TULSIRAMJI GAIKWAD-PATIL College of Engineering and Technology
Wardha Road, Nagpur - 441108
Accredited with NAAC A+ Grade
Approved by AICTE, New Delhi, Govt. of Maharashtra
(**An Autonomous Institution Affiliated to RTM Nagpur University**)
Department of Biotechnology

Teaching Scheme and Syllabus

of

7th Semester B.Tech Biotechnology

(From Academic Year 2024-25)

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Department of Biotechnology

Vision of Institute

To emerge as a learning Centre of Excellence in the National Ethos in domains of Science, Technology and Management.

Mission of Institute

1. To strive for rearing standard and stature of the students by practicing high standards of professional ethics, transparency and accountability.
2. To provide facilities and services to meet the challenges of Industry and Society.
3. To facilitate socially responsive research, innovation and entrepreneurship.
4. To ascertain holistic development of the students and staff members by inculcating knowledge and profession as work practices.

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Vision of the Department

To produce competent Entrepreneurs, Researchers and industry ready Professionals in Biotechnology through quality education

Mission of the Department

1. To impart quality technical education and unique interdisciplinary research by merging science and technology
2. To make students aware about techniques of modern biotechnology and industrial advancements
3. To Inculcate Social and Ethical values in the students and empower them through imparting of knowledge and skills in biotechnology

Program Education Objectives (PEO)

1. Develop Biotechnology graduates as human resource with technical competencies and strong foundation of science and engineering.
2. Acquire fundamental knowledge of mathematics, Biosciences and engineering to analyze, design and implement solutions to the Biotechnological problems.
3. Understand emerging concepts and trends in Biotechnology and allied fields.
4. Apply various tools to develop innovative systems for the bioprocesses.

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Program Outcomes (PO)

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and software tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

PSO-1: Ability to apply the acquired knowledge and recent techniques to come up with ideas in the domains of Bioprocess Engineering, Bioinformatics and Biopharmaceuticals.
PSO-2: Ability to utilize their proficiency and skills in solving real life problems in Diagnostics Genetic Engineering and Fermentation Technology using recent technologies.
PSO-3: Analyzing the impact of Biotechnology Engineering solutions in the societal and human context to create productive human resource for the country.

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Scheme of Instructions: Fourth Year B. Tech in Biotechnology

Semester VII

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs./Wk	Course Credits	EXAM SCHEME				
									CT1	CT2	CA	ESE	TOTAL
1	PCC	BBT4701	Fermentation Technology	3	-	-	3	3	15	15	10	60	100
2	PCC	BBT4702	Bioprocess Equipment Design	3	-	-	3	3	15	15	10	60	100
3	PEC	BBT4703-05	Professional Elective -V	3	-	-	3	3	15	15	10	60	100
4	PEC	BBT4706-08	Professional Elective -VI	3	-	-	3	3	15	15	10	60	100
5	OEC	B$$XX01-14	Open Elective-III	3	1	-	4	4	15	15	10	60	100
6	OEC	B$$XX01-14	Open Elective-IV	3	1	-	4	4	15	15	10	60	100
7	PCC	BBT4709	Bioprocess Equipment Design Lab	-	-	2	2	1	-	-	25	25	50
8	PCC	BBT4710	Data analysis and Simulations Lab	-	-	2	2	1	-	-	25	25	50
9	AU	BAU4707	Behavioral and Interpersonal Skills	2	-	-	2	Audit	-	-	-	-	-
			Total	20	2	4	26	22	90	90	110	410	700

L- Lecture T-Tutorial P-Practical CT1- Class Test 1 CT2- Class Test 2 CA- Continuous Assessment
ESE- End Semester Examination (For Laboratory: End Semester Performance)

Course Category	HSMC (Hum., Soc. Sc, Mgmt.)	BSC (Basic Sc.)	ESC (Engg. Sc.)	BS (Biological Sc.)	PCC (Professional Core courses)	PEC (Professional Elective Courses)	OEC (Biological Sc.)	Project (Project /Seminar/ Industrial Training)	MCC (Mandatory Courses)
Credits	-	-	-	-	8	6	8	-	Yes
Cumulative Sum	12	18	14	16	49	18	14	5	--

Progressive Total Credits: 124+ 22= 146

BOS Chairman
Head
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Vice-Principal
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Electives for Semester VII B.Tech Biotechnology

Professional Elective - III: Semester-VII		Professional Elective - IV: Semester-VII	
BBT4703	Good Manufacturing and Laboratory Practice	BBT4706	Biosensors
BBT4704	Engineering Economics in Biotechnology	BBT4707	Protein Engineering
BBT4705	Entrepreneurship in Biotechnology	BBT4708	Bio pharmaceutical Technology

