ACADEMIC CURRICULA

POST GRADUATE DEGREE PROGRAMME

Master of Technology

(NEP based Flexible Credit System)

Syllabi for M Tech in Biotechnology Programme

Professional Core and Elective Courses

BIRLA INSTITUTE OF TECHNOLOGY, MESRA

(Deemed to be university)

Mesra, Ranchi, Jharkhand, 835215, India

The following Members attended BoS held on 19.06.2026

[Dr. Vinod Kumar Nigam]
Member

[Dr. D. M. Pandey]
Member

[Dr. Manish Kumar]
Member

[Dr. S. G. Sachan]
Member

[Dr. Alok Jain]
Member

[Dr. Koel Mukherjee]
Member

[Dr. S. R. Sharma]
Member

[Dr. Biswatrish Sarkar]
Member

19/6/26
[Dr. Amit Tiwari]
Member

22/06/26
[Dr. Shashi Kumar]
External Member, from Industry & Alumni

22/06/26
[Dr. Gourav Basu Choudhury]
External Member, from Industry & Alumni

[Dr. Kunal Mukhopadhyay]
Chairman

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

- To educate students at Undergraduate, Post Graduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

The Department of Bioengineering and Biotechnology has a vision to impart international standard quality education in the field of Bioscience, Biotechnology and Bioengineering.

Department Mission

- To create state-of-the-art infrastructure for Research and Training in Biotechnology and Bioengineering.
- To provide globally acceptable technical education in Bioscience, Biotechnology and Bioengineering.
- To nurture graduates for innovation and creativity in the field of Bioscience, Biotechnology and Bioengineering having ethical and social concern.
- To promote collaboration with Academia, Industries and Research Organizations at National and International level to enhance quality of education and research.
- To contribute to socioeconomic development through education and bioentrepreneurship.

Programme Educational Objectives (PEOs)- M.Tech (Biotechnology)

PEO 1: Students will acquire necessary knowledge and skills in the frontier areas of Biotechnology.

PEO 2: Students will think critically and creatively about the use of biotechnology to address local and global problems.

PEO 3: Students will be able to implement the engineering principles to biological systems for development of industrial applications, as well as entrepreneurship skills to start biotech industries.

PROGRAM OUTCOMES (POs)

M.Tech in Biotechnology

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program of biotechnology. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Recognize the need for continuous learning and will prepare oneself to create, select, learn and apply appropriate techniques, resources, and modern instrumentation to solve complex biotechnological activities with an understanding of the limitations.

PO5: Demonstrate knowledge of biotechnology and management principles and apply to manage projects efficiently and economically with intellectual integrity and ethics for sustainable development of society.

PO6: Recognize opportunities and contribute to collaborative-multidisciplinary research, demonstrate a capacity for teamwork, decision-making based on open-mindedness and rational analysis in order to achieve common goals.

Teaching and Learning Scheme

As per the new **National Credit Framework**, an account of 30 hours of learning is equivalent to 01 credit. It comprises of Classroom instructions (CI), Lab instructions (LI), Term work + Self Learning (TW + SL) in hours per semester. The division of the components mentioned will be as per the following teaching and learning schemes.

Sl. No.	Total credits	Classroom Instructions (CI) in hours per semester		Lab Instructions (LI) in hours per semester	Term work (TW)and Self Learning (SL) (TW + SL) in hours per semester	Total no. of Hours per semester
		Lectures	Tutorials			
1	**04 (Four) Theory**	42	14	0	64	120
2	**03 (Three) Theory**	28	14	0	48	90
3	**03 (Three) Theory**	42	0	0	48	90
4	**02 (Two) Theory**	28	0	0	32	60
5	**02 (Two) Lab**	0	0	56	4	60
6	**1.5 (One and half) Lab**	0	0	42	3	45
7	**01 (One) Lab**	0	0	28	2	30
8	**02 (Two) Project**	0	0	0	60	60
9	**03 (Three) Project**	0	0	0	90	90
10	**06 (Six) Project**	0	0	0	180	180
11	**03 (Three) Vocational**	14	0	56	20	90

Legend:

CI Classroom Instruction (includes different instructional/ implementation strategies i.e. Lecture (L), Tutorial (T), case method, Demonstrations, video demonstration, problem-based learning etc. to deliver theoretical concepts)

LI Laboratory Instruction (includes experiments/ practical performances, problem-based experiences in laboratory, workshop, field or other locations using different instructional/ implementation strategies)

TW Term Work (includes assignments, seminar micro projects, industrial visits, any other student activities etc.)

SL Self Learning, MOOCs, spoken tutorials, online educational resources etc. (if provided in curriculum structure)

Signed by:

Dr. Sandeep Singh Solanki
Dean (PGS)
Chairperson

Dr. Gautam Sarkhel
Dean (UGS)
Member

Dr. Raju Poddar
Dean (RIE)
Member

Dr. Praveen Srivastava
Dean (SA)
Member

Dr. Ashoke Sharon
Dean (FA)
Member

Dr. Manish Kumar
Dean (AAC)
Member

Dr. Ritesh Kumar Singh
Controller of Examination
Member

Dr. Animesh Ghosh
Director (IQAC)
Member

Dr. Rajesh Jain
Registrar
Member

Dr. Sukalyan Chakroborty
Associate Dean (UGS & PGS)
Member

Mr. Siddhi Kant Mishra
Asst. Registrar (Acad. Prog.)
Member Secretary

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI

REVISED COURSE STRUCTURE OF M. TECH

(BIOTECHNOLOGY)

SEMESTER/ Session of Study (Recommended)	Course Level	Category of Course	Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial;P-Practicals*			Total Credits *C- Credits*
					L *(Periods /week)*	**T** *(Periods /week)*	p *(Periods /week)*	C
		THEORY						
FIRST/ Monsoon	Fifth	Programme Core (PC)	BE26501	r-DNA Tech. & Genetic Engineering	3	0	0	3
			BE26503	Advanced Bioprocess Engineering	3	0	0	3
			BE26505	Modern Methods of Instrumentation	3	0	0	3
			BE26507	Modern Bioinformatics & Artificial Intelligence	2	1	0	3
		Programme Elective (PE)		PE I	3	0	0	3
		Skill development I	BE26506	IPR, Biosafety and Technical Writing in Biotechnology	0	1	2	2
		LABORATORIES						
		Laboratory (PC)	BE26502	Molecular Biology & r-DNA Techniques Lab	0	0	3	1.5
			BE26504	Bioprocess Engineering Lab	0	0	3	1.5
		TOTAL						**20**
SECOND/ Spring	Fifth	Programme Core (PC)						
			BE26509	Bioprocess Plant Design	3	0	0	3
			BE26511	Nanobiotechnology and Advanced Biomaterials	3	0	0	3
			BE26513	Biophysics	3	0	0	3
			BE26515	Advanced Bioseparation Engineering	3	0	0	3
		Programme Elective (PE)		PE II	3	0	0	3
		Skill development II	BE26512	Professional Ethics and Entrepreneurial Skills	0	1	2	2
		LABORATORIES						

		Programme Core (PC)	BE26510	Bioseparation Engineering Lab	0	0	3	1.5
			BE26514	Bioprocess Plant Design Lab	0	0	3	1.5
		TOTAL						**20**
THIRD/ Monsoon	Sixth	Programme Core (PC)	BE26600	Thesis (Part I)				14
		Open Elective (OE)		OEI/MOOC (MOOC-I (Biotech Emerging Areas)				3
				OEII/MOOC (MOOC-II (AI/ML in Life Sciences / Bioprocess)				3
		TOTAL						**20**
FOURTH/ Spring	Sixth	Programme Core (PC)	BE26650	Thesis (Part II)				20
		TOTAL						**20**
GRAND TOTAL FOR PROGRAMME (20 + 20 + 20 + 20)								**80**

PROGRAM ELECTIVES	CODE	COURSE
PE I		
	BE 26517	Environmental Biotechnology
	BE 26519	Advances in Immunotechnology
	BE 26521	Protein Engineering
PEII		
	BE 26523	Stem Cells & Tissue Engineering
	BE26525	Pharmaceutical Biotechnology
	BE 26527	Advanced Biomedical Instrumentation

OPEN ELECTIVES OFFERED TO OTHER DEPARTMENTS	CODE	COURSE
OE1	BE 26601	Biomedical Instrumentation
OE2	BE 26603	Advances in Nanobiotechnology

COURSE INFORMATION

Course code	BE26501
Course title	Recombinant DNA Technology & Genetic Engineering
Pre-requisite(s)	Nil
Co-requisite	Nil
Credits	3
Class schedule per week	L: 3 T:0 P: 0
Class	MTech
Semester / Level	I
Branch	Biotechnology
Name of Teacher	Dr Kunal Mukhopadhyay

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	Impart knowledge on basic concepts of various molecular biology techniques
2	Exemplify different types of polymerase chain reactions and their applications
3	Implement, organize and design different vectors for gene cloning and expression
4	Generating contextual and conditional knowledge of gene function for various applications

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Apply the principles of molecular biology techniques.
CO2	Analyse the experimental data using AI to select suitable PCR for particular applications
CO3	Evaluate selectivity and specificity of vectors for cloning genes and their expressions

CO4	Apply AI to examine gene function, gene modulation and their effects on improvement of crops and animals.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lectures*
1	Basics Concepts of RDNA Technology	Restriction and DNA modifying enzymes; Labeling of DNA using different techniques; Hybridization techniques: Southern, Northern, Colony and Fluorescence hybridization; Southwestern and Far-western; DNA Protein Interactions, Protein-protein interaction Metagenomics and its role in environment.	08
2	Cloning & expression vectors	Plasmids; Phagemids, EMBL Replacement vectors, Shuttle vectors; Yeast vectors, Artificial chromosomes, Agrobacterium vectors, Expression vectors (eukaryotic and prokaryotic); His-tag recombinant Protein purification, Construction of cDNA and genomic DNA libraries.	08
3	PCR and Sequencing Its Applications	The technique, Primer design, Fidelity of thermostable DNA polymerases; Types of PCR, T/A-vectors for cloning of PCR products; Quantitative Real Time PCR; applications in molecular diagnostics; Enzymatic DNA sequencing; Automated DNA sequencing; Next generation DNA sequencing techniques, RNA sequencing; AI-based assembly and annotation of sequenced DNA	08
4	Gene silencing techniques	RNA Interference, Small double stranded RNAs, siRNA, Micro RNA, AI-based artificial construction of siRNA vectors; Creation of knock down mutants	08
5	Applications of Genetic Engineering	Gene therapy, Gene replacement & Suicide gene therapy, DNA vaccine, Terminator technology, Golden rice, Safety guidelines in recombinant DNA research.	08

Learning Resources	
Text Books	***Reference Books***
1. S.B. Primrose, R.M. Twyman and R.W. Old; Principles of Gene Manipulation. 6th Edition 2. TA. Brown, Genomes, 3rd ed. Garland Science 2006	Michael R. Green and Joseph Sambrook 2012 4th Ed Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001. 3.

