BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEWCOURSE STRUCTURE - To be effective from academic session 2021- 22
Based on CBCS system & OBE model
Recommended scheme of study
(For Non-Circuit Branches)

Course Level	Semester of Study (Recomended)	Course Code	Subjects	Mode of delivery & credits *L-Lecture; T-Tutorial;P-Practicals*			Total Credits *C- Credits*
				L (*Periods/ week*)	**T *(Periods/week)***	**P *(Periods/week)***	**C**
FIRST	**FS**	MA103	Mathematics - I	3	1	0	4
		PH113	Physics	3	1	0	4
		BE101	Biological Science for Engineers	2	0	0	2
	GE	EE101	Basic Electrical Engineering	3	1	0	4
		CS101	Programming for Problem Solving	3	1	0	4
	HSS	MT132	Communication Skills - I	0	0	3	1.5
	LABORATORIES						
	FS	PH114	Physics Lab	0	0	3	1.5
	GE	CS102	Programming for Problem Solving Lab	0	0	3	1.5
		PE101	Workshop Practice	0	0	3	1.5
	MC	MC101/102 /103/104	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
							25
SECOND	**FS**	MA107	Mathematics - II	3	1	0	4
		CH101	Chemistry	3	1	0	4
		CE101	Environmental Science	2	0	0	2
	GE	ME101	Basics of Mechanical Engineering	3	1	0	4
		EC101	Basics of Electronics and Communication Engineering	3	1	0	4
	LABORATORIES						
	FS	CH102	Chemistry Lab	0	0	3	1.5
	GE	EC102	Electronics and Communication Lab	0	0	3	1.5
		ME102	Engineering Graphics	0	0	4	2
	MC	MC105/106 /107/108	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
							24

THIRD	**THEORY**						
	FS	MA203	Numerical Methods	2	0	0	2
	HSS	MT131	UHV2: Understanding Harmony	3	0	0	3
	PC	BE202	**Cell and Molecular Biology**	3	0	0	**3**
		BE203	**Microbiology**	3	0	0	**3**
		BE204R1	**Biochemistry and Enzyme Technology**	3	0	0	**3**
		BE205	**Basics of Bioinformatics**	3	0	0	**3**
		BE206	**Chemical Process Calculations**	3	0	0	**3**
	LABORATORIES						
	PC	BE207	**Cell Biology and Biochemistry Lab**	0	0	3	**1.5**
	FS	MA204	Numerical Methods Lab	0	0	2	1
	MC	MC201/202 / 203/204	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
TOTAL							**23.5**
FOURTH			**THEORY**				
	PC	**BE208**	**Biology of Immune System**	3	0	0	**3**
		BE209	**Fluid Mechanics & Heat Transfer**	3	0	0	**3**
		BE210	**Thermodynamics of Chemical & Biological Systems**	3	0	0	**3**
	PE		**Programme Elective -I**	3	0	0	**3**
			Programme Elective -II	3	0	0	**3**
	OE		Open Elective-I/ MOOC	3	0	0	3
	LABORATORIES						
	PC	**BE211**	**Microbiology and Immunology Lab.**	0	0	3	**1.5**
		BE212	**Fluid Mechanics & Heat Transfer Lab**	0	0	3	**1.5**
	GE	EE102	Electrical Engg. Laboratories	0	0	3	1.5
	MC	MC205/206 /207/208	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
TOTAL							**23.5**

FIFTH			**THEORY**				
	PC	**BE301**	**Bio-analytical techniques**	3	0	0	**3**
		BE302	**Functional Genomics and rDNA Technology**	3	0	0	**3**
		BE303	**Mass Transfer Operations**	3	0	0	**3**
		BE304	**Reaction Engineering**	3	0	0	**3**
	PE		**Programme Elective -III**	3	0	0	**3**
	HSS	MT133	Communication Skills - II	0	0	3	1.5
	OE		Open Elective-II/ MOOC	3	0	0	3
	LABORATORIES						
	PC	**BE305**	**Molcular Biology & rDNA Technology Lab.**	0	0	3	**1.5**
		BE306	**Bio-analytical Lab.**	0	0	3	**1.5**
TOTAL							**22.5**
SIXTH	**THEORY**						
	PC	**BE307**	**Bioprocess Engineering**	3	0	0	**3**
		BE308	**Bioseparation Engineering**	3	0	0	**3**
		BE403	**Plant & Agriculture Biotechnology**	3	0	0	**3**
	PE		**Programme Elective -IV**	3	0	0	**3**
			Programme Elective -V	3	0	0	**3**
	OE		Open Elective-III/ MOOC	3	0	0	3
	LABORATORIES						
	PC	**BE310**	**Bioprocess Engineering Lab.**	0	0	3	**1.5**
		BE311	**Mass Transfer and Bioseparation Engg. Lab.**	0	0	3	**1.5**
		BE404	**Plant Cell Technology Lab.**	0	0	3	**1.5**
	PROJ	MC300	Summer Training				2
TOTAL							**24.5**
SEVENTH	**THEORY**						
	PC	**BE402**	**Bioreactor and Bioprocess design**	3	0	0	**3**
		BE 407	**Nanobiotechnology**	3	0	0	**3**
	PE		**Programme Elective VI**	3	0	0	**3**
	HSS	MT204	Constitution of India	2	0	0	NC
	OE		Open Elective-IV/ MOOC	3	0	0	3
	LABORATORIES						
	PROJ	BE400M	Minor Project				3
TOTAL							**15**
EIGTH	**PROJ**	BE400	**Research project / Industry Internship**				**10**
							168.0

