TULSIRAMJIGAIKWAD-PATILCollegeofEngineeringandTechnology
Wardha Road, Nagpur - 441108
AccreditedwithNAACA+ Grade
ApprovedbyAICTE,NewDelhi,Govt.ofMaharashtra
(AnAutonomousInstitutionAffiliatedtoRTMNagpurUniversity)

Department of Biotechnology

Teaching Scheme and Syllabus

of

5th Semester B.Tech Biotechnology

(From Academic Year 2025-26)

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

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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SCHEMEOFINSTRUCTION& SYLLABI

Programme: B.Tech Biotechnology

Scheme of Instructions: Third Year B.Tech. in Biotechnology (As Per NEP 2020)

Semester–V

SN	Sem	Type	BoS/ Dept	Sub Code	Subject	T/P	Contact Hours			Credits	% Weightage			ESE Duration	Total Marks
							L	P	Hrs		CT/IA	CA	ESE		
1	V	PCC	BT	BBT33501	Bioprocess Engineering	T	3	2	5	3	30	10	60	3 Hrs	100
2	V	PCC	BT	BBT33502	Genetic Engineering and rDNA Technology	T	3	2	5	3	30	10	60	3 Hrs	100
3	V	PCC	BT	BBT33503	Fluid Mechanics and Solid Handling	T	3	2	5	3	30	10	60	3 Hrs	100
4	V	PCC	BT	BBT33504	Bioprocess Engineering lab	P	0	2	4	1	25		25	-	50
5	V	PCC	BT	BBT33505	Genetic Engineering and rDNA Technology Lab	P	0	2	4	1	25	-	25	-	50
6	V	PCC	BT	BBT33506	Fluid Mechanics and Solid Handling Lab	P	0	2	4	1	25	-	25		50
7	V	PEC	BT	BBT33507-9	Program Elective I	T	4	2	6	4	30	10	60	3 Hrs	100
8	V	MDM	MBA	BBA33501	Digital Marketing and Content Development	T	4	2	6	4	30	10	60	3 Hrs	100
9	V	OEC			Open Elective III	T	2	2	4	2	14	6	30	2 Hrs	50
Total							**19**	**6**	**43**	**22**					**700**

Course Category	BSC/ ESC (Basic Science Course/ Engineering Science Course.)	PCC (Programme Core courses	) Multidisciplinary Minor/ (OEC) Open Elective Course	VSEC (Skill Course)	Humanities Social Science & Management		Experiential Learning Courses	CC (Co-Curricular Courses)
					AEC(Ability Enhancement Course)	IKS(Indian Knowledge System)		
Credits	00	32	6	2	0	0	0	0
Cumulative Sum	29	50	10	6	8	2	2	4

PROGRESSIVE TOTAL CREDITS : 83+22=105

Chairperson	DeanAcademics	VicePrincipal	Principal	Date of Release	Version	Applicable for AY 2025-26 Onwards
Head Department Of Biotechnology Tulsiramji Gaikwad Patil Collage Of Engineering & Technology, Nagpur	Dean Academics Tulsiramji Gaikwad-Patil College Of Engineering and Technology, Nagpur	Vice Principal Tulsiramji Gaikwad-Patil College Of Engineering & Technology, Nagpur.	Principal Tulsiramji Gaikwad Patil College Of Engineering and Technology, Nagpur	June,2025	1.00	

Programme: B.Tech Biotechnology

List of **Program Electives** offered by The **Biotechnology** Department

Program Elective- I	Program Elective-II	Program Elective-III	Program Elective- IV	Program Elective- V
Semester V	**Semester VI**	**Semester VI**	**Semester VII**	**Semester VIII**
BBT33507- Biopharmaceutical Technology	**BBT33605-** Enzyme Technology	**BBT33608-** Biosimilars Technology	**BBT34703-** Nanotechnology	**BBT34706-** Good Manufacturing and Laboratory Practices
BBT33508- Introduction to Bioinformatics	**BBT33606-** Precision Medicine Technology	**BBT33609-** Stem cell Technology	**BBT34704-** Tissue Engineering and organ Printing	**BBT34707-** Biosensors
BBT33509- Bioremediation and Biodegradation	**BBT33607-** Biofertilizer and Biopesticide technology	**BBT33610-** Bioenergy and Biofules	**BBT34705-** Industrial Microbiology and its Application	**BBT34708-** Pollution control and Remediation

Program:B.Tech Biotechnology

List of **Open Electives** offered by **Biotechnology** Department

Open Elective-I	Open Elective-II	Open Elective-III
Semester-III	**Semester-IV**	**Semester-V**
BBT32309: Food and Nutrition	**BBT32408:** Waste Management	**BBT35310:**Bioterrorism and National Security