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Nil***
Pos met through Gaps in the Syllabus	***Nil***
Topics beyond syllabus/Advanced topics/Design	***Nil***
Pos met through Topics beyond syllabus/Advanced topics/Design	***Nil***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***			
	Continuous Internal Assessment	50%			
	Semester End Examination	50%			
	Continuous Internal Assessment	***% Distribution***			
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%			
	Assignment(s)	10%			
	Seminar before a Committee	10%			
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***
	Continuous Internal Assessment	√	√	√	√
	Semester End Examination	√	V	√	√
Indirect Assessment					

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	3	3	3
CO2	3	2	1	2	3	2
CO3	3	1	2	1	3	2
CO4	3	3	3	1	3	1
CO5						

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Kunal Mukhopadhyay

COURSE INFORMATION

Course code	BE26502
Course title	Molecular Biology and rDNA Techniques lab
Pre-requisite(s)	Nil
Co-requisite	Nil
Credits	1.5
Class schedule per week	L: 0 T:0 P: 3
Class	M.Tech
Semester / Level	I/5
Branch	Biotechnology
Name of Teacher	Dr Kunal Mukhopadhyay

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	Explain the principles used to nuclear and plasmid DNA & cellular RNA isolation methods and to perform PCR techniques.
2	Can isolate DNA, RNA, plasmids, and perform gel electrophoresis
3	Can perform PCR, cDNA synthesis, RT-PCR, and Real-time PCR
4	Generating contextual and conditional knowledge of gene cloning for various applications

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Understand the principles of isolation of biomolecules using molecular biology techniques.
CO2	Analyse the experimental data using AI to select suitable PCR technique for need-based applications
CO3	Evaluate vectors for cloning genes
CO4	Apply AI to examine function of cloned genes

Syllabus

Sl. No.	*Detailed Contents*	*No. of classes*
1	Demonstration of instruments used in Molecular Biology Laboratory	3
2	Preparation of DNase-Free and RNase-Free Glassware and Plasticware	3
3	Isolation of DNA from Plant Leaves	3
4	Quantification of DNA using NanoDrop Spectrophotometer	3
5	Agarose Gel Electrophoresis of DNA	3
6	Isolation of RNA from Plant Leaves	3
7	Quantification of RNA using NanoDrop Spectrophotometer	3
8	Denaturing Agarose Gel Electrophoresis of RNA	3
9	Media preparation and Growth of Bacteria for Isolation of Plasmid DNA	3
10	Isolation of Plasmid DNA using Alkaline Lysis Method	3
11	Agarose Gel Electrophoresis of Plasmid DNA	3
12	Primer Designing for PCR (Demonstration)	3
13	Polymerase Chain Reaction (PCR) and Agarose Gel Electrophoresis of amplified products	3
14	Real-Time Quantitative PCR (qPCR) (Demonstration)	3

Learning Resources	
Text Books	***Reference Books***
Michael R. Green and Joseph Sambrook 2012 4th Ed Molecular Cloning: A Laboratory Manual, Vols 1-3, Cold Spring Harbor Laboratory, 2016.	

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Nil***
Pos met through Gaps in the Syllabus	***Nil***
Topics beyond syllabus/Advanced topics/Design	***Nil***
Pos met through Topics beyond syllabus/Advanced topics/Design	***Nil***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***			
	Continuous Internal Assessment	50%			
	Semester End Examination	50%			
	Continuous Internal Assessment	***% Distribution***			
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%			
	Assignment(s)	10%			
	Seminar before a Committee	10%			
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***
	Continuous Internal Assessment	√	√	√	√
	Semester End Examination	√	V	√	√
Indirect Assessment					

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	3	3	3
CO2	3	2	1	2	3	2
CO3	3	1	2	1	3	2
CO4	3	3	2	1	3	1
CO5						

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD3
CO2	CD3
CO3	CD3
CO4	CD3

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

		Dr Kunal Mukhopadhyay

COURSE INFORMATION

Course code	**BE26503**
Course title	**Advanced Bioprocess Engineering**
Pre-requisite(s)	**B.E. /B. Tech./M.Sc. in Biotechnology/Life Sciences**
Co-requisite	**None**
Credits	**3**
Class schedule per week	**L: 3 T: 0 P: 0**
Class	**M. Tech**
Semester / Level	**1/5**
Branch	**Biotechnology**
Name of Teacher	**Dr. Soham Chattopadhyay**

Course Objectives

This course aims to provide students with:

Sl. No.	Objectives
1	State the enzyme kinetics, various factors regulating catalysis, different models for analyzing the enzyme kinetics, Immobilization and large-scale production of enzyme;
2	Extend comprehensive knowledge about media constituents, formulations and microbial growth as well as measurement of cell biomass and analysis of mass balance, different methods of sterilization, agitation, oxygen transfer rate and operation of bioreactor;
3	Demonstrate about concept and criteria of scale up of laboratory process, Instrumentation and process control- offline and online,
4	Gain knowledge about the design of production of bioproducts under aerobic and anaerobic states, process economic and preparation of flow sheet of production process

Syllabus

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
COs	**Course Outcomes**
CO1	Analyze enzyme-catalyzed reactions, enzyme kinetics, and immobilization techniques for the design and application of enzymatic bioprocesses.
CO2	Design and optimize fermentation media and evaluate microbial growth kinetics, stoichiometry, and mass balance for industrial bioprocess development.
CO3	Select and operate appropriate bioreactor systems, and assess the effects of sterilization, aeration, agitation, and oxygen transfer on bioprocess performance.
CO4	Apply principles of bioreactor scale-up, scale-down, instrumentation, and process control for efficient industrial bioprocess operation.
CO5	Evaluate industrial biochemical production processes, develop process flow sheets, and analyze the economic aspects of bioprocess industries.

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	**Principles of Enzyme Catalysis**	Introduction to enzymes, Mechanistic models for simple enzyme kinetics, Effect of pH and temperature, Methods of immobilization, Diffusional limitations in immobilized enzyme systems	**8**
2	**Microbial Growth**	Introduction to microbial growth and related kinetics, Factors affecting the growth, Medium constituents, Designing of fermentation medium and its optimization.	**8**
3	**Bioreactor Operations**	Bioreactor components, Basic design of different Bioreactors, Batch, Fed-batch and Continuous bioreactors, Oxygen transfer in bioreactors	**8**
4	**Scale up, Operation and Control of Bioreactors**	Continuous sterilization, Scale-up, various criteria for scale-up, Scale-down, Bioreactor instrumentation and control.	**8**
5	**Industrial Process**	Bioprocesses for the commercial large-scale production of industrially important products	**8**

Learning Resources	
Text Books	***Reference Books***
1. Michael L. Shuler, FikretKargi, Bioprocess Engineering – Basic Concepts, 2nd Ed., Pearson Education India, 2015 2. James Bailey, David Ollis, Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill Education, 2017	1. Roger G. Harrison, Paul W. Todd, Scott R. Rudge, Demetri P. Petrides, Bioseparations Science and Engineering, 2nd Ed., Oxford University Press, 2003. 2. Pauline M. Doran, Bioprocess Engineering Principles, 2nd Ed., Academic Press, 2012
Gaps in the Syllabus (to meet Industry/Profession requirements)	Design of real-time industrial projects

Pos met through Gaps in the Syllabus	*PO5 and PO6*
Topics beyond syllabus/Advanced topics/Design	*Software based optimization of media components*
Pos met through Topics beyond syllabus/Advanced topics/Design	*PO5 and PO6*

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***			***% Contribution during CO Assessment***		
	Continuous Internal Assessment			50%		
	Semester End Examination			50%		
	Continuous Internal Assessment			***% Distribution***		
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.			30%		
	Assignment(s)			10%		
	Seminar before a Committee			10%		
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Y	Y	Y	Y	
	Semester End Examination	Y	Y	Y	Y	Y
Indirect Assessment	Student Feedback on Course Outcome					

Mapping Between Course Outcomes and Program Outcomes						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	2	3	1	1
CO2	2	3	3	3	3	2
CO3	2	1	3	2	2	3
CO4	2	2	2	3	2	3
CO5	1	2	3	3	3	2

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1,CD6
CO2	CD1, CD6
CO3	CD1, CD2, CD3,CD6

CO4	CD1, CD3,CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	BE26504
Course title	Bioprocess Engineering Lab
Pre-requisite(s)	Nil
Co-requisite	BE26502 Advanced Bioprocess Engineering
Credits	1.5
Class schedule per week	L: 0, T: 0, P: 3
Class	M.Tech
Semester / Level	I/5
Branch	Biotechnology
Name of Teacher	Dr. Ramesh Chandra

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	To extend comprehensive knowledge about media constituents, formulations and microbial growth as well as measurement of cell biomass and analysis of it. To expose students with different methods of sterilization processes.
2	To expose students with enzymatic reaction design and enzyme kinetics, various factors regulating catalysis, methods of immobilization and its kinetic analysis.
3	To expose students with bioreactor and its operation, its instrumentation, oxygen transfer, agitation, and process control- both offline and online.
4	To expose them with typical bioprocesses for a bioproduct.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Design medium for microbial growth, solve the mass balance of production process, propose and use the sterilizers for removal of microbial contaminants.
CO2	Explain the kinetics of enzyme catalysed reaction in free and immobilized states.
CO3	Know the laboratory bioreactor and its operation with respect to bioreactor design and its operation, its instrumentation, oxygen transfer, agitation, and process control- both offline and online.
CO4	Carry out typical bioprocesses for various bioproducts.

Syllabus

Experiments are based on theory course BE26502 Advanced bioprocess engineering.

List of experiments (minimum eight to be performed)

Experiment-1 Bioreactor parts and accessories and its operation

Experiment-2 Calibration of pH electrode and DO probe of a bioreactor

Experiment-3 To prepare standard plot of protein

Experiment-4 To prepare standard plot of ammonia

Experiment-5 To prepare standard plot of sugar

Experiment-6 Growth of Bacteria/Yeast and estimation of specific growth rate

Experiment-7 Growth of Bacteria/Yeast and study of oxygen supply to medium in fermenter/Bioreactor

Experiment-8 Immobilization of enzymes by entrapment

Experiment-9 Kinetic study of enzymes

Experiment-10 Medium optimization by monofactorial search method

Experiment-11 Medium optimization by using models/AI&ML tools

Experiment-12 Estimation of D value for sterilization of microbial culture

Learning Resources	
Text Books	**Reference Books**
1. Michael L. Shuler, Fikret Kargi, Bioprocess Engineering – Basic Concepts, 2nd Ed., Pearson Education India, 2015 2. James Bailey, David Ollis, Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill Education, 2017	1. Roger G. Harrison, Paul W. Todd, Scott R. Rudge, Demetri P. Petrides, Bioseparations Science and Engineering, 2nd Ed., Oxford University Press, 2003. 2. Pauline M. Doran, Bioprocess Engineering Principles, 2nd Ed., Academic Press, 2012

Gaps in the Syllabus (to meet Industry/Profession requirements)	Nil
POs met through Gaps in the Syllabus	Nil

Topics beyond syllabus/Advanced topics/Design	Nil
POs met through Topics beyond syllabus/Advanced topics/Design	Nil

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***% Distribution***				
	Lab Record	30%				
	Experiment Viva	20%				
	Quiz	10%				
	Semester End Examination	***% Distribution***				
	Performance	30%				
	Quiz	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	2	1	-
CO2	3	3	3	2	1	-
CO3	3	3	3	2	-	-
CO4	3	3	3	2	2	2
No mapping = -, < 34% = 1, 34-66% = 2, > 66% = 3						

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1. CD3, CD7
CO2	CD1, CD3, CD7
CO3	CD1, CD3, CD7
CO4	CD1, CD5

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Ramesh Chandra

COURSE INFORMATION

Course code	BE26505
Course title	Modern Methods of Instrumentation
Pre-requisite(s)	Nil
Co-requisite	Nil
Credits	3
Class schedule per week	L: 3 T: 0 P: 0
Class	M. Tech
Semester / Level	1/5
Branch	Biotechnology
Name of Teacher	Dr. Manish Kumar

Course Objectives

This course aims to provide students with:

Sl. No.	Objectives
1	An ability to demonstrate the basic science as well biotechnology knowledge of biotech industry in multidisciplinary teams and independently.
2	Develop the skills to understand the theory and practice of bioanalytical techniques
3	Scientific understanding of analytical techniques and detail interpretation of results.
4	A master degree in this field prepares a student for careers in biotech research in different domains including industry.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

COs	Course Outcomes
CO1	able to use selected analytical techniques. Familiarity with working principals, tools and techniques of analytical techniques
CO2	understand the strengths, limitations and creative use of techniques for problem solving.
CO3	develop expertise, an understanding of the range and theories of instrumental methods available in biological research/ biotechnology.
CO4	to design bioanalytical techniques for quality control and product development, etc