***Requirment of Programme Elective courses (Theory/ Lab) : 18 credit or above**

Sem		CODE	SUBJECT	L	T	P	C
4th	**PE 1**	BE215R1	Cellular Electrophysiology	3	0	0	3
		BE216	Enzyme Technology	3	0	0	3
	PE 2	BE214R1	Natural Product Biotechnology	3	0	0	3
		BE318	Bioenergy and Biofuels	3	0	0	3
5th	**PE 3**	BE317	Stem cell and Tissue Engineering	3	0	0	3
		BE213	Pharmaceutical Biotechnology	3	0	0	3
6th	**PE 4**	BE309	Fermentation Engineering	3	0	0	3
		BE312	Biomaterials	3	0	0	3
		BE321	Cheminformatics	3	0	0	3
	PE5	BE315	Food Science and Technology	3	0	0	3
		BE319	Bioelectronics–Concept & Instrumentation	3	0	0	3
7th	**PE6**	BE313	Metabolic Engineering	3	0	0	3
		BE316	Bioinformatics Algorithms	3	0	0	3
		BE412	Process Biotechnology	3	0	0	3

4th	OE 1	BE 205	Basics of Bioinformatics	3	0	0	3
		BE 213	Pharmaceutical Biotechnology	3	0	0	3
5th	OE 2	BE 319	Bioelectronics–Concept & Instrumentation	3	0	0	3
		BE320	Biotreatment of Municipal and Industrial wastes	3	0	0	3
6th	OE 3	BE 316	Bioinformatics Algorithms	3	0	0	3
		BE 318	Bioenergy and Biofuels	3	0	0	3
7th	OE 4	BE 407	Nanobiotechnology	3	0	0	3
		BE411	Molecular Modelling and Drug Design	3	0	0	3

In-depth Specialization in Computational Biotechnology with B. Tech (Biotechnology)

S.No	Semester of Study (Recomended)	Course Code (*TBD*)	Subjects	Mode of delivery & credits			Total Credits
				L (*Periods/ week*)	T (*Periods/week*)	P (*Periods/week*)	C
1	5TH	BE328	Molecular Simulation of Biomolecules	3	1	0	4
2		BE329	Perl & Bioperl Programming	3	1	0	4
3	6TH	BE330	Biosequence analysis and Programming lab	2	0	2	3
4		BE331	Advanced algorithmic techniques & Communication	3	0	0	3
5	7TH	BE415 R1	System Biology	3	0	0	3
6		BE417	Molecular modelling & Drug Design Lab	2	0	2	3
TOTAL							**20**

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI

Minor in Biotechnology offerred for B.Tech Programme (for other than B.Tech Biotechnology students) To be effective from academic session 2021-22

Semester/ Session of Study (Recomended)	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								
Fifth Monsoon	Second	PC	BE202	Cell & Molecular Biology	3	0	0	3
	Third	PC	BE332	Biochemistry & Microbiology	3	1	0	4
TOTAL								7
Sixth Spring	Second	PC	BE213	Pharmaceutical Biotechnology	3	1	0	4
	Third	PC	BE307	Bioprocess Engineering	3	0	0	3
TOTAL								7
Seventh Monsoon	Fourth	PC	BE412	Process Biotechnology	3	0	0	3
	Fourth	PC	BE405	Basic Biotechnology Lab	0	0	3	1.5
	Fourth	PC	BE416	Process Biotechnology Lab	0	0	3	1.5
TOTAL								6
GRAND TOTAL CREDITS								**20**

Department of Bioengineering and Biotechnology

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.

Vision of Department

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

Mission of Department

- 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 bio entrepreneurship.

Sl. No.	**Programme educational objectives**
PEO 1	To produce graduates in Biotechnology with strong technical competence in Bio-science, -technology, -engineering and management.
PEO 2	To develop teamwork and awareness amongst students towards the importance of multidisciplinary approach for problem solving skills in Biotechnology.
PEO 3	To develop trained human resource in Biotechnology to promote quality education and to initiate life-long learning process for productive career.
PEO 4	To generate potential knowledge pools with interpersonal and collaborative skills to identify, assess and formulate problems and execute the solution in closely related biological industries.

Program Educational Objectives (PEO)

- Students will acquire necessary knowledge and skills in the frontier areas of Biotechnology.
- Students will think critically and creatively about the use of biotechnology to address local and global problems.
- 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.