Course Category	BSC (Basic Science Course)	ESC (Engineering Science Course.)	PCC (Programme Core courses	PEC (Programme Elective courses)	Multi-disciplinary courses	VSEC (Skill Course)	Humanities Social Science & Management	Experiential Learning Courses	CC (Liberal Learning Courses	Semester Wise Credits
Sem -I	8	5	2	--	--	2	--	--	2	**22**
Sem -II	8	8	--	--	--	2	2	2	2	**21**
Sem -III	--	--	8	--	2	-	4	2	--	**20**
Sem -IV	--	--	8	--	4	2	6	--	--	**20**
Sem -V	--	--	11	4	4	--	--	--	--	**22**
Sem -VI	--	--	8	8	4	2	--	2	--	**20**
Sem -VII	--	--	4	2	-	--	--	12	--	**18**
Sem -VIII	--	--	4	6	-	--	--	8	--	**22**
Cumulative Sum	**16**	**13**	**66**	**20**	**14**	**8**	**12**	**26**	**4**	**165**

Chairperson	DeanAcademics	VicePrincipal	Principal	Date of Release	Version	Applicable for AY 2025-26 Onwards
Head Department Of Biotechnology Tulsiramji Gaikwad Patil College Of Engineering & Technology, Nagpur	Dean Academics Tulsiramji Gaikwad-Patil College Of Engineering and Technology, Nagpur	Vice Principal Tulsiramji Gaikwad-Patil College Of Engineering & Technology, Nagpur.	Principal Tulsiramji Gaikwad Patil College Of Engineering and Technology, Nagpur	June,2025	1.00	

Third Year (Semester-V) B.Tech. Biotechnology			
BBT33501: Bioprocess Engineering			
Teaching Scheme		**Examination Scheme**	
Lectures	3Hr / 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 introduce methods for isolating, preserving, and improving industrial microorganisms, including the use of cell banks.
2.	To explain media formulation, sterilization, and process optimization, focusing on key physical and chemical parameters.
3.	To cover inoculum development, fermentation kinetics, and bioprocess applications, along with basics of GMP, QC, and QA.

Course Contents	
Unit I	Introduction to fermentation processes, Microbial culture selection for Fermentation, Microbial types of fermentation process- Aerobic and Anaerobic, Surface and submerged fermentation, Continuous and batch fermentation, single culture and mixed culture fermentation.
Unit II	Media for industrial fermentations; optimization and sterilization: Media design and formulation, Media sterilization, disposal of media. Optimization of parameters: physical parameters like temperature, pressure, surface tension, viscosity of the medium, etc. Chemical parameters like pH, salt concentration, dissolved oxygen. Medium optimization (Factorial Design)
Unit III	Inocula development and fermentation kinetics: The development of inocula for bacterial, streptomycete, yeast, fungal processes. The aseptic inoculation of plant fermenters, Fermentation Kinetics - Microbial Growth Kinetics (Development of growth equation, Quantifying cell concentration, Growth patterns and Kinetics), Substrate consumption kinetics, Product formation kinetics
Unit IV	Design of fermenter and process optimization- generalized design of fermentation unit, structure of main unit and accessory parts, Introduction to GMP, QC and QA. Sterility, Toxicity and Product testing
Unit V	Production of citric acid, amino acids, antibiotics, brewing of alcoholic products, glycerol, acetone, butanol, Production of Vit B12. Brief account of steroid transformation.

Text Books	
T.1	Pauline Doran, Bioprocess engineering principles
T.2	Michael Shuler, Fikret Kargi, Matthew DeLisa, Bioprocess Engineering: Basic Concepts, 3rd Edition

Reference Books	
R.1	Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2001
R.2	Bioreaction Engineering, Bioprocess Monitoring (Bioreaction Engineering) by Karl Schügerl

Useful Links	
1	https://www.researchgate.net/publication/281716235_Industrial_fermentation
2	https://www.sciencedirect.com/topics/engineering/inoculum-development
3	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7466055/#:~:text=During%20fermentation%2C%20yeast%20cells%20convert,influence%20beer%20flavor%20%5B9%5D.

Course Code	Course Outcomes	CL	Hours
BBT33501.1	**Describe** types and principles of fermentation under aerobic, anaerobic, batch, and continuous conditions**.**	**2**	**9**
BBT33501.2	**Formulate** fermentation media using design and optimization principles under physical and chemical constraints.	**3**	**9**
BBT33501.3	**Analyze** microbial growth, substrate, and product kinetics in relation to inoculum development and fermentation conditions.	**4**	**9**
BBT33501.4	**Explain** fermenter design and QA/QC practices based on GMP and sterility requirements.	**2**	**9**
BBT33501.5	**Compare** the production processes of industrial products such as citric acid, antibiotics, and vitamins under specified conditions.	**4**	**9**

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Third Year (Semester-V) B.Tech. Biotechnology			
BBT33502: Genetic Engineering and rDNA Technology			
Teaching Scheme		**Examination Scheme**	
Lectures	3Hr / 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 introduce the principles and tools of recombinant DNA technology, including enzymes, vectors, and cloning methods, for the manipulation and analysis of genetic material.
2.	To explore the applications of genetic engineering in agriculture and medicine, including the development of transgenic organisms, recombinant therapeutics, and molecular diagnostics.