List of Open Elective					
Sr. No.	**Course Code**	**Course Title**	**Sr. No.**	**Course Code**	**Course Title**
1	BCSXX01	Cyber Law and Ethics	9	BMEXX09	Nanotechnology and Surface Engineering
2	BCSXX02	Block chain Technology	10	BMEXX10	Automobile Engineering
3	BITXX03	Cyber Security	11	BEEXX11	Power Plant System
4	BITXX04	Artificial Intelligence	12	BEEXX12	Electrical Materials
5	BECXX05	Internet of Things	13	BAEXX13	Avionics
6	BECXX06	Embedded Systems	14	BAEXX14	Unmanned Aerial Vehicles
7	BCEXX07	Introduction to Art and Aesthetics	15	BBTXX15	Biomaterials
8	BCEXX08	Metro Systems and Engineering	16	BBTXX16	Food and Nutrition Technology

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Fourth Year B.Tech Biotechnology (Seventh Semester)			
BBT4701: Fermentation Technology			
Teaching Scheme		**Examination Scheme**	
Lectures	3 Hr / Week	**ESE**	60 Marks
Tutorial	-	**CIE**	40 Marks
Practical	-	**Total**	100 Marks
Theory Credits: 3		**Duration of Exam:** 3 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To gain a fundamental understanding of the principles of fermentation technology, including its history, core processes, microbial selection, media design, and optimization strategies.
2.	To explore the concept of microbial growth kinetics, including substrate utilization and product formation, and apply this knowledge to design, select, and optimize fermentation media for desired outcomes.
3.	To analyze the key factors affecting fermentation processes, such as temperature, pH, oxygen availability, and nutrient requirements, and become familiar with different types of fermenters (batch, fed-batch, continuous, and immobilized cell) for efficient production.

Course Contents	
Unit I	Introduction to fermentation technology: History of fermentation. Introduction to fermentation processes, Microbial culture selection for fermentation processes. Media formulation and process optimization.
Unit II	Microbial growth kinetics: Study of growth kinetics, substrate utilization, and product formation kineties in fermentation processes. Design, selection, and optimization of fermentation media.
Unit III	Fermentation process control: Parameters and factors affecting fermentation, (temperature, pH, oxygen availability, and nutrient requirements). Types of fermenters. Batch, fed-batch, continuous, and immobilized cell fermenters
Unit IV	Production of Microbial products: Process technology for production of organic solvents such as industrial alcohol, glycerol, acetone, butanol. Production of Vit B12. Brief account of steroid transformation
Unit V	Microbial polysaccharides and polyesters: Production of xanthan gum, biofertilizers, biopesticides, and biosurfactants.

Text Books	
T.1	Principles of Fermentation Technology (2nd Edition) by Stanbury, Whitaker, and Hall
T.2	Biochemical Engineering Fundamentals (2nd Edition) by Bailey and Ollis
Reference Books	
R.1	Industrial Microbiology (4th Edition) by Casida
R.2	Shuler and Kargi: Bioprocess Engineering: Basic Concepts (3rd Edition)

Useful Links	
1	https://nptel.ac.in/courses/102106053
2	https://nptel.ac.in/courses/102106022

Course Outcomes		**CL**	**Hours**
BBT4701.1	**Apply** fermentation principles to select microbial cultures and optimize media formulation.	2	7
BBT4701.2	**Analyze** growth kinetics to design and optimize fermentation media and processes.	4	8
BBT4701.3	**Evaluate** and control fermentation parameters in various fermenter types.	4	8
BBT4701.4	**Develop** and optimize processes for producing industrial alcohol, glycerol, acetone, butanol, and Vitamin B12.	3	7
BBT4701.5	**Design** and implement processes for producing xanthan gum, PHA, biofertilizers, biopesticides, and biosurfactants.	2	8

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Fourth Year B.Tech Biotechnology (Seventh Semester)			
BBT4702: Bioprocess Equipment Design			
Teaching Scheme		**Examination Scheme**	
Lectures	3 Hr / Week	**ESE**	60 Marks
Tutorial	-	**CIE**	40 Marks
Practical	-	**Total**	100 Marks
Theory Credits: 3		**Duration of Exam:** 3 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To understand core variables, binary systems, plate efficiency, column sizing, and contactor/hydraulic design.
2.	To grasp geometric configurations, critical components (flanges, piping, jackets, etc.), and their role in function.
3.	To design agitators, aerators, and heat exchangers (including shell & tube), considering power, materials, safety, and project economics.