Programme Outcomes

The student will have

a. An ability to apply knowledge of mathematics, science, and engineering
b. An ability to design and conduct experiments, as well as to analyze and interpret data
c. An ability to design a system, component, or process to meet the desired needs within realistic constraints, such as, economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. An ability to identify, formulate, and solve engineering problems
e. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
f. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
g. Graduates are trained to maintain the green catalysts philosophy with sustainability of various environmental resources.
h. An understanding of professional and ethical responsibility
i. An ability to function in multidisciplinary teams
j. An ability to communicate effectively
k. An ability to demonstrate knowledge and understanding of the engineering principles and apply these to manage projects work
l. A recognition of the need for and an ability to engage in life-long learning

COURSE INFORMATION SHEET

Course code: **BE101**
Course title: **Biological Science for Engineers**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits: 2 L:2 T:0 P:0
Class schedule per week: 02
Class: **B. Tech**
Semester / Level: **I**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Recognize and understand the basic cell biology, biomolecules, related metabolic pathways and applicable bioenergetics.
2.	Relate common biological phenomenon at molecular level.
3.	Describe the chemical nature of enzymes and mechanism of action for their function in biochemical reactions.
4.	Correlate the molecular methods of biological signal generation and propagation in living system.
5.	Comprehend the steps involved in common application of biotechnology such as applicable for creation of transgenics, stem cells, plant metabolites production PCR, ELISA.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules involved in living system.
CO2	Interpret the biomechanism involved in signal generation and transmission.
CO3	Correlate the basic methods involved in common biotechnological application.
CO4	Apply and effectively communicate scientific reasoning and data involved in common biotechnological applications.

(BE101) Biological Science for Engineers

Module-1: Basic Cell Biology: [6L]
Origin of life, Cell theory, Cell Structure and function, Biomolecules, Cell cycle and cell division, Biological Organization.

Module-2: Bioenergetics and Metabolism: **[6L]**
Gibbs free energy and thermodynamics, aerobic and anaerobic respiration, Glycolysis, Krebs cycle and electron transport chain, Beta oxidation, Photosynthesis.

Module-3: Enzymes and its Application: [6L]
Classification of enzymes, Structure and mechanism of enzyme action and uses of enzymes, factors affecting enzyme activity, Immobilization of enzymes and their application.

Module-4: Biological Signal Generation and Propagation: [6L]
Nerve cell structure and signal propagation. Mechanism of vision and hearing, cell signaling, Circadian rhythm.

Module-5: Engineering Biological Systems and its Applications: [6L]
Central dogma of molecular biology, Methods in genetic engineering and application, PCR, ELISA and its application, stem cell and tissue engineering. Artificial Intelligence in Biology, Plant factory.

Books Recommended
Recommended Text Book
1. Purves et al, (1998) Life: *The Science of Biology,* 4th Ed.
2. R. Dulbecco, The Design of Life.
3. Lehninger A, Principals of Biochemistry, 5th Ed

Reference Book

1. Stryer, L. (2002). *Biochemistry*. New York: W.H. Freeman.
2. K. Wilson & K.H. Goulding, (2006) *A biologist's guide to Principles and Techniques of Practical Biochemistry*.

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4
Mid Sem Examination Marks	√	√	√	√
End Sem Examination Marks	√	√	√	√
Quiz I	√	√	√	
Quiz II	√	√	√	

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	J	k	L
1	3	3	3	3	1	1	1	2	1	1	1	1
2	3	3	3	3	1	1	1	2	1	1	1	1
3	1	3	3	3		1	1	1		1	1	1
4	2	2	2	2		2	2	2		1	1	2

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4	CD1, CD2, CD3, CD8
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1, CD2, CD3, CD8
CD3	Seminars		
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: MA203
Course title: Numerical Methods
Pre-requisite(s): NIL
Co- requisite(s):--NIL
Credits:2 L: 2 T: 0 P:0 C: 2
Class schedule per week: 2 Lectures
Class: B Tech
Semester/ Level: III
Branch: ALL
Name of teacher:

Course Objectives: This course enables the students to

1.	derive appropriate numerical methods to solve algebraic and transcendental equations
2.	derive appropriate numerical methods to solve linear system of equations
3.	approximate a function using various interpolation techniques
4.	to find the numerical solution of initial value problems and boundary value problems

Course Outcomes: After the completion of this course, students will be able to

C01	solve algebraic and transcendental equation using an appropriate numerical method arising various engineering problem
C02	solve linear system of equations using an appropriate numerical method arising in computer programming. Chemical engineering problems etc.
C03.	Approximate a function using an appropriate numerical method in various research problems
C04	evaluate derivative at a value using an appropriate numerical method in various research
C05	solve differential equation numerically

(MA203) Numerical Methods

Module I: Errors and Nonlinear Equations: [**5L**]

Error Analysis: Definition and sources of errors, propagation of errors, floating-point arithmetic Solution of Nonlinear equations: Bisection method, Regula-Falsi method, Secant method, Newton-Raphson method and its variants, General Iterative method.

Module II: System of Linear Equations: [**5L**]

Gauss-Elimination, Gauss-Jordan, LU-Decomposition, Gauss-Jacobi and Gauss- Siedel methods to solve linear system of equations and Power method to find least and largest eigenvalues.

Module III: Interpolation: [**5L**]

Lagrange's interpolation, Newton's divided differences interpolation formulas, inverse interpolation, interpolating polynomial using finite differences.

Module IV: Differentiation and Integration: [**5L**]

Differentiation using interpolation formulas, Integration using Newton-Cotes formulas: Trapezoidal rule, Simpson's rule

Module V: Solution of Ordinary Differential Equations: [**5L**]

Euler's method, modified Euler's method, Runge - Kutta Methods of second and fourth order to solve initial value problems.