Course Contents	
Unit I	**Introduction to Genetic Engineering & rDNA Technology** Enzymes used in recombinant DNA technology: Nuclease, DNA ligase, polymerase, reverse transcriptase, terminal deoxynucleotidyl transferase, alkaline phosphatase; Modification of restriction fragment ends: sticky and blunt end ligation with linkers & adapters. DNA markers, Marker assisted Selection and its application.
Unit II	**Cloning Vectors** Concept of vectors: Properties and selection criteria; Types of vectors: Plasmids (pBR322, pUC series); Bacteriophages (Lambda phage, M13); Phagemids, and Cosmids; Yeast Artificial Chromosomes (YAC) and Bacterial Artificial Chromosomes (BAC); Viral vectors (Adenovirus, Retrovirus, Lentivirus). Expression of vectors – use of promoters and expression cassettes; Isolation and purification of genomic and plasmid DNA.
Unit III	**DNA Libraries and Sequencing Methods** Gene libraries: Genomic library, screening of libraries (shot gun approach) & cDNA library; Polymerase chain reaction (PCR): Basic principle, components of PCR, PCR techniques: Standard PCR, Inverse PCR, Reverse Transcriptase mediated PCR and Real Time PCR; Molecular DNA Sequencing: dideoxynucleotide method (Sanger sequencing), Chemical degradation (Maxum-Gilbert method); Strategies for sequencing large DNA fragments; Automated sequencing and pyrosequencing.
Unit IV	**Transformation, Transfection, and Selection Techniques** Transformation of recombinant vectors into bacterial cells; Transfection; Selection of recombinant clones; Colony hybridization, Plaque hybridization, immunochemical methods.
Unit V	**Application of Genetic Engineering:** Application of genetically modified organism in Agriculture (Marker assisted selection in different crops, BT Cotton and other transgenic plants), Medical and

	Pharmaceutical (Production of human proteins: Insulin and Somatostatin; recombinant vaccines and human gene therapy).

Text Books	
T.1	Biotechnology-Expanding Horizons by B.D.Singh (Edition: Fifth)
T.2	Recombinant DNA technology by Keya Choudhary
Reference Books	
R.1	PrinciplesofGenemanipulationandgenomicsbyS.B.Primrose&R.M.Twyman(Edition: Seventh).
R.2	Gene Cloning and DNA analysis-An Introduction by T.A. Brown (Edition: Eight).

UsefulLinks	
1	https://nptel.ac.in/courses/102104052
2	https://nptel.ac.in/courses/102103013

Course Code	Course Outcomes	CL	Hours
BBT33502.1	**Explain** role of enzymes to modified DNA by r-DNA technology.	**2**	**9**
BBT33502.2	**Discussed** the types of vector used for cloning and expression of gene.	**4**	**9**
BBT33502.3	**Demonstrate** the principle of various PCR to amplify the gene sequences	**3**	**9**
BBT33502.4	**Illustrate** different selection techniques for visual identification of recombinants.	**3**	**9**
BBT33502.5	**Compare** application of genetic engineering in different fields.	**3**	**9**

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Third Year (Semester-V) B.Tech. Biotechnology			
BBT33503:Fluid Mechanics and Solid Handling			
Teaching Scheme		**Examination Scheme**	
Lectures	3Hr / 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 impart foundational knowledge of fluid flow principles, flow measurement techniques, and pump systems relevant to bioprocess operations and industrial applications.
2.	To familiarize students with mechanical operations such as crushing, grinding, filtration, and mixing, including equipment types, operating principles, and efficiency considerations in bioreactor systems.

Course Contents	
Unit I	**Nature of fluid and fluid flow.** Mechanism of non-compressible fluid flow, Rheological properties of fermentation broths, continuity equation, Bernoulli equation, Reynolds number, frictional losses in pipe line.
Unit II	**Measurement of fluid flow**, Orifice Meter, Venturi Meter, Pitot Tube, Rotameter, Notches and weirs.
Unit III	**Pumps:** Classification and selection of pumps, Positive displacement pump and centrifugal pump.
Unit IV	**Theory of crushing**, Rittinger's law, Kick's law, Bond's Law Crushing and grinding machinery; their classification, general description of jaw crusher, gyratory crusher, roll crusher, hammer mills, ball mills, open circuit and closed-circuit Systems.
Unit V	**Filtration:** Types of filtration equipment, their application and operation, sand filters, filter press, leaf filters, rotary filters, filter aids. Centrifugal filtration. **Mixing in Bioreactor:** Fundamental of mixing and characteristics of mixing equipment, power consumption and efficiency.

