigate air pollutants, Biochar; application in improving fertility of soil.

Unit III

Kinetics and process design of activated sludge systems; stoichiometry and kinetics of nitrification and denitrification; nitrous oxide emissions. Shortcut nitrogen removal: partial nitrification-anammox in side-stream and mainstream configurations, anammox physiology and out-selection of nitrite-oxidizing bacteria; complete ammonia oxidation (comammox) and its process implications. Enhanced biological phosphorus removal: polyphosphate and glycogen accumulating organisms. Aerobic granular sludge: granulation mechanisms, feast-famine selection and extracellular polymeric substances. High-rate anaerobic reactors (UASB, EGSB, ABR); moving bed and hybrid attached-growth systems; membrane bioreactors: configurations, critical flux, biofouling mechanisms and quorum quenching; water reclamation and reuse.

Unit IV

Principles and strategies of bioremediation: natural attenuation, biostimulation and bioaugmentation; in-situ and ex-situ technologies including bioventing, biosparging, biopiles and slurry bioreactors. Aerobic and anaerobic metabolic pathways and enzyme systems (monooxygenases, dioxygenases, laccases, dehalogenases) for













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Unit V

(a) Anaerobic digestion and biomethanation; biogas upgrading; volatile fatty acid platform and microbial chain elongation to medium-chain carboxylates.

(c) Biohydrogen production by dark and photo-fermentation; gas fermentation and C1 bioconversion by methanotrophs and acetogens; microalgal and cyanobacterial carbon capture and photobioreactor systems.

(d) bioleaching, biomining and recovery of metals from electronic waste; microbially enhanced oil recovery.

1. B. E. Rittmann and P. L. McCarty, *Environmental Biotechnology: Principles and Applications*, 2nd Edition, McGraw-Hill Education, 2020.
2. Metcalf & Eddy | AECOM (G. Tchobanoglous, H. D. Stensel, R. Tsuchihashi and F. Burton), *Wastewater Engineering: Treatment and Resource Recovery*, 5th Edition, McGraw-Hill, 2014.
3. M. Henze, M. C. M. van Loosdrecht, G. A. Ekama and D. Brdjanovic (eds.), *Biological Wastewater Treatment: Principles, Modelling and Design*, IWA Publishing, 2008.
4. M. C. M. van Loosdrecht, P. H. Nielsen, C. M. Lopez-Vazquez and D. Brdjanovic (eds.), *Experimental Methods in Wastewater Treatment*, IWA Publishing, 2016.
5. G. M. Evans and J. C. Furlong, *Environmental Biotechnology: Theory and Application*, 2nd Edition, Wiley-Blackwell, 2011.
6. C. P. L. Grady, G. T. Daigger, N. G. Love and C. D. M. Filipe, *Biological Wastewater Treatment*, 3rd Edition, CRC Press, 2011.
7. M. T. Madigan, K. S. Bender, D. H. Buckley, W. M. Sattley and D. A. Stahl, *Brock Biology of Microorganisms*, 16th Edition, Pearson, 2021.
8. H. L. Ehrlich, D. K. Newman and A. Kappler (eds.), *Ehrlich's Geomicrobiology*, 6th Edition, CRC Press, 2015.
9. M. L. Shuler, F. Kargi and M. DeLisa, *Bioprocess Engineering: Basic Concepts*, 3rd Edition, Pearson, 2017.
10. B. E. Logan, *Microbial Fuel Cells*, John Wiley & Sons, 2008.
11. A. Scragg, *Environmental Biotechnology*, 2nd Edition, Oxford University Press, 2005.

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12. Research papers and review articles from Water Research, Environmental Science & Technology, Bioresource Technology and Applied and Environmental Microbiology, as selected by the course instructor.

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Dr. Jyoti K. Singh
12/08/2022

Course Title: BIOENERGY

Evaluation Scheme:

Course Type	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
			L	T	P	MSE	TA	Lab.	Total		
PrePh.D	BPHD702	4	3	1	0	30	20	-	50	50	100

Course Objective:

- To give an overview of biomass energy source
- To create an understanding on biomass derived fuel system
- To generate understanding on energy utilization of bio-based fuel.

Course outcome:- On successful completion of the course student will be able to –

CO1	To learn about present energy scenario in the world and importance of alternate energy	Understand
CO2	To understand basics of biofuels, their production technologies and applications in various energy utility routes	Understand
CO3	To understand and evaluate various biomass pretreatment and processing techniques in terms of their applicability for different biomass type for biomass conversion processes	Evaluate
CO4	Able to understand the process of pyrolysis and gasification of biomass: Thermo-chemical conversion	Understand,
CO5	The student will be capable to explain Biochemical conversion process	Evaluate

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Prof.
Chandrajit
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Dr. Jyoti K. Singh
12/08/2022

SYLLABUS

Unit I

Introduction: Energy world demand, Bio Energy Resources, World Bio Energy Potential, India's Bio Energy Potential, Biomass Resources and classification, Physio-chemical characteristics. Energy and fossil fuel use, fossil fuel reserves, sustainable fuel sources. Consequences of burning fossil fuel effects of industrial (anthropogenic) activity on greenhouse gases, reduction in global greenhouse gases, sequestration of carbon dioxide, alternative energy sources.