TextBooks:

1. Jain M.K, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age Publications, 2004.
2. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI.
3. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Reference Books:

1. S.C. Chapra and R. P. Canale, Numerical Methods for Engineers, McGraw Hill, 1985.
2. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, Seventh Edition, 2003.
3. R. W. Hamming: Numerical Methods for Scientists and Engineers, Second Edition, Dover

Course Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	✓
Tutorials/Assignments	✓
Seminars	
Mini projects/Projects	✓
Laboratory experiments/teaching aids	
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	✓
Simulation	

Course outcome (co) attainment assessment tools & evaluation procedure Direct assessment

Assessment tool	% contribution during co assessment
Mid semester examination	25
End semester examination	50
Quiz (s)	10+10
Assignment	5

I. Student feedback on course outcome

Mapping of course outcomes onto program outcomes

Course outcome #	Program outcomes											
	PO1	P02	P03	P04	POS	P06	P07	P08	P09	PO10	PO11	P012
1	3		2		1	1	1	1	3	3	2	2
2	3		2		1	1		1	3	3	2	2
3	3		2		1	1	1	1	3	3	2	2
4			3	1	1	1	1	1	3	3	2	2
5			3	3	1	2	1	1	3	3	2	2

If satisfying< 34%=1, 34-66% =2, > 66% = 3.

COURSE INFORMATION SHEET

Course code: **BE202**
Course title: **Cell and Molecular Biology**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits: 3 **L:3** **T:0** **P:0**
Class schedule per week: 03
Class: **B. Tech**
Semester / Level: **III**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives:

This course enables the students to:

1.	Build on the knowledge of cell structure and function gained and understand how eukaryotic cells work at the molecular level.
2.	Provide an overview of cell structure and function at the molecular level, including the flow of information from genes to proteins, and regulation of cellular processes, signaling and proliferation in eukaryotic cells.
3.	Introduce some of the major ideas and experimental approaches in cell and molecular biology
4.	Develop basic knowledge and skills in cell and molecular biology
5.	Become aware of the complexity and harmony of the cell.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Integrate the different levels of biological organization, from molecules to cells to organisms.
CO2	Gather, critically assess, and utilize primary scientific literature to research a topic.
CO3	Demonstrate the knowledge of common and advanced laboratory practices in cell and molecular biology
CO4	Exhibit clear and concise communication of scientific data
CO5	Understand and practice the ethics surrounding scientific research
CO6	Plan for professional growth and personal development within and beyond the undergraduate program.

(BE202) Cell and Molecular Biology

Module-1: Cell Basics: **[8L]**
Structure of prokaryotic and eukaryotic cell, Electron micrograph of cell wall, cell membranes, Freeze Fracture technique, Patch clamp method, FRAP, cell organelles.

Module-2: Cell-cell Interaction and Signaling: **[8L]**
Principles of cell communication, Principles of cell signaling, Signaling via G-Protein linked cell-surface Receptors and Signaling via enzyme- linked cell-surface receptors, Target cell adaptation, Signal transduction pathways.

Module-3: Cell Cycle and its Regulation: [8L]
Components of the cell cycle, Regulation of cell cycle progression, Intracellular control of the cell cycle events, Extracellular control of cell division, Cell growth, and apoptosis, Regulation of meiotic cell cycle.

Module-4: Basic Genetic Mechanism: [8L]
DNA replication, DNA repair, DNA methylation, RNA splicing, RNA editing. Protein synthesis, Chromatin packing, Genetic recombination, Manipulating Proteins, Membrane transport mechanism, Control of gene expression.

Module-5: Protein Processing & Transportation: [8L]
Intracellular Compartmentalization, Protein targeting, mechanism of co-translational transport of protein, Post-translational transport of protein into organelles, Protein entry sorting and modification, Protein degradation.

Books Recommended
Text Books
T1. Channarayappa: Molecular Biology
T2. U. Satyanarayana: Biotechnology
Reference Books:
R1. Alberts et al, Molecular Biology of the Cell
R2. Lodish et al, Molecular Cell Biology
R3. DeRobertis, Cell Biology
R4. Harper, The Cell

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors√
Tutorials/Assignments√
Seminars√
Mini projects/Projects
Laboratory experiments/teaching aids√
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets√
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	20
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5	CO6
Mid Sem Examination Marks	√	√				
End Sem Examination Marks	√	√	√	√	√	√
Quiz I	√	√	√			
Quiz II				√		√

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	A	b	c	d	e	f	g	h	i	j	k	l
1	3		1									
2	3	2	2									
3	3		2		2							
4	3					2			2	3		
5		1	1			1		2				
6				3			3					2

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD3, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD3, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **BE203**
Course title: **Microbiology**
Pre-requisite(s): **Basics of Biological Sciences**
Co- requisite(s): **Microbiology Lab**
Credits: 3 **L: 3 T: 0 P: 0**
Class schedule per week: 3
Class: **B. Tech**
Semester / Level: **III**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	To establish an understanding of the major historical events and basic techniques (concept of aseptic work, cultivation and identification) in microbiology
2.	To describe basic cell structure, metabolism, nutrition, reproduction and ecology of prokaryotic microorganisms, eukaryotic microorganisms and viruses
3.	To describe microbial interactions and their significance in agriculture, food and pharmaceuticals
4.	To outline principles of physical and chemical methods used in the control of microorganisms and apply this understanding to the prevention and control of infectious diseases
5.	To describe nonspecific body defenses and the immune responses and apply this understanding to the infectious disease process as well as the prevention and control of infectious diseases
6.	To develop and execute oral and writing skills necessary for effective communication of the course, the ability to think critically regarding a topic and the delivery of scientific principles to both scientists and non-scientists