Text Books	
T.1	Unit Operations of Chemical Engineering, by McCabe and Smith
T.2	A TextBook of Fluid Mechanics and Hydraulic Machines by Bansal, R.K. (2014), (In S.I. Units, Revised Ninth Edition). Laxmi Publications, Telangana.
T.3	Bioreactor Studies and Computational Fluid Dynamics by H.Singh&D.W. Hutmacher
Reference Books	
R.1	Bioreactors: Sustainable Design and Industrial Applications in Mitigation of GHG Emissions,1stEdition-April7,2020,LakhveerSingh,AbuYousuf,DurgaMadhabMahapatra
R.2	Bioreactors:Design,OperationandNovelApplicationsbyCarl-FredrikMandenius

Useful Links	
1	https://onlinecourses.nptel.ac.in/noc23_me42
2	https://microbiologynote.com/bioreactor/
3	https://www.ndsu.edu/pubweb/~qifzhang/Tech_Filtration-01.pdf

Course Code	Course Outcomes	CL	Class Sessions
BBT33503.1	**Examine** the nature of fluid and fluid flow under theoretical and lab-scale conditions.	**3**	**9**
BBT33503.2	**Apply** the techniques for measuring fluid flow using standard flow measurement devices in laboratory settings.	**3**	**9**
BBT33503.3	**Examine** the working and classification of pumps in typical hydraulic system environments.	**3**	**9**
BBT33503.4	**Summarize** the theories of crushing and crushers in the context of mechanical operations.	**2**	**9**
BBT33503.5	**Outline** the processes of filtration and mixing in a bioreactor during bioprocess operations.	**4**	**9**

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Third Year (Semester-V) B.Tech. Biotechnology			
BBT33504:Bioprocess Engineering Lab			
Teaching Scheme		**Examination Scheme**	
Lectures	2Hr / 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 equip students with hands-on skills in microbial isolation, culture preservation, and fermentation media optimization for industrial biotechnology applications using modern analytical and statistical tools.
2.	To train students in fermentation techniques, including microbial kinetics, inoculum development, sterilization methods, and product quality analysis for efficient bioprocess monitoring and yield estimation.

Sr. No.	**Experiments**	**CO**
1	To isolate bacteria or fungi used in industrial fermentation (e.g., *Aspergillus*, *Bacillus*).	CO1
2	To demonstrate slant storage methods for culture preservation.	CO1
3	To compare the growth of a microorganism by varying a parameter required for it's growth.	CO2
4	To formulate and optimize fermentation media using statistical tools.	CO2
5	To compare moist heat, filtration, and chemical sterilization methods.	CO3
6	To study how temperature, pH, and agitation affect microbial kinetics.	CO3
7	To develop and scale-up inoculum for bacterial or fungal fermentation.	CO4
8	To study microbial growth phases and calculate specific growth rate (μ) in a batch fermenter.	CO4
9	To perform QC/QA checks such as sterility and pH analysis on fermented products.	CO5
10	To produce citric acid using *Aspergillus niger* and estimate yield using titration.	CO5

Text Books	
T.1	Anju Dahiya, Bioenergy: Biomass to Biofuels and Waste to Energy, 2nd Edition, Academic Press, 2020.
T.2	John E. Smith, Biotechnology, 5th Edition, Cambridge University Press, 2009

Reference Books	
R.1	Jay Cheng (Ed.), Biomass to Renewable Energy Processes, 2nd Edition, CRC Press, 2017
R.2	Michael C. Flickinger, Stephen W. Drew (Eds.), Encyclopedia of Bioprocess Technology: Fermentation, Biocatalysis, and Bioseparation, John Wiley & Sons, 1999

Useful Links	
1.	https://www.sciencedirect.com/science/article/pii/S2215017X21000320
2.	https://pmc.ncbi.nlm.nih.gov/articles/PMC524071/

Course Code	Course Outcomes	CL	Hours
BBT33504.1	**Demonstrate** isolation and preservation techniques for industrially relevant microorganisms.	**3**	**9**
BBT33504.2	**Compare** microbial growth under varying parameters to assess environmental influences on kinetics	**4**	**9**
BBT33504.3	**Formulate** and optimize fermentation media using statistical tools and design approaches.	**3**	**9**
BBT33504.4	**Evaluate** sterilization methods based on their effectiveness in fermentation processes.	**4**	**9**
BBT33504.5	**Calculate** microbial growth rate and yield using batch fermenter data and titration methods.	**3**	**9**

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Third Year (Semester-V) B.Tech. Biotechnology			
BBT33505:Genetic Engineering and rDNA Technology Lab			
Teaching Scheme		**Examination Scheme**	
Lectures	2Hr / 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 provide hands-on training in molecular biology techniques including DNA isolation, quantification, PCR amplification, restriction digestion, and electrophoresis for genetic analysis and manipulation.
2.	To develop practical skills in gene expression analysis, bacterial transformation, and molecular marker techniques such as RFLP and CAPS for applications in genetic engineering and biotechnology.