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	Chromatographic Techniques-I	(a) Introduction to chromatography; General principles, column chromatography – columns, stationary phases. Partition and adsorption chromatography. (b) Affinity Chromatography; Principle, materials – matrix, selection of attachment of ligands, practical procedures, specific and non-specific elution, applications. (c) Ion Exchange Chromatography: Principle, types of exchangers, materials, choice of exchangers and buffers and applications.	**8**
2	Chromatographic Techniques-II	(a) Gas Chromatography: Principle of GC system, solid support, capillary column, stationary phase, preparation and application of sample, separation conditions, detection systems and applications. (b) HPLC: Principle, components of HPLC system, pumping systems, detectors systems, and its applications; UPLC, determination of protein sequence and mass with LCMS/MS and applications of MS in the analysis of drugs and macromolecules.: a case study.	**8**
3	Atomic spectrometry	Atomic absorption, X-ray fluorescence methods Flame atomic emission and absorption, flame emission photometer, flame absorption spectrometer, spectral interferences, quantitative aspects, ICP, X-ray fluorescence principle, Instrumentation, quantitative analysis.	**8**
4	Electrophoresis	Gel electrophoresis; Types of gels, principle, apparatus and methods, gradient gels, Twodimensional gels, isoelectric focusing, determination of molecular weight using electrophoresis, Case study.	**8**
5	Analytical and Imaging Instruments	Principle, instrumentation and application of FACS, FRET, cell on a chip, Thermogravimetry, fluorescence life time imaging (FLIM), Two photon and multiphoton microscopy.	**8**

Learning Resources	
Text Books	***Reference Books***

1. Skoog, D.A., Crouch, S.R., and Holler, F.J. "Principles of Instrumental Analysis", 6th edition, Brooks/Cole, USA, 2006. 2. Williams, D. and Fleming, I. "Spectroscopic Methods in Organic Chemistry", 6th edition, McGraw-Hill Higher Education, Maidenhead,UK, 2008. 3. Freifelder D., Willard and Merrit, Instrumental Methods and Analysis 4. Ewing GW, Instrumental Methods of Chemical analysis.	

Gaps in the Syllabus (to meet Industry/Profession requirements)	Students will be demonstrated on instruments with real samples, so that they can use the instruments.
Pos met through Gaps in the Syllabus	Nil
Topics beyond syllabus/Advanced topics/Design	Nil
Pos met through Topics beyond syllabus/Advanced topics/Design	Nil

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Y	Y	Y	Y	
	Semester End Examination	Y	Y	Y	Y	Y

Indirect Assessment	Student Feedback on Course Outcome

Mapping Between Course Outcomes and Program Outcomes						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	1	3	-	-
CO2	3	-	1	3	-	1
CO3	3	1	2	3	2	1
CO4	3	2	2	3	2	2

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1,CD6
CO2	CD1, CD6
CO3	CD1, CD2, CD3,CD6
CO4	CD1, CD3,CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Manish Kumar

COURSE INFORMATION

Course code	BE26506
Course title	IPR, Biosafety and Technical Writing in Biotechnology
Pre-requisite(s)	NA
Co-requisite	NA
Credits	2
Class schedule per week	L: 0 T: 1 P:2
Class	MTech
Semester / Level	I/5
Branch	Biotechnology
Name of Teacher	Dr. Hare Ram Singh

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To introduce students to Intellectual Property Rights (IPR) and biosafety regulations relevant to biological sciences.
2	To develop scientific and technical writing skills for academic and professional communication.
3	To enhance oral presentation and scientific dissemination skills.
4	To prepare students for research, industry, entrepreneurship, and higher studies.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO 1	Understand various forms of IPR and their significance in biotechnology.
CO 2	Apply biosafety and bioethical principles in laboratory and research environments.
CO 3	Prepare scientific reports, technical documents, and research summaries.
CO 4	Demonstrate professional communication skills in academic and industrial settings.

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	Introduction to IPR:	Introduction to Intellectual Property Rights, Types of IPR, Patents, Copyrights, Trademarks, Trade Secrets and Geographical Indications, Importance of IPR in Biotechnology, Patentable and Non-Patentable Inventions. Agreements and Treaties, Indian patent act 1970 & recent amendments.	6
2	Basics of Patent and Concept of Prior Art:	Type of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete. Basics of Patent Filing procedure, Biotechnology Patents: Case Studies	6
3	Biosafety and Regulatory Framework:	Principles of Biosafety, Laboratory Biosafety Levels (BSL-1 to BSL-4), Good Laboratory Practices (GLP), Recombinant DNA Safety Guidelines	5
4	Technical Writing and Structured Documentation:	Drafting reports, research papers, thesis, understanding document structure and referencing styles (APA/IEEE basics) and tools. Formatting text, equations, tables figures, Bibliography and Citation. Avoiding Plagiarism and using AI writing assistants ethically.	5
5	Effective Presentation and Professional Communication Skills:	Slide design (Clarity, Visuals, minimal text), Structuring a presentation, data visualization, presentation tools (PPT, Google slide/Slides/Canva), Poster Design. Voice modulation, Body language, Handling Q&A session.	5

Learning Resources

Text Books	***Reference Books***
Deepa Goel. *IPR, Biosafety and Bioethics*	Sateesh, M.K. *Bioethics and Biosafety*.
Day, R.A. & Gastel, B. *How to Write and Publish a Scientific Paper*.	WIPO Training Materials on Intellectual Property.
Alley, M. *The Craft of Scientific Presentations*.	COPE Guidelines on Publication Ethics.

Ganguli, P. *Intellectual Property Rights: Unleashing the Knowledge Economy*.	DBT Biosafety Guidelines, Government of India.
WHO. *Laboratory Biosafety Manual*.	
Gaps in the Syllabus (to meet Industry/Profession requirements)	Nil
Pos met through Gaps in the Syllabus	NA
Topics beyond syllabus/Advanced topics/Design	Nil
Pos met through Topics beyond syllabus/Advanced topics/Design	NA

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	100%				
	Continuous Internal Assessment	***% Distribution***				
	Best 3 Quiz marks out of 4 Quizzes of 20 marks each.	60%				
	Assignment(s)	20%				
	Seminar before a Committee	20%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
Indirect Assessment						

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Hare Ram Singh

COURSE INFORMATION

Course code	BE26507
Course title	Modern Bioinformatics & Artificial Intelligence
Pre-requisite(s)	B.E. /B. Tech./M.Sc. in Biotechnology/Life Sciences
Co-requisite	None
Credits	3
Class schedule per week	L: 2 T: 1 P: 0
Class	M. Tech.
Semester / Level	I/05
Branch	Biotechnology
Name of Teacher	Dr. Alok Jain

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1.	Introduce fundamental concepts and methodologies in modern bioinformatics and artificial intelligence.
2.	Develop competency in the analysis and interpretation of biological data using computational approaches.
3.	Provide knowledge of machine learning techniques and their applications in life sciences.
4.	Familiarize students with AI-driven approaches for structural biology and drug discovery.
5.	Expose students to emerging applications of bioinformatics and artificial intelligence in biotechnology and biomedical research.
1.	Introduce fundamental concepts and methodologies in modern bioinformatics and artificial intelligence.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Explain the principles and applications of bioinformatics and artificial intelligence in biological research.
CO2	Apply computational and machine learning approaches to analyze biological data and solve domain-specific problems.
CO3	Analyze biological sequences, structures, and large-scale datasets using appropriate bioinformatics and AI methodologies.
CO4	Evaluate the effectiveness and limitations of computational strategies for biotechnology and biomedical applications.
CO5	Critically assess emerging developments in bioinformatics and artificial intelligence and formulate solutions for complex biological problems.

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1.	Biological Databases and Sequence Analysis	Introduction to biological databases. Sequence alignment fundamentals, pairwise sequence alignment using Needleman–Wunsch and Smith–Waterman algorithms, scoring matrices (PAM and BLOSUM), sequence similarity searching using BLAST.	8
2.	Multiple Sequence Analysis and Evolutionary Bioinformatics	Multiple Sequence Alignment methods and tools, phylogenetic tree construction and interpretation, distance-based and character-based phylogenetic methods, and applications of evolutionary analysis in biological research.	8
3.	Fundamentals of Artificial Intelligence and Machine Learning	Introduction to Artificial Intelligence in biology and medicine. Fundamentals of machine learning, supervised and unsupervised learning, feature engineering and data preprocessing, regression and classification algorithms including Linear Regression, Decision Trees, Random Forests, Support Vector Machines. Model evaluation and validation techniques, cross-validation, performance metrics, basics of Artificial Neural Networks, Deep Learning architectures.	8
4.	Structural Bioinformatics and AI-Driven Protein Modeling	Protein structure hierarchy and classification, protein structure prediction approaches including homology modeling, threading, and ab initio methods. AI-driven protein structure prediction using AlphaFold, protein structure validation,	8

		molecular docking and virtual screening techniques.	
5.	Advanced Applications of AI in Bioinformatics and Biotechnology	Applications of Artificial Intelligence and Bioinformatics in biotechnology and biomedical research: omics and multi-omics data analysis, AI-driven drug discovery and development, ADMET prediction, protein engineering, precision medicine and critical analysis of recent research articles in Bioinformatics and Artificial Intelligence.	8

Learning Resources	
Text Books	***Reference Books***
Mount, D.W., Bioinformatics: Sequence and Genome Analysis, 2nd Edition, Cold Spring Harbor Laboratory Press.	Xiong, J., Essential Bioinformatics, Cambridge University Press.
Pevsner, J., Bioinformatics and Functional Genomics, 4th Edition, Wiley-Blackwell.	Baxevanis, A.D. and Ouellette, B.F.F., Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Wiley.
Lesk, A.M., Introduction to Bioinformatics, 6th Edition, Oxford University Press.	Alpaydin, E., Introduction to Machine Learning, MIT Press.
	Goodfellow, I., Bengio, Y., and Courville, A., Deep Learning, MIT Press.
	Charu C. Aggarwal, Neural Networks and Deep Learning, Springer.
	Goh, G.B., Hodas, N.O., and Vishnu, A. (Eds.), Deep Learning for the Life Sciences, O'Reilly Media.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Nil
Pos met through Gaps in the Syllabus	Nil
Topics beyond syllabus/Advanced topics/Design	Nil
Pos met through Topics beyond syllabus/Advanced topics/Design	Nil

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	1	-	-
CO2	3	2	3	2	-	-
CO3	3	2	3	2	-	1
CO4	3	2	3	3	1	1
CO5	3	3	3	3	2	2

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD4
CO5	CD2, CD4, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Alok Jain

COURSE INFORMATION

Course code	BE26509
Course title	Bioprocess Plant Design
Pre-requisite(s)	Nil
Co-requisite	Nil
Credits	03
Class schedule per week	L:3 T:0 P:0
Class	M. Tech
Semester / Level	II/05
Branch	Biotechnology
Name of Teacher	Dr. Koel Mukherjee

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1.	Imparts advanced knowledge on bioreactor design for efficient utilization of the principles in bioprocess technology
2.	Acquire knowledge about materials of construction for bioprocess plants & mechanical design of process equipment and its economy
3.	Get details of instrumentation and control of bioprocesses
4.	Design of facilities for cleaning of process equipment

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Have basic concepts of bioreactor design.
CO2	Detail out about materials used for construction of bioprocess plant reactors
CO3	Design of vessels for biotechnology application
CO4	Calculate and analyse process economics

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	Generalized Bioprocess & Design	Generalized bioprocess plants and their design view, process flow sheeting, review of mass and energy balance, Use of AI in process design and simulation packages.	8
2	Piping & Instrumentation Diagram	Basic concepts of piping and instrumentation in bioprocessing; materials of construction; overview of piping systems including size, layout, valves, and fittings; fundamentals of mechanical design of process equipment.	8
3	Design of Vessels for Biotechnology Application	Design of Upstream and Down Stream process equipments; design considerations for maintaining sterility of process streams processing equipment; Selection and basic concepts of design of heat exchangers used in bioprocess industries.	8
4	Hazards and Safety	Design of facilities for cleaning of process equipment used in biochemical industries; Plant safety , procedures to overcome hazards from safety point of views.	8
5	Process Economics	Capital Cost Analysis, environmental protection and environmental impact analysis using AI.	8