Course Outcomes

After the completion of this course, students will be:

CO1	Identify microbiological techniques, microbial evolution, phylogeny and know the defining characteristics of the major groups of microorganisms
CO2	Describe the structure, function and growth of bacteria, structure of viruses
CO3	Evaluate the industrially important microbes and also how microorganisms interact with the environment in beneficial or detrimental ways
CO4	Assess plant- microbe interaction in beneficial or detrimental ways
CO5	Determine ways in which microorganisms play an integral role in disease, and the microbial and immunological methodologies are used in disease treatment and prevention
CO6	Apply the scientific method by stating a question; researching the topic; determining appropriate tests; performing tests; collecting, analyzing, and presenting data and communicate with both specialist and non-specialist audiences using genres commonly used in microbiology

(BE203) Microbiology

Module-I Basics of Microbiology: [8L]
Brief history on the development and scope of microbiology, Methods in Microbiology-Microscopy, Methods of sterilization; culture media, Pure culture methods, Staining of Bacteria, Micrometry, Air sampling, Classification of microorganisms

Module-II Growth of Microorganism: [8L]
Cell structure and major characteristics of cellular (bacteria, fungi, algae, protozoa) and acellular (viruses) organisms, Archaebacteria, Growth of Microorganisms: Nutritional and physical requirements, Batch culture, Continuous culture, Synchronous growth, Fed-batch culture

Module-III: Environmental & Industrial Microbiology: **[8L]**
Water treatment, Bacteriological analysis of water, Bioleaching, Bioremediation, Industrially important micro-organisms and secondary metabolites.

Module-IV: Agricultural Microbiology: **[8L]**
Plant-microbial interactions, Biodeterioration of agricultural products, control of microbes and safe storage of agricultural products/food.

Module-V: Medical Microbiology: **[8L]**
Microbial flora of healthy human host, host-pathogen interactions in animals, Diseases caused by bacteria, virus, fungi and protozoans; natural resistance and nonspecific defense mechanisms.

Text books:
T1. Prescott, Harley, and Klein, Microbiology, 7th Ed., Tata McGraw-Hill, 2008

Reference books:
R1. Pelczar, Chan and Krieg, Microbiology, 5th Edition, Tata McGraw-Hill, 1986
R2. Frazier and Westhoff, Food Microbiology, 4th Edition, Tata McGraw-Hill, 1995

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors✓
Tutorials/Assignments✓
Seminars✓
Mini projects/Projects
Laboratory experiments/teaching aids✓
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets✓
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	20
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5	CO6
Mid Sem Examination Marks	√	√				√
End Sem Examination Marks	√	√	√	√	√	√
Assignment*		√	√	√	√	√
Quiz I	√	√	√			
Quiz II				√	√	√

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	D	e	f	g	h	i	j	k	l
1	3					2						
2	3		3		2	2						
3	3		3			2						
4	3		3		3	2						
5			3		3	2						
6		2			3				2	2		1

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD5 and CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3 and CD8
CD3	Seminars	CO3	CD1, CD2, CD3 and CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD3 and CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD3 and CD8
CD6	Industrial/guest lectures	CO6	CD2, CD4, CD5
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **BE204 R1**
Course title: **Biochemistry and Enzyme Technology**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits: 3 **L:3** **T:0** **P:0**
Class schedule per week: 03
Class: **B. Tech**
Semester / Level: **III**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students to :

1.	Describe/recognize structure & function of biomolecules, Compare & contrast DNA and RNA, mono-, di-, and polysaccharides and lipid structures, including lipids found in cell membranes and their transport across membranes, describe their physical and chemical properties and their function in living organisms, Define primary, secondary, tertiary and quaternary structure in proteins and identify the types of interactions important in each case. Recognize biological membrane's structure, gated channels and transport processes. understand biosynthesis of lipids and their regulations, summarize the function of protein
2.	Describe what happens during carbohydrate digestion, glycolysis, glycogenesis, and glycogenolysis, Citric acid cycle & the electron transport chain and oxidative phosphorylation and fatty acid oxidation. Understand biosynthesis of lipids and their regulations. Explain and give examples of the strategies of metabolism, emphasizing the role of ATP coupled reactions, and coenzymes that exist in oxidized and reduced form
3.	List the essential and non-essential amino acids and describe the general strategies for amino acid synthesis. Describe biosynthesis of various amino acids and understand their regulation. Explain what happens during digestion of proteins, catabolism of amino acids and the urea cycle. Understand biological processes like biosynthesis of nucleic acids and their catabolism.
4.	Describe the chemical nature of enzymes and their function in biochemical reactions. Explain how enzyme activity is (a) regulated, and (b) affected by temperature, pH, and concentration. Describe Allosteric enzymes. Explain mode of enzyme action, Describe and compare enzyme inhibition.
5.	Impart knowledge about the enzyme immobilization, methods of enzyme immobilization and their applications in textile, food and pharmaceutical industry. Gain concept regarding enzyme stability and methods involved.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules.
CO2	Understanding of metabolic pathways and the regulation of biological/biochemical processes.
CO3	Be capable of undertaking suitable experiments/research methods.
CO4	Apply and effectively communicate scientific reasoning and data analysis in both written and oral forums.
CO5	Understand and practice the ethics surrounding scientific research.
CO6	Understanding of societal and environmental issues and deriving a solution to a problem