Sr. No.	**Experiments**	**CO**
1	To isolate and identify genomic DNA by gel electrophoresis	CO1
2	To perform restriction digestion of bacterial genomic DNA	CO1
3	To isolate and analyze plasmid DNA	CO2
4	To quantify DNA using UV-Spectrophotometer	CO2
5	To amplify DNA by PCZ	CO3
6	Recovery of genomic DNA embedded in agarose gel	CO3
7	To investigate bacterial transformation by Lac I^+/ I^-	CO4
8	To check the purity of DNA by E_{260}/ E_{280}	CO4
9	To perform RFLP	CO5
10	To perform SDS- PAGE.	CO5

Text Books

T.1	Molecular Biology of the Gene, James D. Watson et al. Pearson Education, 7th Edition, 2013
Reference Books	
R.1	Principles and Techniques of Biochemistry and Molecular Biology, Keith Wilson and John Walker, Cambridge University Press, 7th Edition. 2010.

Useful Links	
1	https://vlab.amrita.edu/?sub=3&brch=77
2	https://www.asbmb.org/education/online-teaching/online-lab-work
3	http://biomodel.uah.es/en/lab/inicio.htm

Course Code	Course Outcomes	CL	Lab Sessions
BBT33505.1	Explain the banding Pattern of DNA fragments on Agarose gel.	**2**	**9**
BBT33505.2	Perform the isolation and identification of given DNA samples.	**2**	**9**
BBT33505.3	Demonstrate the technique of amplification and elution of DNA from gel.	**3**	**9**
BBT33505.4	Execute the method of transformation of in bacteria	**3**	**9**
BBT33505.5	Analyze the different banding pattern on agarose and SDS-PAGE	**4**	**9**

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Third Year (Semester-V) B.Tech. Biotechnology			
BBT33506:Fluid Mechanics and Solid Handling Lab			
Teaching Scheme		**Examination Scheme**	
Lectures	2Hr / 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 develop practical understanding of fluid flow behavior and measurement techniques by analyzing laminar and turbulent flow, discharge coefficients, and friction factors using standard fluid mechanics equipment.
2.	To impart hands-on experience in mechanical operations such as particle size analysis, crushing efficiency, and filtration performance relevant to bioprocess and chemical engineering applications.

Sr. No.	**Experiments**	**CO**
1	To observe the Laminar and Turbulent flow using Reynold' sapparatus.	CO1
2	Verify Bernoulli's theorem through experimentation.	CO1
3	Calculate the coefficient of discharge of an orifice meter.	CO2
4	Compute the coefficient of discharge of a venturi meter	CO2
5	To Determine the coefficient of dicharge of Rectangular Notch	CO3
6	To Determine the coefficient of dicharge of Triangular Notch	CO3
7	Evaluate the friction factor in a fluid flow system.	CO4
8	Measure average particle size in a sample.	CO4
9	Demonstrate particle crushing using the bead mill.	CO5
10	Assess the efficiency of the filter through experimentation.	CO5
11	Sedimentation studies apparatus	CO5

Text Books	
T.1	Unit Operations of Chemical Engineering, by McCabe and Smith
Reference Books	
R.1	Bioreactors: Sustainable Design and Industrial Applications in Mitigation of GHG Emissions,1stEdition-April7,2020,LakhveerSingh,AbuYousuf,DurgaMadhabMahapatra

Useful Links	
1	https://vlab.amrita.edu/?sub=3&brch=77
2	https://www.asbmb.org/education/online-teaching/online-lab-work
3	http://biomodel.uah.es/en/lab/inicio.htm

Course Code	Course Outcomes	CL	Hours
BBT33505.1	**Classify** the flow regime as laminar or turbulent by observing fluid behavior using Reynolds apparatus.	**2**	**9**
BBT33505.2	**Explain** the relationship between pressure, velocity, and elevation through Bernoulli's theorem experiment.	**2**	**9**
BBT33505.3	**Apply** the coefficient of discharge using orifice meter, venturimeter, and notches in lab experiments.	**3**	**9**
BBT33505.4	**Apply** the friction factor in pipe flow using friction factor test setup.	**3**	**9**
BBT33505.5	**Calculate** average particle size, crushing efficiency, and filtration performance through particle technology experiments.	**4**	**9**