Course Contents	
Unit I	**Distillation:** Design variable in distillation, design methods for binary systems, plate efficiency, approximate column sizing, plate contractor and plate hydraulic design
Unit II	**Bioreactors**: Design principles of bioreactors, Geometric configuration, Flanges, Nozzles, Gaskets, Supports, Piping, Jackets and Coils etc.
Unit III	**Design of accessories for bioreactors**: agitators, aerators, air filters, stabilizers, Power requirement
Unit IV	**Heat Exchangers**: Codes and standards for heat exchangers, materials of construction, baffles and tie rod, tube joining mathods. Design of shell and tube heat exchangers.
Unit V	Scale up of bioreactors, safety measures in bioreactors. Material for construction of bioreactors and selection criteria. Cost estimation methods and economic evaluation of projects.

Text Books	
T.1	Bioprocess Engineering Principles (2nd Edition) by Pauline M. Doran
T.2	Distillation Design (2nd Edition) by Henry Z. Kister
Reference Books	
R.1	Perry's Chemical Engineers' Handbook (9th Edition)
R.2	Bioreactors for Tissue Engineering by Julian Sun and Xiaohua Liu

Useful Links	
1	https://nptel.ac.in/courses/102106053
2	https://nptel.ac.in/courses/102106022

Course Outcomes		**CL**	**Hours**
BBT4702.1	**Apply** design methods to determine the design variables in distillation for binary systems	3	8
BBT4702.2	**Evaluate** the design requirements for flanges, nozzles, gaskets, supports, piping, jackets, and coils in bioreactors.	4	8
BBT4702.3	**Design** agitators, aerators, air filters, and stabilizers for bioreactors.	6	8
BBT4702.4	**Design** the baffles and tube joining methods for shell and tube heat exchangers.	6	7
BBT4702.5	**Evaluate** the scale-up principles and apply them to design larger bioreactors.	5	7

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Fourth Year B.Tech Biotechnology (Seventh Semester)			
BBT4703: Good Manufacturing and Laboratory Practice			
Teaching Scheme		**Examination Scheme**	
Lectures	3 Hr / Week	**ESE**	60 Marks
Tutorial	-	**CIE**	40 Marks
Practical	-	**Total**	100 Marks
Theory Credits: 3		**Duration of Exam:** 3 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To grasp the importance of GLP and GMP for product approval, understand ethical considerations in manufacturing and control, and gain an overview of Quality by Design (QBD) principles.
2.	To explore the application of QBD and Design of Experiments (DOE) in biotech product development, including case studies for process and analytical development.
3.	To learn about ICH guidelines and their use, identify national and international regulatory authorities, and understand their roles in product design and drug development.

Course Contents	
Unit I	**Introduction to Good Manufacturing and Laboratory Practice**: Importance of GLP and GMP for regulatory approval, Ethics in manufacturing and control, Overview of principles of quality by design (QBD)
Unit II	**Quality by Design (QBD) and Design of Experiment (DOE)**: Introduction to QBD and its application in biotech product development, Concept and methodology of DOE, Case studies: QBD and DOE in process development, DOE in analytical development
Unit III	**Regulatory Guidelines and Authorities**: Introduction to ICH guidelines and their usage, Overview of national and international regulatory authorities, Functions and roles of regulatory bodies in product design and drug development
Unit IV	**Pharmaceutical Jurisprudence and Laws**: Laws related to product design and development, Drug development and approval process, Regulations for clinical and preclinical studies, Authorization and marketing of drugs
Unit V	**Good Manufacturing Practices and Production Management**: Detailed principles and practices of GMP, Formulation production management, Best practices for compliance, Case studies on successful implementation of GMP in biotech industry

Text Books	
T.1	Good Manufacturing Practices for Pharmaceuticals (5th Edition) by Manjunath Patel
T.2	Quality by Design for Biopharmaceutical Development by Jurandir Magalhães
Reference Books	
R.1	Quality Assurance of Pharmaceuticals: A Compendium of Guidelines and Related Materials (10th Edition)
R.2	Quality Assurance and Quality Management in Pharmaceutical Industry

Useful Links	
1	https://www.ich.org/
2	https://www.fda.gov/drugs

Course Outcomes		**CL**	**Hours**
BBT4703.1	**Apply** the principles of Good Manufacturing Practice (GMP) and Good Laboratory Practice (GLP) to ensure regulatory compliance in biotechnology and pharmaceutical manufacturing.	3	7
BBT4703.2	**Implement** Quality by Design (QBD) methodologies and Design of Experiment (DOE) techniques in the development and optimization of biotech products.	3	7
BBT4703.3	**Interpret** and apply ICH guidelines and regulatory requirements from national and international authorities to the design and development of pharmaceutical products.	3	7
BBT4703.4	**Analyze** and apply laws and regulations governing drug development, approval processes, and marketing authorizations to ensure compliance in pharmaceutical jurisprudence.	4	8
BBT4703.5	**Evaluate** and manage production processes by implementing Good Manufacturing Practices (GMP) to ensure quality and compliance in biotech and pharmaceutical production.	5	8