(BE204R1) Biochemistry and Enzyme Technology

Module-1: Biomolecules: [8L]

Structure & function of nucleic acids, Types of DNA and RNA, Organization of eukaryotic DNA double helix, Chargaff's rule, Structure and function of carbohydrates (mono, oligo & polysaccharides), standard amino acids, physicochemical properties of amino acids, Structure of proteins, levels of organization, characteristics of protein denaturation, Classification and functions of lipids (simple, compound & derived lipid with examples), Essential fatty acids, Biological membrane structure and transport processes.

Module-2: Carbohydrate & Lipid Metabolism: [8L]

Glycolysis, Gluconeogenesis, Kreb's Cycle, Electron transport chain, Oxidative phosphorylation, Biosynthesis of carbohydrates and their regulations, Beta and omega oxidation pathway, malate-aspartate and citrate shuttle, Biosynthesis of fatty acids.

Module-3: Amino acid & Nucleic acid metabolism: [8L]

Biosynthesis of tryptophan and glutamic acid, general pathways of amino acid metabolism, Deamination, Transamination, decarboxylation reactions, detoxification of ammonia, synthesis of purines & pyrimidines and degradation of nucleic acids.

Module-4: Enzymes: [8L]

Enzyme classification, Concept of apoenzyme and holoenzyme, Mechanism of enzyme action, Mechanism of enzyme catalysis, Enzyme kinetics, Specific activity, Factors affecting enzyme activity. Types &Mechanism of enzyme inhibition, Enzyme turnover number, Feedback regulation, allosteric enzymes.

Module-5: Immobilization of Enzymes and Enzyme Stabilization: [8L]

Methods of enzyme immobilization, production and application of free and immobilized enzymes in food and feed, detergent, textiles, pulp and paper, pharmaceuticals, diagnostics. Kinetics of immobilized enzymes.

Stability of enzymes: Enzyme stabilization by selection and genetic engineering, protein engineering, reaction environment rebuilding.

Textbooks:

T1- Eric, E. Conn., Paul, K. Stumpf., George, B. Roy., H, Doi. Outlines of Biochemistry. 5th Edition, Wiley India Private Limited, 2006.

T2- Satyanarayana, U., Chakrapani, U. Biochemistry. 5th Edition, Elsevier, 2020.

Reference books:

R1- Nelson, D. L., Lehninger, A. L., Cox, M. M. Lehninger. Principles of Biochemistry. 5th Edition, United Kingdom: W. H. Freeman, 2008.

R2- Jeremy, M. Berg., John, L. Tymoczko., Gregory, J. Gatto., L. Stryer. Biochemistry. 9th Edition, Macmillan International Higher Education, 2019.

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	20
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5	CO6
Mid Sem Examination Marks	√	√				√
End Sem Examination Marks	√	√	√	√	√	√
Assignment*		√	√	√	√	√
Quiz I	√	√	√			
Quiz II				√	√	√

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	A	b	c	d	e	f	g	h	i	j	k	l
1	3		2									
2	3	3	2	2	3							
3	3	3	2		3	2			2			
4	2		3			2			2	2		
5		1	3			2		2				
6			3	3			3			2		1

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD3, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD3, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **BE205**
Course title: **Basics of Bioinformatics**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits: 4 L:3 T:1 P:0
Class schedule per week: 4
Class: **B. Tech**
Semester / Level: **III**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	Basic objective is to give students an introduction to the basic principle of bioinformatics
2.	Able to explain the major steps in pairwise and multiple sequence alignment, explain the principle for, and execute pairwise sequence alignment by dynamic programming
3.	Evolutionary tree generation and find the ancestor.
4.	Able to predict the secondary and tertiary structures of protein sequences.
5.	Provide practical training in bioinformatics methods including accessing the major public sequence databases

Course Outcomes

After the completion of this course, students will be:

CO1.	Become familiar with the use of a wide variety of internet applications, biological database and will be able to apply these methods to research problems
CO2.	Analyze and discuss the results in light of molecular biological knowledge
CO3.	Development of useful tools for automation of complex computer jobs, and making these tools accessible on the network

(BE205) Basics of Bioinformatics

Module 1: Introduction: [9L]
What is bioinformatics and its relation with molecular biology, Different File formats: sequence and structure, General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL); Protein databases (Primary, Composite, and Secondary); Specialized Genome databases: (SGD, TIGR, and ACeDB); Structure databases (CATH, SCOP)

Module 2: Homology and Programming: [9L]
Similarity, Identity, Homology, Selectivity/Sensitivity, Linear and Affine Gap Penalty, Basics of Scoring system and matrices (PAM, BLOSUM). Dot matrix method, Global (Needleman-Wunsch) and Local Alignment (Smith-Waterman) using Dynamic programming. BLAST and FASTA, Theory and Algorithms. Multiple Sequence Alignment: Basic Concepts.