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Third Year (Semester-V) B.Tech. Biotechnology			
BBT33507: Bio pharmaceutical Technology			
Teaching Scheme		**Examination Scheme**	
Lectures	3Hr / 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 I	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 I	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 I	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 Code	Course Outcomes	CL	Hours
BBT33507.1	**Summarize** the scope and products of biopharmaceutical technology in comparison to traditional pharmaceuticals.	**2**	**9**
BBT33507.2	**Describe** production and regulatory processes under quality control and assurance requirements.	**2**	**9**
BBT335078.3	**Analyze** formulation and stabilization strategies under conditions relevant to biopharmaceutical development.	**4**	**9**
BBT33507.4	**Evaluate** analytical techniques for characterization and regulatory compliance in product validation.	**4**	**9**
BBT33507.5	**Apply** knowledge of market trends and therapeutic uses to solve commercialization challenges in biopharmaceuticals.	**3**	**9**

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Third Year (Semester-V) B.Tech. Biotechnology

BBT33508: PEI-Introduction to Bioinformatics

Teaching Scheme			**Examination Scheme**	
Lectures	4Hr / Week		**ESE**	60 Marks
Tutorial	-		**CIE**	40 Marks
Practical	-		**Total**	100 Marks
Theory Credits: 4			**Duration of Exam:** 3 Hours	

Course Objectives

The Objectives of this course is:

1.	To introduce students to core bioinformatics tools and databases for analyzing genomic, proteomic, and structural data, enabling effective data retrieval, sequence alignment, and biological interpretation.
2.	To develop practical skills in computational biology, including gene prediction, protein modeling, phylogenetic analysis, and computer-aided drug design for applications in genomics, personalized medicine, and biotechnology research.

Course Contents

Unit I	**Introduction to Bioinformatics** Definition, scope, and objectives of bioinformatics, Interdisciplinary nature of bioinformatics, Applications in genomics, proteomics, drug discovery, and personalized medicine, Introduction to biological data: types (genomic, proteomic, metabolomic), formats, and quality.
Unit II	**Biological Databases** Classification of databases: primary, secondary, specialized**,** Nucleotide sequence databases: GenBank, EMBL, DDBJ**,** Protein sequence databases: UniProt, PIR, TrEMBL**,** Protein family/domain databases: PROSITE, PRINTS, Pfam, BLOCKS**,** Structural databases: PDB, SCOP, CATH, MMDB**,** Specialized databases: KEGG, BRENDA
Unit III	**Sequence Alignment & Phylogenetic Analysis (8L)** Sequence alignment and applications, Pairwise sequence alignment (Needleman-Wunsch and Smith-Waterman), Multiple sequence alignment: ClustalW, Scoring matrices: PAM, BLOSUM, Database Similarity searching tools: BLAST, FASTA – algorithms and statistical significance
Unit IV	**Genomics and Proteomics** Gene prediction, Conserved domain analysis, Protein structure visualization, Prediction of protein secondary structure, Tertiary structure prediction- Homology modelling, Threading, Ab-initio prediction. Validation of the predicted structure using Ramachandran plot, stereochemical properties, Structure- structure alignment.
Unit V	**Phylogenetics and Computational Drug Design** Phylogenetics basics, Phylogenetic tree construction methods - Distance-based methods, Character based methods, Phylogenetic tree evaluation, Introduction to Molecular Docking, Drug discovery, Computer aided drug design.

Text Books	
T.1	Bioinformatics: Sequence and Genome Analysis, David W. Mount, Cold Spring Harbor Laboratory Press, 2nd Edition, 2004.
T.2	Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, 5th Edition, 2019.
Reference Books	
R.1	Bioinformatics: Principles and Applications, Ghosh and Mallick, Oxford University Press (India), 1st Edition, 2008.
R.2	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Andreas D. Baxevanis and B. F. Francis Ouellette, Wiley-Interscience, 3rd Edition, 2004.

Useful Links	
1	https://www.youtube.com/watch?v=lhU3CzslFqw
2	https://archive.nptel.ac.in/courses/102/106/102106065/

Course Code	Course Outcomes	CL	Hours
BBT33508.1	**Explain** bioinformatics applications in genomics, proteomics, and drug discovery	**3**	**9**
BBT33508.2	**Classify** biological databases for effective data retrieval	**4**	**9**
BBT33508.3	**Compare** alignment tools and matrices to assess sequence similarity.	**5**	**9**
BBT33508.4	**Predict** gene/protein structures using bioinformatics tools.	**3**	**9**
BBT33508.5	**Evaluate** phylogenetic trees and docking results for evolutionary and drug insights.	**5**	**9**

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Third Year (Semester-V) B.Tech. Biotechnology			
BBT33509:PEI-Bioremediation and Biodegradation			
Teaching Scheme		**Examination Scheme**	
Lectures	4Hr / Week	**ESE**	60 Marks
Tutorial	-	**CIE**	40 Marks
Practical	-	**Total**	100 Marks
Theory Credits: 4		**Duration of Exam:** 3 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To understand the fundamental principles, classification, and influencing factors involved in bioremediation and microbial degradation of pollutants.
2.	To study microbial metabolic pathways and genetic mechanisms underlying the degradation of organic and inorganic contaminants.
3.	To evaluate current bioremediation technologies, molecular monitoring tools, and assess real-world applications through industrial and environmental case studies.