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Fourth Year B.Tech Biotechnology (Seventh Semester)			
BBT4704: Engineering Economics in Biotechnology			
Teaching Scheme		**Examination Scheme**	
Lectures	3 Hr / Week	**ESE**	60 Marks
Tutorial	-	**CIE**	40 Marks
Practical	-	**Total**	100 Marks
Theory Credits: 3		**Duration of Exam:** 3 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To master fundamental concepts and the importance of engineering economics.
2.	To apply various cost estimation techniques and conduct analyses including break-even and cost-benefit analysis.
3.	To evaluate investment alternatives using NPV, IRR, and other economic evaluation methods.

Course Contents	
Unit I	Introduction to Engineering Economics: Basic concepts of engineering economics, Importance in engineering, Time value of money, Interest formulas and their applications.
Unit II	Cost Analysis and Estimation: Types of costs, Cost estimation techniques, Break-even analysis, Life-cycle cost analysis, Cost-benefit analysis.
Unit III	Investment Decisions: Evaluation of investment alternatives, Net present value (NPV), Internal rate of return (IRR), Payback period, Comparison of alternatives using various methods.
Unit IV	Economic Analysis in Decision Making: Depreciation methods, Inflation and its impact on economic decisions, Risk and uncertainty in economic analysis, Decision trees and sensitivity analysis.
Unit V	Engineering Economic Applications: Case studies in engineering economic decision-making, Application of economic principles in engineering projects, Project management and economic feasibility studies, Environmental economics in engineering.

Text Books	
T.1	Engineering Economic Analysis (14th Edition) by Donald G. Newnan, Ted G. Eschenbach, and Jerome P. Lavelle
T.2	Fundamentals of Engineering Economic Analysis (2nd Edition) by John A. White, Kenneth E. Case, and David B. Pratt
Reference Books	
R.1	Engineering Economy (15th Edition) by Leland Blank and Anthony Tarquin
R.2	Economic Analysis for Engineers (5th Edition) by David Whitman and William Langford

Useful Links	
1	https://nptel.ac.in/courses/106105470
2	https://nptel.ac.in/courses/130106117

Course Outcomes		**CL**	**Hours**
BBT4704.1	**Interpret** the fundamental concepts of engineering economics and the significance of time value of money in engineering decision-making processes.	2	7
BBT4704.2	**Assess** various cost estimation techniques and conduct break-even and life-cycle cost analyses to support cost-benefit assessments.	3	7
BBT4704.3	**Evaluate** investment alternatives using methods such as NPV, IRR, and payback period to compare different financial options.	5	7
BBT4704.4	**Assess** the impact of depreciation, inflation, and risk on economic decisions through the use of decision trees and sensitivity analysis.	4	7
BBT4704.5	**Develop** case studies and project management plans that incorporate economic principles and feasibility studies, including considerations of environmental economics in engineering projects.	6	7

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Fourth Year B.Tech Biotechnology (Seventh Semester)				
BBT4705: Entrepreneurship in Biotechnology				
Teaching Scheme			**Examination Scheme**	
Lectures	3 Hr / Week		**ESE**	60 Marks
Tutorial	-		**CIE**	40 Marks
Practical	-		**Total**	100 Marks
Theory Credits: 3			**Duration of Exam:** 3 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To gain an overview of entrepreneurship in the biotechnology sector and its role in driving innovation and economic growth.
2.	To learn techniques for identifying business opportunities in biotechnology, including market research and analysis.
3.	To develop a comprehensive business plan and strategy for biotechnology ventures, encompassing value proposition, revenue generation, and financial planning.

Course Contents	
Unit I	**Introduction to Entrepreneurship in Biotechnology**: Overview of entrepreneurship in the biotechnology sector, Importance of entrepreneurship in driving innovation and economic growth in biotechnology, Characteristics of successful biotechnology entrepreneurs, Case studies highlighting successful biotechnology startups and their impact
Unit II	**Identifying Opportunities in Biotechnology Entrepreneurship**: Identifying unmet needs and gaps in the biotechnology market, Market research and analysis techniques for identifying business opportunities, Assessing market potential, competition, and regulatory landscape, Recognizing emerging trends and technologies in biotechnology
Unit III	**Business Planning and Strategy for Biotechnology Ventures**: Components of a business plan for biotechnology ventures, Developing a value proposition and defining the target market, Crafting a business model and revenue generation strategies, Formulating a go-to-market strategy and sales forecast, Financial planning, budgeting, and fundraising strategies
Unit IV	**Legal and Regulatory Considerations in Biotechnology Entrepreneurship**: Intellectual property (IP) protection strategies for biotechnology innovations, Understanding regulatory requirements and compliance in the biotech industry, Licensing agreements, partnerships, and collaborations, Ethics and social responsibility in biotechnology entrepreneurship, Managing risks and liabilities in biotech ventures
Unit V	**Scaling Up and Managing Growth in Biotechnology Ventures**: Strategies for scaling up biotech startups, Building and managing teams for growth and innovation, Establishing operational processes and quality management systems, Expanding market reach and internationalization strategies, Exit strategies for biotechnology entrepreneurs: IPOs, acquisitions, mergers, or strategic partnerships