Learning Resources

Text Books	*Reference Books*
1. Plant Design and Economics for Chemical Engineers, M. Peters and K. Timmerhaus, McGraw-Hill. 2. Applied Process Design for Chemical and Petrochemical Plants, E.E. Ludwig, Butterworth-Heinemann. 3. Paulin Doran, Bioprocess Engineering Principles. Ed 2, 2013, Elsevier ***4.*** Fundamentals of Chemical Engineering, BezerBencho	1. Chemical Engineering, R.K. Sinnott, J.M. Coulson and J.F. Richardsons, Butterworth Heinemann 2. Chemical Engineers Handbook, R.H. Perry and D.W. Green, McGraw-Hill 3. Manufacturing Facilities Design and Material Handling, F.E. Meyers and M.P. Stephens, Prentice Hall 4. Process Plant Layout and Piping Design, E. Bausbacher and R. Hunt, Prentice Hall PTR.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Nil
Pos met through Gaps in the Syllabus	Nil
Topics beyond syllabus/Advanced topics/Design	Nil
Pos met through Topics beyond syllabus/Advanced topics/Design	Nil

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					
Indirect Assessment						

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	3	-	1	1
CO2	1	1	3	1	-	1
CO3	2	1	3	1	-	1
CO4	1	1	1	1	1	-

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4, CD6
CO4	CD2, CD3, CD6, CD7

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Koel Mukherjee Dr. Muthu Kumar Sampath

COURSE INFORMATION

Course code	**BE26510**
Course title	**Advanced Bioseparation Engineering Lab**
Pre-requisite(s)	**BE507 Advanced Bioseparation Engineering**
Co-requisite	**Nil**
Credits	**1.5**
Class schedule per week	**L: 0 T: 0 P: 3**
Class	**M Tech**
Semester / Level	**II/05**
Branch	**Biotechnology**
Name of Teacher	**Dr. Vinod Kumar Nigam**

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1.	To Understand the basic principles in Downstream process
2.	To decide the most suitable chromatography method for protein purification
3.	To separate a protein, pigments from a mixture and their analysis
4.	To apply their knowledge to make dry powder of a given product

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Extract intra-cellular materials and separate biomolecules from production medium
CO2	Isolate a biomolecule by adsorption/ precipitation and extraction method
CO3	Purify a protein using different chromatography techniques
CO4	Separate molecule by membrane-based filtration
CO5	Perform drying of a biomolecule

Syllabus

Name of Experiments	*Detailed Contents*
Experiment-1	To study the drying kinetics of tomato.
Experiment-2	Isolation of lycopene from tomato.
Experiment-3	Screening and selection of media for lipase production from a given bacteria
Experiment-4	Precipitation of protein using ammonium sulphate salt.
Experiment-5	Quantitative estimation of protein by Bradford reagent.
Experiment-6	Bacterial cell lysis by sonication.
Experiment-7	Purification of protein by gel filtration chromatography.
Experiment-8	Separation and identification of protein in SDS-PAGE.
Experiment-9	Isolation of pigment from plant leaf using different solvents.
Experiment-10	Identification of different pigments separated by TLC.

Learning Resources	
Text Books	***Reference Books***
1. *Shuler and Kargi, Bioprocess Engineering – Basic Concepts. Prentice Hall PTR, 2002* 2. *Doran, Bioprocess Engineering Principles, Academic Press, 1995*	1. *Bailey and Ollis, Biochemical Engineering Fundamentals, 1986* 2. *Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2001.* 3. *Roger Harrison et al., Bioseparations Science and Engineering, Oxford University Press, 2003*

Gaps in the Syllabus (to meet Industry/Profession requirements)	**Yes**

POs met through Gaps in the Syllabus	**Nil**
Topics beyond syllabus/Advanced topics/Design	**Nil**
POs met through Topics beyond syllabus/Advanced topics/Design	**Nil**

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***% Distribution***				
	Record of experiments	30%				
	Lab Quiz	10%				
	Viva for experiment perfomed	20%				
	Semester End Examination	***% Distribution***				
	Lab experimental performance	30%				
	Quiz	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	-	3	2
CO2	3	-	1	3	-	2
CO3	3	1	2	1	2	2
CO4	3	2	2	2	2	3
CO5	3	-	2	1	-	-

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD5,CD6
CO4	CD1,CD2,CD5,CD6
CO5	CD1,CD2,CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Vinod Kumar Nigam

COURSE INFORMATION

Course code	BE26511
Course title	Nanobiotechnology and Advanced Biomaterials
Pre-requisite(s)	Nil
Co-requisite	Nil
Credits	03
Class schedule per week	L: 03 T:0 P: 0
Class	M.Tech.
Semester / Level	II/05
Branch	Biotechnology
Name of Teacher	Dr. Sneha Singh

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	Understand the fundamental principles of nanobiotechnology, including synthesis, properties, characterization, and biological interactions of nanomaterials.
2	Acquire knowledge of advanced biomaterials, their design considerations, functional properties, and biomedical applications.
3	Analyze the applications of nanomaterials and biomaterials in drug delivery, diagnostics, biosensing, and nanomedicine, and healthcare systems.
4	Evaluate the safety, ethical, regulatory, and emerging AI-assisted aspects of nanobiotechnology and biomaterials for responsible innovation and healthcare applications.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Explain the synthesis, characterization, properties, and biological interactions of nanomaterials relevant to biotechnology.
CO2	Evaluate advanced biomaterials based on their physicochemical properties, functionality, and suitability for biomedical applications.
CO3	Analyze nanotechnology-enabled systems for drug delivery, diagnostics, biosensing, and other healthcare applications.

CO4	Assess nanomaterials and biomaterials with respect to nanotoxicity, biosafety, ethical and regulatory considerations, and emerging AI-assisted approaches in biomaterials and nanobiotechnology.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	**Fundamentals of Nanobiotechnology**	Introduction to nanobiotechnology, Nanoscale phenomena and unique properties Classification of nanomaterials, Metallic nanoparticles, Dendrimers, Quantum dots, Carbon nanotubes; Nanofabrication approaches	08
2	**Characterization of Nanomaterials and Biomaterials**	UV-Visible spectroscopy, Dynamic Light Scattering (DLS), Electron microscopy (SEM, TEM) Atomic Force Microscopy (AFM), Surface charge and zeta potential, Mechanical and surface characterization of biomaterials, Material performance assessment	08
3	**Advanced Biomaterials and Functional Materials**	Classification of advanced biomaterials, Bioactive and smart biomaterials, Surface engineering and functionalization, Stimuli-responsive biomaterials, Biomaterials fabrication	08
4	**Nanomedicine, Drug Delivery and Biosensing**	Principles of nanomedicine, Drug delivery systems, Nanocarriers, Biosensors & Nanobiosensors, Cancer Nanotechnology, Theranostics, Bioimaging	08
5	**Responsible Nanobiotechnology and Emerging Trends**	Nanotoxicology and toxicity mechanisms, Biological and environmental impacts of nanomaterials, Risk assessment and biosafety, Ethical, legal and regulatory aspects of nanobiotechnology and biomaterials. AI in Nanobiotechnology and Biomaterials: Introduction to AI and machine learning, AI-assisted design of nanomaterials and biomaterials, AI applications in drug delivery, nanomedicine and nano-bio interactions	08

Learning Resources	
Text Books	***Reference Books***
1. Ratner, B.D., Hoffman, A.S., Schoen, F.J., and Lemons, J.E. (Eds.), Biomaterials Science: An Introduction to Materials in Medicine, 4th Edition, Elsevier Academic Press, 2020. 2. Niemeyer, C.M. and Mirkin, C.A. (Eds.), Nanobiotechnology: Concepts, Applications and Perspectives, Wiley-VCH, 2004. 3. de Villiers, M.M., Aramwit, P., and Kwon, G.S. (Eds.), Nanotechnology in Drug Delivery, Springer, 2008.	1. Bhushan, B. (Ed.), Springer Handbook of Nanotechnology, 4th Edition, Springer, 2017. 2. Fadeel, B., Pietroiusti, A., and Shvedova, A.A. (Eds.), Adverse Effects of Engineered Nanomaterials: Exposure, Toxicology, and Impact on Human Health, 2nd Edition, Academic Press, 2017. 3. Bhatia, S.K. (2016). Biomaterials for Clinical Applications. Springer. ISBN: 978-1493933075. 4. Recent review articles from *ACS Nano*, *Nature Nanotechnology*, *Nano Today*, *Biomaterials*, *Acta Biomaterialia*, and *Journal of Nanobiotechnology* on AI-assisted nanomaterial and biomaterial design.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Nil
Pos met through Gaps in the Syllabus	NA
Topics beyond syllabus/Advanced topics/Design	NA
Pos met through Topics beyond syllabus/Advanced topics/Design	NA

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	3	2	-	-
CO2	2	1	3	2	1	1
CO3	3	2	3	2	1	2
CO4	2	1	2	3	3	1

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4, CD5, CD6
CO4	CD1, CD2, CD5, CD7

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Sneha Singh

COURSE INFORMATION

Course code	BE26512
Course title	Professional Ethics and Entrepreneurial Skills
Pre-requisite(s)	NA
Co-requisite	NA
Credits	2
Class schedule per week	L: 0 T: 1 P:2
Class	MTech
Semester / Level	II/5
Branch	Biotechnology
Name of Teacher	Dr. Rakesh Kumar Sinha

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To introduce students to professional ethics relevant to biological sciences related industries,
2	To develop professional competence for legal compliance and quality assurance,
3	To develop intrapreneurial and entrepreneurial mindset.
4	To prepare students for research, industry, and entrepreneurship.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO 1	Practice professional ethics relevant to biological sciences and industry.
CO 2	Develop professional competence for legal compliance and quality assurance,
CO 3	Develop entrepreneurial mindset.
CO 4	Plan and execute research, industry, and entrepreneurship.