Module 3: Molecular Phylogenetics: [9L]
Molecular Phylogenetics: Basics, molecular clock, Substitution Models of evolution, Tree reconstruction methods (Distance based, character-based method, statistical).

Module 4: Protein Structure: [9L]
Protein Structure: Primary, Secondary, Super Secondary, Domains, Tertiary, Quaternary, Ramachandran plot. Protein secondary structure prediction methods: J-Pred. Protein Tertiary structure prediction methods: Homology Modelling (Modeller and Swiss Model)

Module 5: Current Advancements in Bioinformatics: [9L]
Current Advancements in Bioinformatics: Introduction to System Biology, Structural Biology, Structural bioinformatics, Chemoinformatics, Immunoinformatics.

Text books:

T1. Introduction to Bioinformatics by Aurther M lesk
T2. Developing Bioinformatics Computer Skills By: Cynthia Gibas, Per Jambeck

Reference books:

R1. Fundamental Concepts of Bioinformatics, Dan E Krane, Michael L Raymer, Benjamin- Cummings Pub Co (Sept 2002, ISBN 0805346333)
R2. David W. Mount (2001) Bioinformatics: Sequence and Genome Analysis. Cold Spring harbor Press

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	20
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3

Mid Sem Examination Marks	√	√	
End Sem Examination Marks	√	√	√
Quiz I	√	√	
Quiz II		√	√

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
CO1	3	3		3			3					
CO2	3		3		3							
CO3								2			2	1

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1
CD2	Tutorials/Assignments	CO2	CD1
CD3	Seminars	CO3	CD1 and CD2
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **BE 206**
Course title: **Chemical Process Calculations**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits: **L: 3 T: 0 P:0**
Class schedule per week: 03
Class: **B. Tech**
Semester / Level: **III**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	To acquire a concept of degree of freedom and its application to solution of mass and energy balance equations for single and network of units
2.	The course will cover concepts ranging from basics such as units and dimensions, stoichiometry to the simultaneous application of material and energy balances with and without occurrence of chemical reaction.
3.	Further humidity along with the use of humidity chart will be covered in the course.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand the fundamentals of units and stoichiometric equations.
CO2	Write material balance for different chemical process.
CO3	Write energy balance for different chemical process.
CO4	Do humidity calculations.

(BE206) CHEMICAL PROCESS CALCULATIONS

Module-I: Chemical engineering calculations- **[8L]**

Units and dimensions, mole units, basis of calculations, the chemical equation and stoichiometry, dimensional analysis.

Module-II: Material balance fundamentals: **[8L]**

conversion and yield, material balance problems that do not involve chemical reactions.

Module-III: Material balance problems: **[8L]**

Material that involve chemical reactions, recycle, bypass and purge calculations.

Module-IV: Energy balance concepts: **[8L]**

Energy balance concepts and units, enthalpy changes, general energy balance that do not involve reactions.

Module-V: Energy balance that involves chemical reactions: [8L]

Energy balance that involves chemical reactions, Heat of solution and mixing, Humidity charts and their use.

Text books:

T1. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", EEE Sixth Edition, Prentice Hall Inc., 2003

T2. Felder, R. M. and Rousseau, R. W., "Elementary Principles of ChemicalProcesses",3rd Edn., John Wiley & Sons, New York, 2000.

T3. Bhatt, B.L., Vora, S.M., "Stoichiometry ", 4th Edition, Tata McGraw-Hill (2004)

Reference books:

R1. Hougen O A, Watson K M and Ragatz R A, "Chemical process principles" Part I CBS publishers (1973).

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	Yes
Tutorials/Assignments	Yes
Seminars	Yes
Mini projects/Projects	
Laboratory experiments/teaching aids	
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	Yes
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	20
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4
Mid Sem Examination Marks	√	√		
End Sem Examination Marks	√	√	√	√
Quiz I	√	√		
Quiz II			√	√

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	2	2	1	2							
2			3	3	3				2	1		
3		3	3						2	1		
4			3	3	3	3					3	

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3,4	CD1
CD2	Tutorials/Assignments	CO2	CD1, CD8
CD3	Seminars	CO3,4	CD1 and CD2
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **BE207**
Course title: **Cell Biology and Biochemistry Lab**
Pre-requisite(s): **BE202, BE204**
Co- requisite(s): **NIL**
Credits: 1.5 **L: 0 T: 0 P: 3**
Class schedule per week: 12 per week for 1.5 months
Class: **BTech**
Semester / Level: **III**
Branch: Bio-Engineering
Name of Teacher:

(BE207) Cell Biology and Biochemistry Lab

Experiment 1: Preparation of Buffers.
Experiment 2: Qualitative Test for Carbohydrates.
Experiment 3: Carbohydrate estimation by Anthrone.
Experiment 4: Qualitative Test for Amino Acids.
Experiment 5: Protein Estimation by Bradford Method.
Experiment 6: Protein Estimation by Lowry Method.
Experiment 7: Isolation and Estimation of DNA.
Experiment 8: Protein precipitation and purification SDS PAGE.
Experiment 9: Preparation of slides of mitosis from onion root tip cells.
Experiment 10: Study of different types of cells in the human blood smear.
Experiment 11: Identification of Barr bodies in the human cheek cells.
Experiment 12: To study the effect of plasmolysis and deplasmolysis in onion peel.
Experiment 13: To study the working of Compound microscope.
Experiment 14: To measure the length and breadth of the given cell sample by using micrometer.
Experiment 15: To identify the number of cells present in the given 1ml sample with help of haemocytometer.
Experiment 16: To identify the different types cells present in the leaf cross section.