Course Contents	
Unit I	**Fundamentals of Bioremediation** Bioremediation: definition, history, and significance in environmental biotechnology. Classification into in situ and ex situ techniques. Major influencing factors including microbial activity, contaminant properties, nutrient availability, and environmental parameters. Concepts of natural attenuation and engineered remediation systems.
Unit II	**Microbial Biodegradation Mechanisms** Microbial metabolism of xenobiotic and organic pollutants under aerobic and anaerobic conditions. Enzymatic transformation, cometabolism, and microbial consortia. Genetic basis of biodegradation: role of plasmids, transposons, and mobile genetic elements. Adaptation and resistance of microbial communities in contaminated environments.
Unit III	**Bioremediation of Organic and Inorganic Pollutants** Degradation of hydrocarbons, pesticides, herbicides, and synthetic dyes. Microbial and phytoremediation of heavy metals and radionuclides. Bioaccumulation, biosorption, and biotransformation mechanisms. Case-specific examples of pollutant removal from soil and water environments.
Unit IV	**Bioremediation Technologies and Monitoring Tools** Technologies such as landfarming, composting, slurry-phase bioreactors, bioventing, and biosparging. bioaugmentation and biostimulation strategies for enhancing microbial activity. Application of phytoremediation and mycoremediation. Molecular tools for monitoring: metagenomics, qPCR, microbial biomarkers, biosensors, and GIS-based mapping.
Unit V	**Applications and Case Studies** Industrial and field applications of bioremediation: oil spill remediation, municipal and industrial wastewater treatment, and reclamation of contaminated land. Case studies from India and abroad demonstrating successful implementation. Challenges in field-scalebioremediation and regulatory aspects. Emerging approaches including genetically modified microbes and nanobioremediation.

Text Books	
T.1	Environmental Biotechnology – Bhattacharya and Banerjee, Oxford University Press
T.2	Microbial Biotechnology – Glazer and Nikaido, Cambridge University Press
Reference Books	
R.1	Bioremediation: Principles and Practice – S. Singh and R. Naik, Narosa Publishing House
R.2	Environmental Microbiology – R.M. Maier, I.L. Pepper, C.P. Gerba, Academic Press

Useful Links	
1	https://nptel.ac.in/courses/105/105/105105175/
2	https://www.epa.gov/bioremediation
3	https://microbewiki.kenyon.edu/index.php/Bioremediation

Course Code	Course Outcomes	CL	Hours
BBT33509.1	**Classify** bioremediation principles and types based on pollutant degradation processes	**2**	**9**
BBT33509.2	**Explain** microbial and enzymatic mechanisms under varying environmental conditions	**2**	**9**
BBT33509.3	**Analyze** pollutant-specific bioremediation strategies with respect to microbial interactions	**4**	**9**
BBT33509.4	**Apply** bioremediation technologies and monitoring tools to manage contaminated sites	**3**	**9**
BBT33509.5	**Evaluate** field-based case studies to identify challenges and innovations in bioremediation.	**4**	**9**

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Third Year (Semester-V) B.Tech. Biotechnology			
BBA33501:MDM-Digital Marketing and Content Development			
Teaching Scheme		**Examination Scheme**	
Lectures	4Hr / Week	**ESE**	60 Marks
Tutorial	-	**CIE**	40 Marks
Practical	-	**Total**	100 Marks
Theory Credits: 4		**Duration of Exam:** 3 Hours	

Course Objectives	
The Objectives of this course is:	
1.	The objective of Digital Marketing and Content Writing is to equip individuals with the skills to create compelling, relevant content and utilize digital channels effectively to reach and engage target audiences, ultimately driving brand awareness, customer acquisition, and business growth