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	Professional Ethics	Professional Ethics, Developing Professional Competence, Legal Compliance and Quality Assurance,	3
2	Entrepreneurial mindset	Entrepreneurial mindset and innovation, Opportunity identification and problem selection, Creativity, idea generation, and design thinking, Customer understanding and market validation, Business model and value proposition,	3
3	Entrepreneurial Skills	From research/technology to product development, Startup ecosystem, IPR, funding, and support systems, Teamwork, communication, and pitching,	3
4	Production Systems and Supply Chain Management	Procurement process, product development, pricing and branding, sell of the product, role of negotiation, warehousing and middleman, attributes of local and global market for entrepreneurs, role of AI in production,	3
5	Case Study	Case Studies on Holistic Technologies, Management Models and Production Systems, AI opportunities in entrepreunership.	3

Learning Resources	
Text Books	Reference Books
1. Dynamics of Entrepreneurial development & management; Vasant Desai, Himalay. Publications. 2. Entrepreneurship reflection & investigation; M.S. Bisht & R.C. Mishra, Chugh Publication. 3. Entrepreneurship development in India; Samiuddin, Mittal Publication.	1. Innovation, Product Development and Commercialization: Case Studies and Key Practices for Market. 2. Science Business: The Promise, the Reality, and the Future of Biotech by Gary P. Pisano Harvard Business School Press: 2006. 3. Design and Marketing of New Products by Urban and Hauser, ISBN 0-13-201567-6. 4. Putting Biotechnology to Work: Bioprocess Engineering (1992) Commission on Life Sciences, The National Academy Press.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Types of organization, recruitment process, training and development of skills for entrepreneurs, fund raising techniques
POs met through Gaps in the Syllabus	PO5
Topics beyond syllabus/Advanced topics/Design	Biotech lab management and ethical practices
POs met through Topics beyond syllabus/Advanced topics/Design	PO5

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	100%				
	Continuous Internal Assessment	***% Distribution***				
	Best 3 Quiz marks out of 4 Quizzes of 20 marks each.	60%				
	Assignment(s)	20%				
	Seminar before a Committee	20%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
Indirect Assessment						

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD5
CO2	CD1, CD2, CD3, CD5
CO3	CD3, CD5
CO4	CD3, CD5

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Rakesh Kumar Sinha

COURSE INFORMATION

Course code	BE26513
Course title	BIOPHYSICS
Pre-requisite(s)	NA
Co-requisite	NA
Credits	3
Class schedule per week	L: 3 T:0 P:0
Class	MTech
Semester / Level	II/04
Branch	Biotechnology
Name of Teacher	Dr. Raju Poddar

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1:	Apply fundamental principles of biophysics, including intermolecular forces, diffusion, Brownian motion, molecular dynamics, and force-field concepts to understand biological systems.
2:	Analyze the principles, instrumentation, and applications of advanced spectroscopic and analytical techniques such as ultracentrifugation, IR, Raman, fluorescence spectroscopy (FRET), NMR, and mass spectrometry for biological investigations.
3:	Evaluate structural and functional characteristics of biomolecules and cells using modern imaging and characterization techniques, including X-ray crystallography, electron microscopy, AFM, confocal microscopy, flow cytometry, tomography, and optical tweezers.
4:	Explain membrane biophysics, electrostatic interactions, electrochemical potentials, transmembrane signaling, and Bio-MEMS technologies for studying biological and biomedical systems.
5:	Interpret electrophysiological and neurobiophysical phenomena, apply principles of ECG, EEG, voltage-clamp and patch-clamp techniques, and assess the role of radioisotopes and nuclear medicine in biotechnology and healthcare applications.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
1	Apply principles of mathematics, physics, chemistry, and biology to explain molecular interactions, diffusion processes, molecular dynamics, and other biophysical phenomena in living systems.
2	Design and perform biophysical experiments, analyze and interpret experimental data, and evaluate biological processes using quantitative and computational approaches.
3	Apply the principles, instrumentation, advantages, limitations, and operational aspects of advanced spectroscopic, diffraction, and bioimaging techniques for characterization of biomolecules and biological systems.
4	Analyze membrane biophysics, electrochemical interactions, Bio-MEMS, electrophysiological processes, neurobiophysics, and nuclear medicine for understanding biological function and biomedical applications.
5	Identify and solve multidisciplinary problems related to biological systems and biomaterial interfaces, work effectively in research teams, and apply biophysical knowledge in academic, healthcare, pharmaceutical, and biotechnology sectors.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
I	**Fundamentals of Biophysics**	Intermolecular interactions and Van der Waals forces; Diffusion and Brownian motion; Diffusion equation and steady-state two-dimensional diffusion; Introduction to molecular dynamics simulations; Force-fields and their applications in biological systems.	**8**
II	**Hydrodynamics and Biomolecular Spectroscopy**	Principles of hydrodynamics and ultracentrifugation; Instrumentation, design, and applications of ultracentrifuges; IR and vibrational spectroscopy; Raman spectroscopy; Fluorescence spectroscopy and Förster Resonance Energy Transfer (FRET); Nuclear Magnetic Resonance (NMR) spectroscopy; Mass spectrometry and biological applications.	**8**
III	**Diffraction Techniques and Bioimaging**	Principles of X-ray crystallography and crystal structure determination; Atomic Force Microscopy (AFM); Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM); Confocal microscopy; Flow cytometry and Fluorescence-Activated Cell Sorting (FACS); Tomographic imaging techniques; Optical tweezers and optical trapping for biomolecular manipulation.	**9**
IV	**Electrostatic Interactions and Membrane Biophysics**	Electrostatic interactions in biological systems; Poisson–Boltzmann equation and its solutions; Helix-coil transition and biomolecular self-assembly; Membrane potential and cellular functions; Zeta, Stern, and total electrochemical potentials; Helmholtz–Smoluchowski equation; Measurement of transmembrane potential using microelectrodes; Bio-MEMS: design, fabrication, and biomedical applications.	**9**
V	**Electrophysiology, Neurobiophysics and Nuclear Medicine**	Action potential generation and propagation; Voltage-clamp and patch-clamp techniques; Principles, instrumentation, and signal analysis of Electrocardiography (ECG); Electroencephalography (EEG); Fundamentals of neurobiophysics; Principles of nuclear medicine; Diagnostic and therapeutic applications of radioisotopes; In vivo and in vitro nuclear medicine procedures.	**8**

Learning Resources	
Text Books	***Reference Books***
1. Rodney Cotterill, Biophysics: An Introduction, John Wiley & Sons. 2. Roland Glaser, Biophysics, Springer. 3. David Freifelder, Physical Biochemistry: Applications to Biochemistry and Molecular Biology, W.H. Freeman.	1. Philip Nelson, Biological Physics: Energy, Information, Life, W.H. Freeman. 2. Joseph R. Lakowicz, Principles of Fluorescence Spectroscopy, Springer. 3. John M. Walker (Ed.), Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Computational biophysics and molecular dynamics simulation using modern software tools (e.g., GROMACS, NAMD). AI-assisted biomedical image analysis and quantitative bioimaging.
Pos met through Gaps in the Syllabus	PO2, PO4
Topics beyond syllabus/Advanced topics/Design	Design and simulation of Bio-MEMS devices for biomedical diagnostics and healthcare applications. Computational analysis of electrophysiological signals (ECG, EEG, EMG) using advanced software tools. Case studies on molecular imaging, theranostics, precision medicine, and nuclear medicine applications.
Pos met through Topics beyond syllabus/Advanced topics/Design	PO3, PO4 PO5, PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	1	-	-
CO2	3	2	2	3	-	1
CO3	2	1	3	3	-	-
CO4	2	1	3	2	1	-
CO5	3	2	2	2	3	3

Correlation Scale: 3 = High, 2 = Moderate, 1 = Low, – = No Correlation

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD6
CO2	CD1, CD3, CD6
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD6, CD7
CO5	CD1, CD2

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Raju Poddar

COURSE INFORMATION

Course code	BE26514
Course title	Bioprocess Plant Design Lab
Pre-requisite(s)	Nil
Co-requisite	BE26509 Bioprocess Plant Design
Credits	1.5
Class schedule per week	L:0 T:0 P:3
Class	M. Tech
Semester / Level	II/05
Branch	Biotechnology
Name of Teacher	Dr. Muthu Kumar Sampath

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1.	Imparts advanced knowledge on bioreactor design for efficient utilization of the principles in bioprocess technology
2.	Acquire knowledge about materials of construction for bioprocess plants & mechanical design of process equipment and its economy
3.	Get details of instrumentation and control of bioprocesses
4.	Design of facilities for cleaning of process equipment

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Have basic concepts of bioreactor design.
CO2	Detail out about materials used for construction of bioprocess plant reactors
CO3	Design of vessels for biotechnology application
CO4	Calculate and analyse process economics

Syllabus

List of Experiments

Experiment-1 Familiarization of software-based process design.

Experiment-2 To design a complete flow diagram based on software of different bioprocesses with given inputs.

Experiment-3 Drafting project budgets, estimating capital/operating costs, and evaluating process flow sheets to maximize cost-effectiveness.

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***% Distribution***				
	Quiz	10%				
	Day to Day performance and lab files	30%				
	Viva	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	1. Student Feedback on Faculty 2. Student Feedback on Course Outcome

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	3	-	1	1
CO2	1	1	3	1	-	1
CO3	2	1	3	1	-	1
CO4	1	1	1	1	1	-

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4, CD6
CO4	CD2, CD3, CD6, CD7

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Muthu Kumar Sampath

COURSE INFORMATION

Course code	BE26515
Course title	Advanced Bioseparation Engineering
Pre-requisite(s)	BE26503 Advanced Bioprocess Engineering BE26507 Modern Methods of Instrumentation
Co-requisite	Nil
Credits	3
Class schedule per week	L: 3 T: 0 P: 0
Class	M Tech
Semester / Level	II/05
Branch	Biotechnology
Name of Teacher	Dr. Vinod Kumar Nigam

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1.	To understand the fundamental principles and key operations of downstream bioprocessing
2.	To compare and select suitable chromatography methods for protein purification
3.	To isolate and purify a target protein from the biological mixtures using suitable separation methods
4.	To apply their knowledge to make crystals or dry powder of a biomolecules for storage and formulation

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Explain the principles, objectives, and major unit operations involved in downstream bioprocessing
CO2	Analyse the properties of biomolecules and select appropriate chromatography techniques for their purification
CO3	Perform protein separation and purification from complex biological mixtures using suitable downstream processing methods
CO4	Evaluate and optimize purification processes to achieve desired product quality and yield
CO5	Apply crystallization, drying, and formulation techniques to obtain purified biomolecules in stable crystalline or powdered forms

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	Removal of Insoluble Materials	An overview of Recovery processes, Removal of microbial cells and other solid matters from fermentation broth, Coagulation and Flocculation. Cell disruption techniques: Mechanical and non-mechanical methods, Filtration and Centrifugation	8
2	Isolation of Biomolecules	Protein precipitation and separation; Aqueous-two-phase extraction; Supercritical extraction, Reverse micelles extraction; Adsorption-desorption process: isotherms	8
3	Chromatographic Techniques	Principles and practice of liquid chromatography, gradient elution chromatography, ion- exchange chromatography, size exclusion chromatography, reversed phase chromatography, hydrophobic interaction chromatography, affinity chromatography; HPLC	8
4	Membrane Separation	Membrane materials and organization; Filter modules; Micro filtration, Ultra filtration; Reverse Osmosis, Electrodialysis, Advance membrane-based separation process, e.g. Pervaporation, membrane bioreactor	8
5	Crystallization and Drying	Crystallization: properties of a crystal, crystal growth and purity; Drying: different moisture content, drying kinetics, relative humidity, and Industrial driers	8

Learning Resources	
Text Books	**Reference Books**
1. *Nooralabettu Krishna Prasad, Downstream Process Technology, 1st Ed., Phi learning Pvt. Ltd, New Delhi, 2010* 2. *B. Sivasankar, Bioseparations: Principles and Techniques, 1st Ed., Prentice Hall, 2005* 3. *Michael L. Shuler, Fikret Kargi, Bioprocess Engineering – Basic Concepts, 2nd Ed.,*	1. *Paul A. Belter, E. L. Cussler Wei-Shou Hu, Bioseparations: Downstream Processing for Biotechnology, Wiley India, Pvt Ltd., 1st Ed., 2011* 2. *James Bailey, David Ollis, Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill Education, 2017*

Gaps in the Syllabus (to meet Industry/Profession requirements)	**Purification of non-protein bio molecules**
POs met through Gaps in the Syllabus	**PO3**
Topics beyond syllabus/Advanced topics/Design	**Advance chromatographic separation processes**
POs met through Topics beyond syllabus/Advanced topics/Design	**PO3**

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal	1	2			5

	Assessment					
	Semester End Examination	1	2	3	4	5

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	-	3	2
CO2	3	-	1	3	-	2
CO3	3	1	2	1	2	2
CO4	3	2	2	2	2	3
CO5	3	-	2	1	-	-

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1,CD2,CD6
CO2	CD1,CD2, CD6
CO3	CD1, CD2,CD5,CD6
CO4	CD1,CD2,CD5,CD6, CD7
CO5	CD1,CD2,CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Vinod Kumar Nigam

COURSE INFORMATION

Course code	BE 26517
Course title	Environmental Biotechnology
Pre-requisite(s)	Nil
Co-requisite	Nil
Credits	03
Class schedule per week	L:3 T: 0 P:0
Class	MTech
Semester / Level	I/ 5th
Branch	Biotechnology
Name of Teacher	Dr. Shashwati Ghosh Sachan