Unit II: Bioenergy systems

Current bio-energy applications and conversion technologies, Advantages of applied bioenergy over other sources of energy. Biomass conversion routes: biochemical, chemical, thermochemical and physical processes; Bio-refinery concept: definition; different types of bio-refinery.

Unit-III: Biochemical conversion

Aerobic and Anaerobic conversion, Fermentation; Bio-methanation: biogas production mechanism and technology, types of digesters; Design of biogas plants, installation, operation and maintenance of biogas plants, biogas slurry utilization and management, biogas applications; Cost benefit analysis of biogas for cooking, lighting, power generation applications, Case studies.

Unit-IV: Biogas Systems

Principle, Design of Bio mass Gasifiers, updraft gasifier, down draft gasifier, zero carbon biomass gasification plants, Gasification of plastic-rich waste. Pyrolysis and Gasification of Biomass: Thermo-chemical conversion of ligno-cellulose biomass for liquid fuel production - Pyrolysis of biomass-Pyrolysis regime, effect of particle size, temperature, and products obtained.

Unit-V : Biomass and Biofuel

Biomass composition and energy content; Biofuels, types of biofuels, Biological solid fuels 1st, 2nd and 3rd generation biofuels. Liquid biofuels to replace petrol – methanol production. Large scale ethanol production from biomass, use of lignocellulosics for ethanol production, ethanol extraction after production, use of ethanol as fuel. Liquid biofuel to replace diesel synthetic diesel (FT synthesis).

References

1. Ralph E.H. Simsed. (2004); Bioenergy options for cleaner environment by World Renewable Energy Network.
2. Mutha, V. K. (2010). Handbook of bioenergy and biofuel SBS Publishers, Delhi
3. Clark, J. H., & Deswarte, F. (Eds.). (2014). Introduction to chemicals from biomass. John













Prof. Chandrajit Balomajumder
 Department of Computer Science and Engineering
 Indian Institute of Technology Guwahati
 Guwahati, Assam, India
 Email: chandrajit.balomajumder@iitg.ac.in




Wiley & Sons.

4. Klass, D. L. (1998). Biomass for renewable energy, fuels, and chemicals. Elsevier.
5. Mukunda, H. S. (2011). Understanding clean energy and fuels from biomass. Wiley India
6. Speight, J. (2008). Synthetic fuels handbook: properties, process and performance. McGraw-Hill
7. Dahiya, A. (Ed.). (2014). Bioenergy: Biomass to biofuels. Academic Press.
8. Hall, D. O., & Overend, R.P. (1987). Biomass: regenerable energy

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Course Title: BIOPROCESS TECHNOLOGY

Evaluation Scheme:

Course Type	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
			L	T	P	MSE	TA	Lab.	Total		
PrePh.D.	BPHD704	4	3	1	0	30	20	-	50	50	100

Objective:-

To develop fundamental understanding and analytical ability in enzyme technology, microbial growth, fermentation, product recovery and purification for effective application of bioprocess principles.

Course outcome:- On successful completion of the course, students will be able to analyze the major stages of a bioprocess and select appropriate operating and separation strategies for biological product development.

CO1	Analyze enzyme kinetics, inhibition and immobilization for bioprocess applications.	Analyze
CO2	Analyze microbial growth kinetics and determine important growth parameters using suitable kinetic models.	Analyze
CO3	Analyze fermentation modes and operating parameters involved in bioprocess operations.	Analyze
CO4	Analyze and select suitable product recovery methods based on process and product characteristics.	Analyze
CO5	Analyze and select appropriate purification and product-finishing methods for bioproducts.	Analyze

COs	POs											PSOs	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	3	2	–	–	–	–	–	–	–	–	–	3	3
CO2	3	3	–	–	–	–	–	–	–	–	–	3	3
CO3	3	2	–	–	1	–	–	–	–	–	–	3	3
CO4	3	3	–	–	2	–	–	–	–	–	–	3	3
CO5	3	3	–	–	2	–	–	–	–	–	–	3	3
CO1	3	2	–	–	–	–	–	–	–	–	–	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) *If there is no correlation, put “-”*













Prof. Chandrajit Balomajumder
 Deputy General Secretary
 Chhara Development
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SYLLABUS

UNIT I – Enzyme Technology

Enzyme kinetics and Michaelis–Menten equation; enzyme inhibition; effects of pH and temperature. Enzyme immobilization and industrial applications.