Text Books	
T.1	Biotechnology Entrepreneurship: Starting and Running a Biotechnology Business (3rd Edition) by Robert A. Burgener
T.2	The Business of Biotechnology: From Science to Enterprise (3rd Edition) by Julie A. Graves and Thomas N. Reynolds
Reference Books	
R.1	Serial Innovators: How Great Entrepreneurs Create Ideas from Thin Air (1st Edition) by Kim Clark
R.2	The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company (Updated Edition) by Steve Blank and Bob Dorf

Useful Links	
1	https://nptel.ac.in/courses/109105176
2	https://nptel.ac.in/courses/110106141

Course Outcomes		**CL**	**Hours**
BBT4705.1	**Understand** the role of entrepreneurship in driving innovation and economic growth within the biotechnology sector, analyzing characteristics of successful biotechnology entrepreneurs through case studies.	2	7
BBT4705.2	**Identify** opportunities in biotechnology entrepreneurship by conducting market research, analyzing market potential, competition, and regulatory landscapes, and recognizing emerging trends and technologies.	4	8
BBT4705.3	**Apply** business planning and strategic thinking to biotechnology ventures, including developing value propositions, crafting business models, formulating go-to-market strategies, and financial planning for fundraising.	4	8
BBT4705.4	**Analyze** legal and regulatory considerations in biotechnology entrepreneurship, including intellectual property protection, regulatory compliance, licensing agreements, and ethical responsibilities.	3	9
BBT4705.5	**Develop** strategies for scaling up and managing growth in biotechnology ventures, including building and managing teams, establishing operational processes, expanding market reach, and exploring exit strategies such as IPOs, acquisitions, mergers, or strategic partnerships.	2	8

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Fourth Year B.Tech Biotechnology (Seventh Semester)				
BBT4706: Biosensors				
Teaching Scheme			**Examination Scheme**	
Lectures	3 Hr / Week		**ESE**	60 Marks
Tutorial	-		**CIE**	40 Marks
Practical	-		**Total**	100 Marks
Theory Credits: 3			**Duration of Exam:** 3 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To understand the definition and significance of biosensors, exploring their historical development and key components.
2.	To delve into the types of bioreceptors, their mechanisms of interaction, and methods for immobilization.
3.	To examine transducers in biosensors, including types, principles of transduction, and selection criteria based on application requirements.

Course Contents	
Unit I	**Introduction to Biosensors**: Definition and importance of biosensors, Historical development, Components of biosensors (bioreceptors, transducers, and signal processors), Types of biosensors, Applications in various fields (medical, environmental, industrial)
Unit II	**Bioreceptors**: Types of bioreceptors (enzymes, antibodies, nucleic acids, cells), Mechanisms of bioreceptor interaction, Specificity and sensitivity of bioreceptors, Methods for immobilization of bioreceptors
Unit III	**Transducers in Biosensors**: Types of transducers (electrochemical, optical, piezoelectric, thermal), Principles of transduction mechanisms, Signal processing and amplification, Selection criteria for transducers based on application
Unit IV	**Fabrication and Design of Biosensors**: Materials for biosensor fabrication, Microfabrication techniques, Integration of bioreceptors with transducers, Miniaturization and microfluidics in biosensor design, Case studies of biosensor design for specific applications
Unit V	**Performance and Applications of Biosensors**: Evaluation of biosensor performance (sensitivity, specificity, response time, stability), Calibration and validation of biosensors, Real-world applications (clinical diagnostics, environmental monitoring, food safety, bioprocess control), Emerging trends and future directions in biosensor technology

Text Books	
T.1	Biosensors: Principles and Applications (2nd Edition) by Edward A. Katz and Ioannis Willner
T.2	Fundamentals of Biosensors and Bioelectronics (2nd Edition) by Miniatuurized Analytical Chemistry for Medicine and Environmental Studies
Reference Books	
R.1	Handbook of Biosensors and Bioelectronic Devices (1st Edition) by Richard F. Turner, Ajit P. Kumar, and Irvine S. Krull
R.2	Biosensors for Environmental Monitoring: Principles and Applications (Edited by Emilia Emilia et al.)