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	Details of the factors responsible for environmental pollution
2	Solutions for environmental problems and understand legal aspects related with environmental issues and protection
3	Selection of appropriate methods for the treatment of solid wastes and wastewater
4	Suitable bioremediation methods for the waste management
5	Exposure to significance of biofuels and organic farming

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Details of the factors responsible for environmental pollution and monitoring techniques
CO2	Apply appropriate techniques for management of different types of solid wastes
CO3	Determine the different secondary wastewater and sludge treatment processes and explain the role of AI for improved efficiency
CO4	Design techniques for bioremediation processes and evaluate the role of advanced technologies in environmental clean up
CO5	Identify and evaluate the importance of biofuels and organic farming

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
I	**Introduction**	Ecology, Natural resources, Environmental Protection Acts and Legislations, Biodiversity and its conservation strategies, Environmental Planning for sustainable development, Environmental monitoring & sampling	8
II	**Solid Waste Management**	Solid waste-types and characteristics. Effects of solid waste generation on quality of air, water and public health; Technical approach for solid waste management; Disposal of organic and medical waste; Plastic and E-waste management, Hazardous waste management	9
III	**Wastewater and Sludge Management**	Wastewater analysis, Modes of biological methods for wastewater treatment, aerobic and anaerobic methods, activated sludge digestion process, AI-driven secondary wastewater treatment systems	7
IV	**Bioremediation**	*In-situ* & *Ex-situ*, Microbial degradation and its mechanism, Bioaugmentation, Biosorption, Bioleaching, Phytoremediation, GMOs in waste management, Nano-bioremediation, Biosensors in pollution monitoring, Role of AI in bioremediation of xenobiotics	8
V	**Sustainable Energy & Agriculture**	Biomass as a source of energy, Liquid and gaseous biofuels, Microbial fuel cell, Biofertilizers, Biopesticides, Bio-Composting, Vermiculture	8

Learning Resources

Text Books	***Reference Books***

1. Dash and Dash, Fundamentals of ecology, 3rd Ed., TMH Education, 2009	1. Odum, Fundamentals of Ecology, 5th Ed., Brooks/Cole, 2004
2. Scragg, A, H., Environmental Biotechnology (2nd Edition).: Oxford University Press. 2004	2. Environmental Biotechnology: Theory and Application, Second Edition Gareth M. Evans and Judith C. Furlong © 2011 John Wiley & Sons, Ltd. ISBN: 978-0-470-68418-4
	3. Metcalf and Reddy Inc et al, Wastewater Engineering: Treatment and Reuse, 4th Ed., McGrawHill Higher Education, 2002

Gaps in the Syllabus (to meet Industry/Profession requirements)	Nil
Pos met through Gaps in the Syllabus	NA
Topics beyond syllabus/Advanced topics/Design	Nil
Pos met through Topics beyond syllabus/Advanced topics/Design	NA

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal	✓	✓	✓	✓	✓

	Assessment					
	Semester End Examination	✓	✓	✓	✓	✓
Indirect Assessment						

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	3	2	2
CO2	2	2	3	3	3	3
CO3	2	2	3	3	3	3
CO4	2	2	3	3	3	3
CO5	2	2	3	3	3	3

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Shashwati Ghosh Sachan

COURSE INFORMATION

Course code	BE26519
Course title	Advance in Immunotechnology
Pre-requisite(s)	Nil
Co-requisite	NA
Credits	L:3 T:0 P: 0
Class schedule per week	3
Class	M.Tech
Semester / Level	I/5
Branch	Biotechnology
Name of Teacher	Dr. Shubha Rani Sharma

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	Master molecular techniques to design and produce monoclonal, humanized, and single-chain fragment (scFv) antibodies.
2	Evaluate design principles and clinical pipelines for advanced formulations like mRNA vaccines and CAR-T therapies.
3	Configure high-throughput diagnostic tools including multi-color flow cytometry, SPR biosensors, and multiplex assays.
4	Apply computational biology software to map epitopes and simulate antibody-antigen binding kinetics.
5	Analyze industrial scale-up parameters and regulatory pathways for producing clinical-grade biological drugs.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Deconstruct the complex genetic, cellular, and signaling pathways that regulate systemic immunity, antigen presentation, and receptor repertoire diversity
CO2	Formulate strategic engineering workflows to develop, modify, and optimize therapeutic monoclonal antibodies and drug conjugates.
CO3	Critically evaluate data generated from high-throughput immunological technologies, including multi-parameter flow cytometry and surface plasmon resonance.
CO4	Design next-generation vaccine platforms, cellular therapies, and checkpoint inhibition strategies to treat cancer, infectious diseases, and autoimmune disorders.
CO5	Apply immunoinformatics tools and systems biology frameworks to predict antigen epitopes and model systemic immune interactions.

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	Molecular & Cellular Immunology	Advanced concepts of antigen recognition, Major Histocompatibility Complex (MHC) interactions, and T-cell or B-cell receptor repertoires.	8
2	Antibody Engineering:	Production and development of monoclonal antibodies (mAbs), chimeric/humanized antibodies, single-chain variable fragments (scFvs), and phage display technology.	8
3	Immunotherapeutics & Vaccines:	Principles of active and passive immunization, recombinant vaccines, checkpoint inhibitors, and Chimeric Antigen Receptor (CAR) T-cell therapy.	8
4	Advanced Diagnostics & Instrumentation:	High-throughput assays including Surface Plasmon Resonance (SPR), Flow Cytometry, ELISPOT, and multiplex bead arrays.	8
5	Immunoinformatics & Systems Immunology:	In-silico prediction of T-cell and B-cell epitopes, molecular docking, and systems-level omics analyses of immune responses.	8

Learning Resources	
Text Books	***Reference Books***
1. **Janeway's Immunobiology** by Kenneth Murphy and Casey Weaver	1. **Cellular and Molecular Immunology** by Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai
2. **Kuby Immunology** by Jenni Punt, Sharon Stranford, Patricia Jones, and Judy Owen	2. **Advances in Immunology and Immuno-techniques** by Alok Das Mohapatra and Priyadarshi S. Sahu

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Nil***
Pos met through Gaps in the Syllabus	***NA***
Topics beyond syllabus/Advanced topics/Design	***Nil***
Pos met through Topics beyond syllabus/Advanced topics/Design	***NA***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	2	2	2	2
CO2	2	2	3	2	2	2
CO3	2	2	3	3	2	3
CO4	2	2	3	3	3	3
CO5	1	2	3	3	3	3

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4, CD5, CD6, CD7

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Shubha Rani Sharma

COURSE INFORMATION

Course code	BE26521
Course title	Protein Engineering
Pre-requisite(s)	Nil
Co-requisite	Nil
Credits	3
Class schedule per week	L: 3 T: 0 P:0
Class	M.Tech
Semester / Level	I/5
Branch	Biotechnology
Name of Teacher	Dr. D. M. Pandey

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	To understand about properties of protein, forces determining protein structure and folding pathways
2	To learn about various techniques used to determine the detailed and most accurate 3D structure and their related functionality
3	To impart knowledge about the protein denaturation and functionality of protein and their responses to varying conditions
4	To design and develop novel proteins using various recent approaches and to establish their industrial production

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
1	To know detailed characteristics of protein and mechanism of protein folding
2	Able to use various techniques for determining the most accurate 3D structure and interpreting its functionality for novel uses.
3	Able to gain knowledge about protein alterations and functionality of protein at diverse conditions
4	Able to engineer the novel proteins for industrial level production in different areas like therapeutics, health sectors etc.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	**Protein characteristics**	Physicochemical properties of proteins, forces determining the protein structure, mechanisms of protein folding, molten globule structure, protein folding, role of AI in determining protein characteristics	8
2	**Protein Structure**:	Diversity in protein structure, spectroscopic techniques for protein structure determination, absorption and fluorescence, circular dichroism, FT-IR, X-ray crystallography, NMR, role of AI in protein structure determination	8
3	**Protein Function:**	Need and importance of protein function determination, diversity of protein and their functionality, differential scanning calorimetry, protein denaturation and aggregation, protein functionality in cereals, legume and milk, role of AI in protein function determination	8
4	**Protein Modification:**	Need and importance of protein modification, role of interactions in protein modification, technological processes on nutritional value of food proteins, Role of AI in protein modification determination	8
5	**Protein Production:**	Need of candidate protein production, design of novel proteins, role of site directed mutagenesis fin protein production, learning from specifically engineered protein, strategies for industrial production of engineered proteins and their applications, role of AI in altering protein production	8

Learning Resources

Text Books	*Reference Books*
1. Introduction to Protein Structure. Carl, Branden and Tooze, John (Editors). Garland Publishing, New York. eBook Published in March 2012	1. Spectroscopy of Biological Systems. Clark, R. J. H and Hester, R. E. (Editors) John Wiley and Sons, New York.

DOIhttps://doi.org/10.1201/9781136969898 eBook ISBN9780429062094 2. Protein Engineering. Caroline Köhrer (Editor), Uttam L. RajBhandary (Editor), Springer Publisher, February 15, 2009, ISBN-10: 3540867244. 3. PROTEIN ENGINEERING Principles and Practice. Edited by JEFFREY L. CLELAND CHARLES S. CRAIK, Wiley-Liss Publisher. ISBN-10: 0471103543	Internet Archive: spectroscopyofbi0000unse; ISBN 10: 0471909785 2. Nakai, S. and Modler, H. W. Food Proteins: Properties and Characterization, VCH Publishers, New York. Publication date : December 17, 1996, ISBN-10: 0471186147

Gaps in the Syllabus (to meet Industry/Profession requirements)	Nil
Pos met through Gaps in the Syllabus	Nil
Topics beyond syllabus/Advanced topics/Design	Nil
Pos met through Topics beyond syllabus/Advanced topics/Design	Nil

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					
Indirect Assessment						

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	1	3	1	2
CO2	2	3	1	1	2	3
CO3	2	1	3	1	3	1
CO4	3	2	2	2	1	2

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. D. M. Pandey

COURSE INFORMATION

Course code	BE26523
Course title	**Stem Cells & Tissue Engineering**
Pre-requisite(s)	Nil
Co-requisite	Nil
Credits	3
Class schedule per week	L: 03 T:0 P:0
Class	M.Tech.
Semester / Level	II/05
Branch	Biotechnology
Name of Teacher	Dr. Sneha Singh

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	Understand the fundamental principles of stem cell biology, including self-renewal, potency, stem cell niche, and molecular regulation of stem cell fate.
2	Acquire knowledge of various types, sources, isolation, characterization, and culture techniques of stem cells.
3	Understand the basic concepts and applications of tissue engineering and regenerative medicine.
4	Evaluate the therapeutic potential, translational aspects, biosafety, ethical issues, and regulatory guidelines associated with stem cell research and therapy.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Explain the fundamental properties, regulatory mechanisms, and reprogramming concepts governing stem cell biology.
CO2	Differentiate various types and sources of stem cells and demonstrate understanding of their isolation, characterization, culture, and preservation techniques.
CO3	Analyze the principles and applications of tissue engineering and regenerative medicine for therapeutic purposes.
CO4	Assess stem cell-based therapies with respect to clinical translation, biosafety, ethical considerations, and regulatory requirements.