Course Contents	
Unit I	**Basics of Marketing** Marketing Environment, Marketing Plan, Perceptual Mapping, Consumer Behavior, Enhancing Customer Experience, Communicating with Consumers, Advertisements, Case Studies.
Unit II	**Basics of Digital Marketing** Evolution, Terminologies, Difference Between Traditional and Digital Marketing, Importance and Scope of Digital and Social Media Marketing, Online Retailing and Aggregators
Unit III	**Social Media Marketing** Defining Social Media Marketing Elements of Social Media Marketing, Social Media Vehicles, Elements of Social Media Marketing Strategies, Social Media Mix, Social Media Campaign Management, Social Media(Instagram, Linked in, Face book, etc)
Unit IV	**Types of Content writing** The process of Content Writing – getting the brief, ideating, researching, structuring, formatting, Writing Styles - Non-fiction (Essays, Reports), Advertising, Newspapers, Corporate Communications -- Writing for press releases, newsletters – focus on language, jargon, writing style, target audience, formal and informal language
Unit V	**Plagiarism laws in Content Writing** What is plagiarism, rules on plagiarism, How to write plagiarism-free copies. Interactive Content: Quizzes, Polls, Interactive white papers

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Text Books	
T.1	Seema Gupta, *Digital Marketing*, McGraw Hill Education, Latest Edition
T.2	Puneet Singh Bhatia, *Fundamentals of Digital Marketing*, Pearson, Latest Edition
T.3	Ann Handley, *Everybody Writes: Your Go-To Guide to Creating Ridiculously Good Content*, Harper Business

Reference Books	
R.1	Philip Kotler, *Marketing Management*, Pearson Education
R.2	Ryan Deiss and Russ Henneberry, *Digital Marketing for Dummies*, Wiley

Useful Links	
1	https://www.hubspot.com – HubSpot Academy for Digital Marketing & Content Writing

Course Code	Course Outcomes	CL	Hours
BBA33501.1	**Explain** fundamental concepts of marketing within the context of the digital marketing environment.	**2**	**9**
BBA33501.2	**Evaluate** digital marketing strategies and online platforms to determine their effectiveness in reaching target audiences.	**4**	**9**
BBA33501.3	**Apply** social media tools and techniques for brand communication and campaign execution.	**3**	**9**
BBA33501.4	**Design** content types and formats according to specific audience needs and platforms.	**3**	**9**
BBA33501.5	**Develop** interactive, plagiarism-free content as per content writing standards and legal regulations.	**3**	**9**

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Third Year (Semester-V) B.Tech. Biotechnology			
BBT35310:OE-III -Bioterrorism and National Security			
Teaching Scheme		**Examination Scheme**	
Lectures	2Hr / Week	**ESE**	30 Marks
Tutorial	-	**CIE**	20 Marks
Practical	-	**Total**	50 Marks
Theory Credits: 2		**Duration of Exam:** 2 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To understand the concept, history, and types of bioterrorism, including bioterrorism agents and their mechanisms.
2.	To explore the types of bio-weapons, their methods of dispersal, and examine case studies.
3.	To gain knowledge about surveillance, detection technologies, biosecurity strategies, and ethical and regulatory considerations in bioterrorism management.

Course Contents	
Unit I	**Introduction to Bioterrorism and Biosecurity** Definition and historical perspective of bioterrorism, Traditional vs. new-age terrorists (nuclear, chemical, radiological), Agroterrorism, Biosurveillance and biodiagnostics
Unit II	**Bioterrorism Agents and Bio-Weapons** Types of agents: Bacteria, viruses, and other agents, Priority categories: High (Ebola), Moderate (Q fever, Brucellosis), Low (Hantavirus, Yellow fever),Pathogenicity, epidemiology, and mechanisms of action, Dispersal techniques and case studies: Anthrax, Plague, Botulism, Smallpox, Tularemia, VHF, Genetically engineered microbes
Unit III	**Prevention, Control, and Management of Bioterrorism** Surveillance and detection methods, Equipment and sensors used for detection Novel methods for bioagent identification, Vaccine production for bioagents Biosecurity practices in food and healthcare industries, Ethical issues, information management, government control, Role of national and international organizations, Microbial forensics

Text Books	
T.1	"Bioterrorism Preparedness: Medicine, Public Health, Policy" by Nancy Khardori
T.2	"Biodefense: Research Methodology and Animal Models" by James R. Swearengen
Reference Books	

R.1	"Bioterrorism: A Guide for Hospital Preparedness" by D. A. Henderson
R.2	"The Demon in the Freezer" by Richard Preston

Useful Links	
1	https://www.cdc.gov/bioterrorism/
2	https://www.ncbi.nlm.nih.gov/books/NBK559321/
3	https://www.who.int/initiatives/health-security

Course Code	Course Outcomes	CL	Hours
BBT35310.1	**Explain** the concept, history, and evolution of bioterrorism in the context of emerging biological	**2**	**9**
BBT35310.2	**Classify** bioterrorism agents based on their types and modes of action.	**2**	**9**
BBT35310.3	**Describe** dispersal techniques used in past bioterrorism events.	**2**	**9**

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