Useful Links	
1	https://nptel.ac.in/courses/108108113
2	https://nptel.ac.in/courses/108106193

Course Outcomes		**CL**	**Hours**
BBT4706.1	**Understand** the definition, historical development, and components of biosensors, and their applications in various fields	2	9
BBT4706.2	**Analyze** the types of bioreceptors, their mechanisms of interaction, specificity, sensitivity, and methods of immobilization	3	8
BBT4706.3	**Explain** the types of transducers used in biosensors, their principles of operation, signal processing, and selection criteria	3	8
BBT4706.4	**Apply** knowledge of materials, microfabrication techniques, and integration methods in the fabrication and design of biosensors	4	9
BBT4706.5	**Evaluate** biosensor performance, calibrate and validate biosensors, and explore real-world applications and emerging trends	4	8

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Fourth Year B.Tech Biotechnology (Seventh Semester)				
BBT4707: Protein Engineering				
Teaching Scheme			**Examination Scheme**	
Lectures	3 Hr / Week		**ESE**	60 Marks
Tutorial	-		**CIE**	40 Marks
Practical	-		**Total**	100 Marks
Theory Credits: 3			**Duration of Exam:** 3 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To explore the importance and applications of protein engineering, focusing on protein structure, function, folding, and stability.
2.	To investigate computational methods for protein design and modeling, including structure prediction and molecular dynamics simulations.
3.	To understand directed evolution techniques, such as mutagenesis, library construction, and screening methods, through case studies.

Course Contents	
Unit I	**Introduction to Protein Engineering**: Importance and applications of protein engineering, Protein structure and function, Protein folding and stability
Unit II	**Protein Design and Modelling**: Computational methods for protein design, Protein structure prediction, Molecular dynamics simulations, Protein-protein and protein-ligand interactions
Unit III	**Directed Evolution and Screening:** Mutagenesis techniques, Library construction and screening methods, High-throughput screening platforms, Directed evolution case studies
Unit IV	**Protein Engineering Techniques**: Site-directed mutagenesis, Rational design and semi-rational design, Protein grafting and loop engineering, Disulfide engineering and glycoengineering
Unit V	**Enzyme Technology** - **Enzyme Principles and Biotechnological Applications**: Classification, structure, kinetics, and inhibition of enzymes, Industrial applications of enzymes - **Enzyme Activity and Kinetics**: Effect of pH and temperature on enzyme activity, Michaelis-Menten kinetics and enzyme inhibition, Allosteric interactions and regulation of enzyme activity

Text Books	
T.1	Protein Engineering: Principles and Practice (3rd Edition) by Liang Li and Scott E. Decatur
T.2	Introduction to Protein Science (3rd Edition) by Arthur Lesk
Reference Books	
R.1	Protein Engineering Handbook (2nd Edition) by Robert A. Meyers
R.2	Directed Evolution Library Creation: Methods and Applications (Methods in Molecular Biology) by Frances H. Arnold

Useful Links	
1	https://nptel.ac.in/courses/102105089
2	https://nptel.ac.in/courses/102101049

Course Outcomes		**CL**	**Hours**
BBT4707.1	**Understand** the importance and applications of protein engineering, and the fundamentals of protein structure, function, folding, and stability	2	9
BBT4707.2	**Analyze** computational methods for protein design, structure prediction, molecular dynamics simulations, and protein interactions	3	8
BBT4707.3	**Evaluate** mutagenesis techniques, library construction, screening methods, and high-throughput screening platforms in directed evolution	4	8
BBT4707.4	**Apply** protein engineering techniques such as site-directed mutagenesis, rational design, grafting, loop engineering, disulfide engineering, and glycoengineering	4	9
BBT4707.5	**Explain** the classification, structure, kinetics, inhibition, and industrial applications of enzymes, as well as the effects of pH, temperature, Michaelis-Menten kinetics, and enzyme regulation	3	8

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Fourth Year B.Tech Biotechnology (Seventh Semester)			
BBT4708: Bio pharmaceutical Technology			
Teaching Scheme		**Examination Scheme**	
Lectures	3 Hr / Week	**ESE**	60 Marks
Tutorial	-	**CIE**	40 Marks
Practical	-	**Total**	100 Marks
Theory Credits: 3		**Duration of Exam:** 3 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To grasp an overview and significance of biopharmaceutical technology, understanding its distinctions from traditional pharmaceuticals, key products, and historical development.
2.	To delve into biopharmaceutical production and manufacturing processes, covering upstream and downstream processing, quality control, and regulatory requirements.
3.	To explore biopharmaceutical formulation and delivery principles, including stabilization techniques, delivery systems, and the role of excipients, through case studies on successful formulations and delivery methods.