UNIT II – Microbial Growth

Factors affecting microbial growth; growth kinetics, Monod equation, yield coefficients and measurement of microbial growth.

UNIT III – Fermentation Technology

Inoculum development, media formulation and sterilization. Batch, fed-batch and continuous fermentation. Aeration, agitation and basic process control.

UNIT IV – Product Recovery

Biomass separation, cell disruption, membrane separation, solvent extraction and adsorption.

UNIT V – Product Purification

Precipitation, preparative chromatography, crystallization, drying and freeze-drying.

References

1. Michael Shuler and Fikret Kargi. “*Bioprocess Engineering: Basic Concepts*”, 2nd Edition, Prentice Hall, and Englewood Cliffs, NJ, 2002.
2. Pauline Doran. “*Bioprocess engineering principles*”, Academic Press, 1995.
3. Colin Ratledge, Bjorn Kristiansen, “*Basic Biotechnology*”, 2nd Edition, Cambridge University Press, 2001.
4. Roger Harrison et al., “*Bioseparation Science and Engineering*”, Oxford University Press, 2003.
5. Harrison R.G. Todd P., Rudge S.R. “*Bioseparation Science and Engineering*”, Oxford Press 2003.

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Course Title: ADVANCED BIOSEPARATION PROCESSES

Evaluation Scheme:

Course Type	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
			L	T	P	MSE	TA	Lab.	Total		
Pre-Ph.D.	BPHD706	4	3	1	0	15	20	15	50	50	100

Course Objectives:	To develop the ability to analyze and select appropriate bioseparation, purification and product-finishing processes based on biomolecule characteristics, recovery, purity and stability requirements.
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Course outcome: - On successful completion of the course, a student will be able to –

CO1	Analyze product characteristics, recovery and purity requirements for selection of a suitable bioseparation strategy.	Analyze
CO2	Analyze and select appropriate membrane processes for separation and concentration of bioproducts.	Analyze
CO3	Analyze and select suitable preparative chromatographic techniques for purification of biomolecules.	Analyze
CO4	Apply adsorption principles and analyze extraction methods for selective recovery of bioproducts.	Analyze
CO5	Evaluate polishing and product-finishing operations based on recovery, purity and product stability.	Evaluate

COs	POs											PSOs	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	3	3	2	–	1	–	–	–	–	–	–	3	3
CO2	3	3	2	1*	2	–	–	–	–	–	–	3	3
CO3	3	3	2	1*	2	–	–	–	–	–	–	3	3
CO4	3	3	2	1*	2	–	–	–	–	–	–	3	3
CO5	3	3	2	–	1	–	–	–	–	–	–	3	3
Total	3	3	2	1*	2	–	–	–	–	–	–	3	3

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Syllabus

UNIT I – Bioseparation Strategy

Product characteristics, recovery targets, purity requirements, RIPP concept and selection of downstream processing sequence.

UNIT II – Advanced Membrane Processes

Microfiltration, ultrafiltration, diafiltration, membrane fouling and process selection.

UNIT III – Advanced Chromatography

Preparative ion-exchange, affinity, size-exclusion and hydrophobic interaction chromatography

UNIT IV – Selective Recovery Processes

Adsorption principles; Langmuir and Freundlich isotherms. Batch and continuous extraction; aqueous two-phase extraction

UNIT V – Polishing and Product Finishing

Crystallization: nucleation and crystal growth. Drying, spray drying and freeze-drying. Product stabilization, recovery and purity considerations.

References:

1. Coulson & Richardson's Chemical Engineering – Volume 3 (Chemical and Biochemical Reactors and process controls) ed. Richardson, J.F., Peacock, D.G., First Indian ed. Asian Books Pvt. Ltd. 1998.
2. Process Biotechnology Fundamentals by S.N. Mukhopadhyay (2001). Viva Books Private Limited.
3. Roger G. Harrison, Paul Todd, Scott R. Rudge, Demetri P. Petrides, "Bioseparation Science and Engineering" Oxford University Press, 2003.
4. Protein: Biochemistry and Biotechnology by Gary Walsh (2002 John Wiley & Sons Ltd.)
5. Geankoplis, C.J. Transport Processes and Unit Operations Prentice Hall of (I) 3rd ed. 1997.
6. Mukhopadhyay, S.N. Process Biotechnology Fundamentals, Viva Books Pvt. Ltd. 2001.
7. Keith Wilson and John Walker, Practical Biochemistry—Principles and Techniques, Cambridge, 5th Ed.2000





