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	**Fundamentals of Stem Cell Biology**	Introduction and historical perspective of stem cells, Unique properties of stem cells: self-renewal, potency, plasticity, Stem cell niche and microenvironment, Stem cell division, Molecular regulation of stem cell fate, Concepts of stem cell reprogramming, Stem cell markers	08
2	**Types, Sources and Characterization of Stem Cells**	Classification based on potency: totipotent, pluripotent, multipotent, unipotent, Embryonic stem cells, Adult stem cells, Induced pluripotent stem cells (iPSCs), Perinatal stem cells (cord blood and placenta), Organ/tissue-derived stem cells (hematopoietic, mesenchymal, neural, hepatic, adipose-derived), Isolation and characterization of stem cells	08
3	**Stem Cell Culture and Differentiation**	Basic stem cell culture techniques, Feeder-dependent and feeder-free culture systems, Growth factor requirement, Maintenance and expansion of stem cells, Cell cycle regulators in stem cells, Cryopreservation and stem cell banking	08

4	**Fundamentals of Tissue Engineering and Regenerative Medicine**	Principles and scope of tissue engineering, Components of tissue engineering: cells, scaffolds, and signaling molecules, Cell-based therapies and regenerative medicine, Bioreactors in tissue engineering, Applications of tissue engineering in regenerative medicine	08
5	**Clinical Translation, Ethics and Regulatory Aspects**	Therapeutic applications and clinical translation of stem cells, Biosafety in stem cell handling and transplantation, Ethical, legal, and social issues in stem cell research, National and international regulatory guidelines for stem cell therapy	08

Learning Resources	
Text Books	***Reference Books***
4. Lanza, R., Atala, A., Khademhosseini, A., & Vacanti, J. P. (Eds.). (2014). Principles of Tissue Engineering (4th Edition). Academic Press, Elsevier, USA. ISBN: 978-0123983589. 5. Freshney, R. I. (2016). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (7th Edition). Wiley-Blackwell, USA. ISBN: 978-1118873656. 6. Turksen, K. (Ed.). (2018). Stem Cells: Current Challenges and New Directions. Springer International Publishing, Switzerland. ISBN: 978-3319908632.	5. Atala, A., Lanza, R., Mikos, A. G., & Nerem, R. (Eds.). (2019). Principles of Regenerative Medicine (3rd Edition). Academic Press, Elsevier, USA. ISBN: 978-0128098806. 6. Sell, S. (2013). Stem Cells Handbook (2nd Edition). Humana Press, Springer, USA. ISBN: 978-1617797934. 7. Slack, J. M. W. (2018). Stem Cells: A Very Short Introduction (2nd Edition). Oxford University Press, UK. ISBN: 978-0198803584.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Nil
Pos met through Gaps in the Syllabus	NA
Topics beyond syllabus/Advanced topics/Design	NA
Pos met through Topics beyond syllabus/Advanced topics/Design	NA

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	3	2	-	-
CO2	2	1	3	3	-	1
CO3	3	2	3	2	2	2
CO4	2	2	2	2	3	2

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4, CD5, CD6
CO4	CD1, CD2, CD3, CD5

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Sneha Singh

COURSE INFORMATION

Course code	BE26525
Course title	**Pharmaceutical Biotechnology**
Pre-requisite(s)	Nil
Co-requisite	Nil
Credits	3
Class schedule per week	L: 03 T:0 P:0
Class	M.Tech.
Semester / Level	II/05
Branch	Biotechnology
Name of Teacher	Dr. Ramesh Chandra

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	The major concepts involved in biopharmaceuticals production,
2	The major concepts involved in molecular diagnostic production and its specific application,
3	Details of immunological methods and their application in therapeutics and diagnostics,
4	Demonstrate knowledge and understanding of communication at cellular level

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Conceptualise bioprocesses of involved methods of biopharmaceuticals production,
CO2	Conceptualise the involved methods of production of molecular diagnostic production for specific application,
CO3	Detail the immunological methods and their application in therapeutics and diagnostics,
CO4	Understand the knowledge for processes of communication at cellular level.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	Biotechnology in Pharmaceutical Industry	Pre-biotechnology products, impact of biotechnology, post-biotechnology products, biologics and biopharmaceuticals, Market of biotech products, drug design	08
2	Biotech based Pharmaceutical Products	Therapeutic proteins, Vaccines, mAbs, biosimilars, peptides, mRNA, and bioprocess of conventional fermentation products	08
3	r-DNA Products	Plant products of pharmaceutical importance, Production of secondary metabolites; Heterologous production of human metabolites in microbes, r-DNA products for therapeutic application in human	08
4	Advanced Cellular Processes	Signal transduction, stem cell differentiation, and advanced cell modelling techniques like 3D organoid cultures	08
5	Molecular Diagnostics	Basic diagnostic techniques, Kit based diagnosis (such as pregnancy detection kit), CORONA virus detection technique, and immunochemical techniques such as ELISA. Immunoreagents	08

Learning Resources

Text Books

1. Molecular Biotechnology - Therapeutic Applications and Strategies by SUNIL Maulik and Salil D. Patel , Wiley-Liss
2. Pharmaceutical Biotechnology: A Programmed Text 1st Edition by Steven Strauss, Santo William Zito, S. William Zito, CRC Press
3. Pharmaceutical Biotechnology. Fundamentals and Applications, Third Edition. Edited By Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm, Springer
4. Pharmaceutical Biotechnology. Vyas S.P , V.K. Dixit; CBS Publishers & Distributors
5. Kar, A., Pharmacognosy and pharmacobiotechnology. 2nd Edition, New Age International (P) Ltd., 2007.

Reference Books

1. Atala, A., Lanza, R., Mikos, A. G., & Nerem, R. (Eds.). (2019). Principles of Regenerative Medicine (3rd Edition). Academic Press, Elsevier, USA. ISBN: 978-0128098806.
2. Sell, S. (2013). Stem Cells Handbook (2nd Edition). Humana Press, Springer, USA. ISBN: 978-1617797934.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (6th edition) by Bernard R. Glick, Cheryl L. Patten (Wiley)
4. Molecular Biology of the Gene (7th edition) by James D. Watson (Cold Spring Harbor Press)

Gaps in the Syllabus (to meet Industry/Profession requirements)	Nil
Pos met through Gaps in the Syllabus	NA
Topics beyond syllabus/Advanced topics/Design	NA
Pos met through Topics beyond syllabus/Advanced topics/Design	NA

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					
Indirect Assessment						

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	3	2	1	1
CO2	1	2	3	2	-	2
CO3	1	2	3	2	1	2
CO4	1	1	3	2	-	1

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD4
CO2	CD1, CD2, CD4
CO3	CD1, CD2, CD4,
CO4	CD1, CD2, CD4

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		Dr. Ramesh Chandra

COURSE INFORMATION

Course code	BE26527
Course title	Advanced Biomedical Instrumentation
Pre-requisite(s)	Nil
Co-requisite	Nil
Credits	3
Class schedule per week	L: 3 T: 0 P: 0
Class	M.Tech
Semester / Level	II/5
Branch	Biotechnology
Name of Teacher	Dr. Yogender Aggarwal

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To provide a comprehensive understanding of human physiological systems and the generation and propagation of bioelectric signals in various tissues and organs.
2	To impart knowledge of the principles, design, operation, and clinical applications of biomedical signal acquisition and diagnostic devices such as ECG, EEG, EMG, EOG, and blood pressure monitoring systems.
3	To familiarize students with assistive, therapeutic, surgical, and patient monitoring devices, along with the concepts of electrical safety and hazard prevention in healthcare environments.
4	To introduce the principles and instrumentation of medical imaging modalities including X-ray, CT, MRI, ultrasound, Doppler, SPECT, and PET used in anatomical and functional diagnosis.
5	To develop awareness of biomedical safety practices, sterilization techniques, radiation hazards, and protection measures required for safe and ethical operation of medical equipment.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Explain the physiology of major organ systems and describe the generation and propagation of bioelectric signals in muscles, heart, and nervous system
CO2	Analyze the principles, instrumentation, and applications of various bio-signal acquisition and diagnostic devices
CO3	Evaluate the working principles and clinical applications of assistive, therapeutic, surgical, and patient monitoring devices with emphasis on electrical safety
CO4	Demonstrate understanding of the principles and operation of anatomical and physiological imaging modalities used in diagnosis
CO5	Apply sterilization methods and radiation safety principles for safe and ethical operation of biomedical equipment and healthcare environments

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
I	General Physiology	Physiology of cardiac system, pulmonary system, urinary system, nervous system, muscle and special sense organs. Generation and propagation of action potentials in muscle, heart and nervous system	8
II	Bio-Signal Devices	Electrocardiograph; Electromyograph; Electroencephalograph; Electrogastrograph; Electrooculograph; Phonocardiograph; Plethysmograph; Pulmonary function test devices; Non-Invasive and Invasive Blood Pressure measurement; Holter recorder; Stress test. AI application in signal processing and feature extraction.	8
III	Assistive, Therapeutic and Surgical Devices	Pacemaker; Defibrillator; Anesthesia machine; Ventilator; Heart-Lung machine; Therapeutic and Surgical diathermies; Nerve and Muscle stimulators; Patient Monitoring System; Micro and Macro Electrical Shock Hazards.	8
IV	Anatomical and Physiological Imaging	Generation of X-ray; X-ray imaging device; Catheterization system; Computer Assisted Tomography. Nuclear Magnetic Resonance; Magnetic Resonance Imaging device; Generation and properties of ultrasound;	8

		Ultrasound and Doppler equipment. Functional imaging with Gamma camera; Single Photon Emission Tomography and Positron Emission Tomography.	
V	Biomedical Safety	Need of sterilization; Autoclave; Ethylene Trioxide sterilizer; Ultrasonic and Microwave based sterilization. Ionic and Non-Ionic Radiation hazards; Protection from radiation; Radiation measuring devices.	8

Learning Resources	
Text Books	***Reference Books***
A. C. Guyton. Textbook of Medical Physiology, 8th edition, Prism Indian Publication, Bangalore, 1991	J. D. Bronzino. Biomedical Engineering and Instrumentation, Basic Concepts and Applications, 1st Edison, PWS Publishers, Boston, 1986
R. S. Khandpur. Handbook for Biomedical instrumentation, 3rd edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014	J. G. Webstar. Medical instrumentation, Application & Design, 4th edition, Wiley Student Edition, New Delhi, 2009
	J. J. Kar and J. M. Brown. Introduction to Biomedical Equipment Technology, 4th edition, Pearson India Education Services Pvt. Ltd., Noida, 2016

Gaps in the Syllabus (to meet Industry/Profession requirements)	• *Limited coverage of wearable biosensors and Internet of Medical Things (IoMT)* • *Limited exposure to healthcare informatics*
POs met through Gaps in the Syllabus	PO1, PO3, PO4, PO5, PO6
Topics beyond syllabus/Advanced topics/Design	• *Telemedicine and remote healthcare systems* • *AI and deep learning applications in medical imaging and computer-aided diagnosis*
POs met through Topics beyond syllabus/Advanced topics/Design	PO1, PO2, PO3, PO4, PO5, PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	10%	10%	10%	10%	10%
	Semester End Examination	10%	10%	10%	10%	10%

Indirect Assessment	

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	3	2		
CO2	2	2	3	3	1	1
CO3	2	1	3	3	2	1
CO4	2	1	3	3	1	1
CO5	1	2	2	3	3	1

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Yogender Aggarwal

COURSE INFORMATION

Course code	BE26600
Course title	Thesis (Part I)
Pre-requisite(s)	NA
Co-requisite	NA
Credits	14
Class schedule per week	L: 0 T: 0 P: 28
Class	M.Tech
Semester / Level	III/6
Branch	Biotechnology
Name of Teacher	Dr. Ramesh Chandra

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	To demonstrate a sound technical knowledge of their specific selected project topic. Able to impart knowledge for interdisciplinary, applied engineering and technology aspects.
2	To execute problem identification, formulation and solution operations in order to conduct an engineering project
3	To design engineering solutions to complex problems utilising a systematic methodology.
4	To communicate with engineers/biotechnologists and the community in a professional manner in written and oral forms.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO 1	Able to demonstrate a sound technical knowledge of their specific selected project topic specially in biotechnology. Able to correlate interdisciplinary/applied engineering and technology aspects of biotechnology.
CO 2	Able to collect data related to a societal and scientific issue in the area of biotechnology, analyse and interpret them.
CO 3	Able to identify the scientific problem, design engineering solutions for them by using a systematic approach.