Course Contents	
Unit I	**Introduction to Biopharmaceutical Technology**: Overview and importance, Differences from traditional pharmaceuticals, Key products (monoclonal antibodies, recombinant proteins, vaccines), History and development, Current trends and future prospects
Unit II	**Biopharmaceutical Production and Manufacturing**: Overview of production processes, Upstream processing: cell line development, media optimization, Fermentation and cell culture techniques, Downstream processing: purification, concentration, formulation, Quality control and assurance, Regulatory requirements and GMP
Unit III	**Biopharmaceutical Formulation and Delivery**: Principles of formulation, Stabilization techniques, Delivery systems (injections, oral, transdermal), Challenges and solutions, Role of excipients, Case studies on successful formulations and delivery methods
Unit IV	**Analytical Techniques in Biopharmaceutical Development**: Methods for characterizing biopharmaceuticals (HPLC, mass spectrometry, ELISA), Assessing purity, potency, and stability, Importance of bioassays, Regulatory guidelines, Advances in analytical technologies
Unit V	**Applications and Market Trends in Biopharmaceuticals**: Therapeutic applications (oncology, infectious diseases, autoimmune disorders), Market trends and dynamics, Commercialization challenges and opportunities, Intellectual property considerations, Future directions, Case studies on successful products and market impact

Text Books	
T.1	Biopharmaceutical Production: Principles and Processes (2nd Edition) by Gary Walsh
T.2	Biopharmaceutical Drug Design and Development (2nd Edition) by Sneha Kumari and Ashish Tripathi
Reference Books	
R.1	Recombinant DNA and Biotechnology: A Guide for Students (3rd Edition) by J. Reichardt, A. Rich, and R. Wetzel
R.2	Biopharmaceutical Processing: Validation and Qualification (2nd Edition) by James Robinson

Useful Links	
1	https://nptel.ac.in/courses/102108077
2	https://nptel.ac.in/courses/104102113

Course Outcomes		**CL**	**Hours**
BBT4708.1	**Summarize** about biopharmaceutical technology, its importance, and key products, differentiating from traditional pharmaceuticals	2	9
BBT4708.2	**Describe** biopharmaceutical production processes, including quality control, assurance, and regulatory requirements	2	8
BBT4708.3	**Analyze** biopharmaceutical formulation principles, stabilization techniques, and delivery systems	3	8
BBT4708.4	**Evaluate** analytical techniques for characterizing biopharmaceuticals and assessing regulatory compliance	4	9
BBT4708.5	**Apply** knowledge of market trends, commercialization challenges, and therapeutic applications in biopharmaceuticals	4	8

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(An Autonomous Institution Affiliated to RTM Nagpur University)
Department of Biotechnology

Fourth Year B.Tech Biotechnology (Seventh Semester)				
BBT4709: Bioprocess Equipment Design Lab				
Teaching Scheme			**Examination Scheme**	
Lectures	2 Hr / Week		**ESE**	25 Marks
Tutorial	-		**CIE**	25 Marks
Practical	-		**Total**	50 Marks
Practical Credit: 1			**Duration of Exam:** 2 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To create a clear and labeled diagram depicting the setup of a stirred-tank bioreactor.
2.	To illustrate the assembly process of a chromatography column with detailed labeling for each component.
3.	To design a schematic diagram of a heat exchanger that demonstrates effective temperature control mechanisms.

Sr. No.	**Experiments**
1	Draw a labeled diagram of a stirred-tank bioreactor.
2	Sketch the layout of a membrane filtration unit.
3	Illustrate the assembly of a chromatography column.
4	Design a schematic of a heat exchanger for temperature control.
5	Outline the setup of a centrifuge for cell harvesting.
6	Create a piping diagram for a bioprocess control system.
7	Draw a simple fermentation unit layout.
8	Diagram the internal components of a bioreactor vessel.
9	Sketch a basic cross-section of a filling machine.
10	Create a flowchart for a cell culture process.

Text Books	
T.1	Bioprocess Engineering Principles (2nd Edition) by Pauline M. Doran
T.2	Distillation Design (2nd Edition) by Henry Z. Kister
Reference Books	
R.1	Perry's Chemical Engineers' Handbook (9th Edition)
R.2	Bioreactors for Tissue Engineering by Julian Sun and Xiaohua Liu

Useful Links	
1	https://nptel.ac.in/courses/102106053
2	https://nptel.ac.in/courses/102106022

Course Outcomes		CL	Hours
BBT4709.1	**Apply** design methods to determine the design variables in distillation for binary systems	3	4
BBT4709.2	**Evaluate** the design requirements for flanges, nozzles, gaskets, supports, piping, jackets, and coils in bioreactors.	4	4
BBT4709.3	**Design** agitators, aerators, air filters, and stabilizers for bioreactors.	6	4
BBT4709.4	**Design** the baffles and tube joining methods for shell and tube heat exchangers.	6	4
BBT4709.5	**Evaluate** the scale-up principles and apply them to design larger bioreactors.	5	4

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Fourth Year B.Tech Biotechnology (Seventh Semester)				
BBT4710: Data analysis and Simulations Lab				
Teaching Scheme			**Examination Scheme**	
Lectures	2 Hr / Week		**ESE**	25 Marks
Tutorial	-		**CIE**	25 Marks
Practical	-		**Total**	50 Marks
Practical Credit: 1			**Duration of Exam:** 2 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To utilize MS-Excel for plotting graphs and calculating regression coefficients.
2.	To apply various numerical methods (Jacobi Iterative, Newton-Raphson, Bisection, Regula Falsi, Secant) using MS-Excel/MATLAB for solving simultaneous equations.
3.	To perform linear regression analysis, solve ordinary differential equations, and create pivot tables for data summarization using MS-Excel/MATLAB.

Sr. No.	**Experiments**
1	Plot graph using MS-Excel.
2	Calculate regression coefficient of data using MS-Excel.
3	Perform Linear Regression Analysis
4	Find unknown of simultaneous equations using Jacobi Iterative method using MS-Excel/MATLAB.
5	Find unknown of simultaneous equations using Newton Raphson method using MS-Excel/MATLAB.
6	Find unknown of simultaneous equations using Bisection method using MS-Excel/MATLAB.
7	Find unknown of simultaneous equations using Regula Falsi method using MS-Excel/MATLAB.
8	Find unknown of simultaneous equations using Secant method using MS-Excel/MATLAB.
9	Find Initial Value ordinary differential equation using MS-Excel/MATLAB.
10	Draw Pivot Tables for Data Summarization

Text Books	
T.1	Bioprocess Engineering Principles (2nd Edition) by Pauline M. Doran
T.2	Distillation Design (2nd Edition) by Henry Z. Kister
Reference Books	
R.1	Perry's Chemical Engineers' Handbook (9th Edition)
R.2	Bioreactors for Tissue Engineering by Julian Sun and Xiaohua Liu

Useful Links	
1	https://nptel.ac.in/courses/102105099
2	https://nptel.ac.in/courses/110104125

Course Outcomes		CL	Hours
BBT4709.1	**Plot** graphs using MS-Excel for data visualization	3	4
BBT4709.2	**Calculate** regression coefficients of data using MS-Excel	4	4
BBT4709.3	**Perform** linear regression analysis using MS-Excel	4	4
BBT4709.4	**Utilize** Jacobi Iterative method in MS-Excel/MATLAB to find unknowns of simultaneous equations	4	4
BBT4709.5	**Employ** Newton Raphson method in MS-Excel/MATLAB to find unknowns of simultaneous equations	4	4

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Fourth Year B.Tech Biotechnology (Seventh Semester)

BAU4707: Behavioral and Interpersonal Skills

Teaching Scheme			**Examination Scheme**	
Lectures	2 Hr / Week		**ESE/CIE**	-
Total Credit: Audit			**Duration of Exam: -**	

Course Objectives

The Objectives of this course is:

1.	To help the students to understand their real self by recognizing different aspects of their self-concept that will lead to an increased self-confidence.
2.	To train the students for communicating effectively in both formal as well as in informal settings.
3.	To help the students to understand the importance of non-verbal aspects of effective communication.
4.	To help the students to understand Emotion and emotional intelligence, Managing ones' own emotional reservoirs, effective dealing with emotions at work.
5.	To facilitate the students in understanding the formation and function of group and team and to help them tolearn the skills of a successful leader.
6.	To help the students in understanding and practicing the goal setting process by recognizing the importance of each step involved in goal setting. The activities involved are designed to facilitate their career goal decision making.

Course Contents	**Hours**
Each individual has behavior patterns that are shaped by the context of his or her past. Most often, adapting the behavior to the changing context of the reality a person lives in becomes difficult which may lead to the reduction in personal effectiveness and natural self-expression. The main focus of this course is to equip the students with useful approaches to help in the deeper understanding of self and help individuals empower themselves to be the source of their own growth and development. Thecourse will help students to learn effective communication skills, Group and team building skills and will help them learn the goal setting process and thus become more effective in achieving their goals. The broader objective of this course is to make the students aware about the different facets of self and to help them learn skills to strengthen their inner capacities. So that they are able to understand themselves, think and act effectively, to be able to communicate in an effective manner and to learn to lead and to form an effective team. The activities to achieve the above objectives can be suggested as follows. • Motivational lectures • Group Discussions/activities • Case Study • Games/Stimulation Exercises, Role-Playing • Mindfulness training.	**(08)**

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