CO 4	Able to communicate with engineers/biotechnologists and the community in a professional manner in written and oral forms. They will be able to write an engineering report on a biotechnological issue.

Syllabus

Topic of research work will be assigned by project supervisor

Learning Resources	
Text Books	Reference Books
As per allotted project	As per allotted project
Gaps in the Syllabus (to meet Industry/Profession requirements)	Nil
Pos met through Gaps in the Syllabus	NA
Topics beyond syllabus/Advanced topics/Design	Nil
Pos met through Topics beyond syllabus/Advanced topics/Design	NA

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

	Assessment Tool	***% Contribution during CO Assessment***
Direct Assessment	Continuous Internal Assessment	100%
	External Examiner	*50%*
	DPEC	*25%*
	Project Guide	*25%*

	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***

Indirect Assessment	

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD5, CD7
CO2	CD1, CD2, CD3, CD5, CD7
CO3	CD1, CD2, CD3, CD5, CD7
CO4	CD1, CD2, CD3, CD5, CD7

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Ramesh Chandra

COURSE INFORMATION

Course code	BE26601
Course title	Biomedical Instrumentation
Pre-requisite(s)	Nil
Co-requisite	Nil
Credits	3
Class schedule per week	L: 3 T: 0 P: 0
Class	M.Tech
Semester / Level	II/Sixth
Branch	All
Name of Teacher	Dr. Yogender Aggarwal

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	To provide a comprehensive understanding of human physiological systems and the generation and propagation of bioelectric signals in various tissues and organs.
2	To impart knowledge of the principles, design, operation, and clinical applications of biomedical signal acquisition and diagnostic devices such as ECG, EEG, EMG, EOG, and blood pressure monitoring systems.
3	To familiarize students with assistive, therapeutic, surgical, and patient monitoring devices, along with the concepts of electrical safety and hazard prevention in healthcare environments.
4	To introduce the principles and instrumentation of medical imaging modalities including X-ray, CT, MRI, ultrasound, Doppler, SPECT, and PET used in anatomical and functional diagnosis.
5	To develop awareness of biomedical safety practices, sterilization techniques, radiation hazards, and protection measures required for safe and ethical operation of medical equipment.

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Explain the physiological basis of bioelectric signals and their relevance in healthcare
CO2	Describe the principles and applications of biomedical signal acquisition and monitoring devices
CO3	Explain the operation and applications of therapeutic and assistive medical devices with emphasis on safety
CO4	Compare different medical imaging modalities used for diagnosis and treatment
CO5	Discuss sterilization methods, radiation safety, and emerging trends such as AI, wearable sensors, and digital healthcare

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
I	Human Physiology and Bioelectric Signals	Overview of human physiological systems: cardiovascular, respiratory, nervous, muscular, and sensory systems. Bioelectric phenomena and generation of action potentials. Physiological parameters and their significance in healthcare	8
II	Biomedical Signal Acquisition and Monitoring	Introduction to biosignals and their characteristics. Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Pulse oximeter, Blood pressure measurement, Holter monitoring, and wearable health monitoring devices. Basics of AI-assisted signal analysis and feature extraction	8
III	Therapeutic and Assistive Medical Devices	Principles and applications of pacemakers, defibrillators, ventilators, anesthesia machines, dialysis systems, patient monitoring systems, and prosthetic devices. Electrical safety in hospitals and biomedical equipment	8
IV	Medical Imaging Technologies	Introduction to X-ray imaging, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Ultrasound imaging, Doppler	8

		ultrasound, Positron Emission Tomography (PET), and Single Photon Emission Computed Tomography (SPECT). Applications of medical imaging in disease diagnosis and treatment	
V	Biomedical Safety and Emerging Healthcare Technologies	Sterilization techniques and infection control. Radiation hazards and protection methods. Wearable biosensors, Internet of Medical Things (IoMT), telemedicine, digital healthcare, and applications of artificial intelligence in healthcare	8

Learning Resources	
Text Books	***Reference Books***
A. C. Guyton. Textbook of Medical Physiology, 8th edition, Prism Indian Publication, Bangalore, 1991	J. D. Bronzino. Biomedical Engineering and Instrumentation, Basic Concepts and Applications, 1st Edison, PWS Publishers, Boston, 1986
R. S. Khandpur. Handbook for Biomedical instrumentation, 3rd edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014	J. G. Webstar. Medical instrumentation, Application & Design, 4th edition, Wiley Student Edition, New Delhi, 2009
	J. J. Kar and J. M. Brown. Introduction to Biomedical Equipment Technology, 4th edition, Pearson India Education Services Pvt. Ltd., Noida, 2016

Gaps in the Syllabus (to meet Industry/Profession requirements)	• *Limited exposure to healthcare informatics*
Pos met through Gaps in the Syllabus	PO1, PO3, PO4, PO5, PO6
Topics beyond syllabus/Advanced topics/Design	• *Biomedical signal and image processing using MATLAB/Python* • *Healthcare informatics*
Pos met through Topics beyond syllabus/Advanced topics/Design	PO1, PO2, PO3, PO4, PO5, PO6

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	10%	10%	10%	10%	10%
	Semester End Examination	10%	10%	10%	10%	10%

Indirect Assessment	

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1		3	2		
CO2	1	1	3	3		1
CO3	1	1	3	2	2	1
CO4	1	1	3	3	1	1
CO5	2	2	2	3	3	2

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Yogender Aggarwal

COURSE INFORMATION

Course code	BE26603
Course title	Advances in Nanobiotechnology
Pre-requisite(s)	Nil
Co-requisite	Nil
Credits	03
Class schedule per week	L: 03 T:0 P:0
Class	M.Tech.
Semester / Level	III/06
Branch	All
Name of Teacher	Dr. Sneha Singh

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	Understand the fundamental principles, properties, and biological interactions of nanomaterials relevant to nanobiotechnology.
2	Acquire knowledge of various nanomaterial synthesis methods, characterization techniques, and biomolecular nanostructures.
3	Understand emerging applications of nanobiotechnology in healthcare, diagnostics, agriculture, and environmental systems.
4	Appreciate the societal, ethical, biosafety, and future perspectives of nanobiotechnology, including emerging AI-assisted approaches.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Explain the fundamental concepts, properties, and nano-bio interactions of nanomaterials used in nanobiotechnology.
CO2	Describe the synthesis, characterization, and biomolecular assembly of nanostructures used in biological applications.
CO3	Analyze emerging applications of nanobiotechnology in healthcare, diagnostics, agriculture, and environmental sectors.
CO4	Assess nanobiotechnology applications with respect to biosafety, ethical considerations, future challenges, and AI-assisted developments.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	**Introduction to Nanobiotechnology**	Nanoscale effects and unique properties of nanomaterials; size-dependent phenomena and reduced dimensionality; classification and types of nanomaterials (metal nanoparticles, quantum dots, polymeric nanoparticles, carbon nanotubes, dendrimers); nano-bio interactions.	08
2	**Nanomaterials Synthesis and Characterization**	Nanofabrication methods: Top-down and Bottom-up approaches; biological/green synthesis of nanomaterials; principles and applications of nanoscale characterization techniques: SEM, TEM, AFM, DLS, XRD and spectroscopy-based methods.	08
3	**Biomolecular and Bio-inspired Nanostructures**	DNA and protein-based nanostructures; DNA–gold nanoparticle conjugates; self-assembly in nanobiotechnology; nanomotors and molecular machines; S-layer proteins and bio-inspired nanostructures.	08
4	**Emerging Nanobiotechnologies**	Nanotechnology in Healthcare and Diagnostics: point-of-care diagnostics, biosensors, nanobiosensors, nanolabels, and wearable diagnostic devices; AI-assisted nanomaterial design (introductory level).	08
5	**Applications, Safety and Future Perspectives**	Applications of nanobiotechnology in bioimaging, drug delivery, cancer nanotechnology, regenerative medicine and Nanotechnology in Agriculture and Environment; nanotoxicity, biosafety and ethical concerns; future prospects and challenges in nanobiotechnology.	08

Learning Resources	
Text Books	*Reference Books*

7. Niemeyer, C. M., & Mirkin, C. A. (Eds.). (2004). Nanobiotechnology: Concepts, Applications and Perspectives. Weinheim, Germany: Wiley-VCH Verlag GmbH & Co. KGaA. ISBN: 978-3527306589.
8. Goodsell, D. S. (2004). Bionanotechnology: Lessons from Nature. Hoboken, NJ: Wiley-Liss. ISBN: 978-0471417194.
9. Bhushan, B. (Ed.). (2017). Springer Handbook of Nanotechnology (4th ed.). Cham, Switzerland: Springer. ISBN: 978-3319564944.
5. Kumar, C. S. S. R. (Ed.). (2006). Nanomaterials for Medical Diagnosis and Therapy. Weinheim, Germany: Wiley-VCH. ISBN: 978-3527313907.
6. Jain, K. K. (2017). The Handbook of Nanomedicine (2nd ed.). New York, NY: Humana Press, Springer. ISBN: 978-1493969654.
7. Freitas, R. A. Jr. (1999). Nanomedicine, Volume I: Basic Capabilities. Georgetown, TX: Landes Bioscience. ISBN: 978-1570596452.

Gaps in the Syllabus (to meet Industry/Profession requirements)	Nil
Pos met through Gaps in the Syllabus	NA
Topics beyond syllabus/Advanced topics/Design	NA
Pos met through Topics beyond syllabus/Advanced topics/Design	NA

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment					
	Semester End Examination					

Indirect Assessment	

Mapping Between Course Outcomes and Program Outcomes						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	3	2	-	-
CO2	2	1	3	3	-	1
CO3	3	2	3	2	2	2
CO4	2	1	2	3	3	1

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD4, CD6
CO2	CD1, CD2, CD3, CD4, CD6
CO3	CD1, CD2, CD3, CD4, CD5, CD6
CO4	CD1, CD2, CD3, CD5, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Sneha Singh

COURSE INFORMATION

Course code	BE26650
Course title	Thesis (Part II)
Pre-requisite(s)	NA
Co-requisite	NA
Credits	14
Class schedule per week	L: 0 T: 0 P: 40 SL: 0
Class	MTech
Semester / Level	III/6
Branch	Biotechnology
Name of Teacher	Dr. Ramesh Chandra

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	To demonstrate a sound technical knowledge of their specific selected project topic. Able to impart knowledge for interdisciplinary, applied engineering and technology aspects.
2	To execute problem identification, formulation and solution operations in order to conduct an engineering project
3	To design engineering solutions to complex problems utilising a systematic methodology.
4	To communicate with engineers/biotechnologists and the community in a professional manner in written and oral forms.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO 1	Able to demonstrate a sound technical knowledge of their specific selected project topic specially in biotechnology. Able to correlate interdisciplinary/applied engineering and technology aspects of biotechnology.
CO 2	Able to collect data related to a societal and scientific issue in the area of biotechnology, analyse and interpret them.
CO 3	Able to identify the scientific problem, design engineering solutions for them by using a systematic approach.
CO 4	Able to communicate with engineers/biotechnologists and the community in a professional manner in written and oral forms. They will be able to write an engineering report on a biotechnological issue.

Syllabus

Topic of research work will be assigned by project supervisor

Learning Resources	
Text Books	Reference Books
As per allotted project	As per allotted project
Gaps in the Syllabus (to meet Industry/Profession requirements)	Nil
Pos met through Gaps in the Syllabus	NA
Topics beyond syllabus/Advanced topics/Design	Nil
Pos met through Topics beyond syllabus/Advanced topics/Design	NA

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	100%				
	External Examiner	*50%*				
	DPEC	*25%*				
	Project Guide	*25%*				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***

Indirect Assessment	

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3, CD5, CD7
CO2	CD1, CD2, CD3, CD5, CD7
CO3	CD1, CD2, CD3, CD5, CD7
CO4	CD1, CD2, CD3, CD5, CD7

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***
		Dr. Ramesh Chandra