Book

1. **Gerczei Fernandez, Timea / Pattison, Scott:** Biochemistry laboratory manual for undergraduates: An inquiry-based approach
2. **Arun Rastogi**: Laboratory Manual in Biochemistry

Course Outcomes

After the completion of this course, students will be able to:

1.	Apply knowledge of biotechnology, inculcate acknowledge of various issues related to biotechnological techniques. Evaluate the limitations of and troubleshoot experimental approaches.
2.	Design and conduct experiments, as well as to analyze and interpret data of different biotechnological methods.
3.	identify, formulate, and solve problems arisen due to the inefficient functioning of

	the systems in life sciences.
4.	Use the techniques, skills, and modern tools necessary for detection of the presence of biomolecules and their estimation collection and analysis of data, and interpretation of results.
5.	demonstrate knowledge and understanding of the engineering principles and apply these to manage projects work and recognition of the need for and an ability to engage in life-long learning
6.	Compare the structure of eukaryotic cells with the structure of simpler prokaryotic cells and with the structure of viruses.
7.	Independently execute a laboratory experiment using the standard methods and techniques in molecular biology, with the appropriate analysis and interpretation of results obtained.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment 60% (Distribution is as follows) a) Day to day performance & Lab files b) Quiz (es) c) Viva	60 30 10 20
Semester End Examination (Distribution is as follows) a) Examination Experiment Performance b) Quiz	40 30 10
Total	100

Indirect Assessment –

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

COURSE INFORMATTON SHEET

Course code: MA 204
Course title: Numerical Methods Lab
Pre-requisite(s): NIL
Co- rcquisite(s): - NIL
Credits:1 L: 0 T: 0 P: 2
Class schedule per week: 2 Sessional
Class: BE
Semester /Level: III
Branch: ALL
Name of Teacher:

List of Assignment

1. Find a simple root of $f(x)=0$ using bisection method. Read the end points of the interval (a,b) in which the root lies, maximum number of iterations n and error tolerance eps.
2. Find a simple root of $f(x)=0$ using Regula-Falsi method. Read the end points of the interval (a,b) in which the root lies, maximum number of iterations n and error tolerance eps.
3. Find a simple root of $f(x)=0$ using Newton Raphson method. Read any initial approximation x_0, maximum number of iterations n and error tolerance eps.
4. Solution of a system of $n \times n$ linear equations using Gauss elimination method with partial pivoting. The program is for 10×10 system or higher order system.
5. Matrix inversion and solution of $n \times n$ system of equations using Gauss-Jordan method. If the system of equations is larger than 15×15 change the dimensions of the float statement.
6. Program to solve a system of equation using Gauss-Seidel iteration method. Order of the matrix is n, maximum number of iterations $niter$, error tolerance is eps and the initial approximation to the solution vector is x_0. If the system of equations is larger than 10×10 change the dimension in float.
7. Program to find the largest Eigen value in magnitude and the corresponding Eigen vector of a square matrix A of order n using power method.
8. Program for Lagrange interpolation.
9. Program for Newton divided difference interpolation.
10. Program for Newton's forward and backward interpolation.
11. Program for Gauss's central difference interpolation (both backward and forward).
12. Program to evaluate the integral of $f(x)$ between the limits a to b using Trapezoidal rule of integration based on n subintervals or $n+1$ nodal points. The values of a,b and n are to be read. The program is tested for $f(x)=1/(1+x)$.
13. Program to evaluate the integral of $f(x)$ between the limits a to b using Simpson's rule of integration based on $2n$ subintervals or $2n+1$ nodal points. The values of a,b and n are to be read and the integrand is written as a function subprogram. The program is tested for $f(x)=1/(1+x)$.
14. Program to solve an IVP, $dy/dx=f(x), y(x_0)=y_0$ using Euler method. The initial value x_0, y_0 the final value x_f and the step size h are to be read. The program is tested for $f(x,y)=-2xy^2$.
15. Program to solve an IVP, $dy/dx=f(x), y(x_0)=y_0$ using the classical Runge-Kutta fourth order method with step size h, $h/2$ and also computes the estimate of the truncation error. Input parameters are: initial point, initial value, number of intervals and the step length h. Solutions with h, $h/2$ and the estimate of the truncation error are available as output. The right hand side The program is tested for $f(x,y)=-2xy^2$.

BE208 Biology of Immune System

Course code: **BE208**
Course title: **Biology of Immune System**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits: 3 **L: 3 T: 0 P: 0**
Class schedule per week: 3
Class: **B. Tech**
Semester / Level: **IV**
Branch: **Biotech**
Name of Teacher:

Course Objectives

This course enables the students:

1.	To provide a thorough understanding of various Immunological phenomenon occurring in the body to fight the entry of the antigen.
2.	To provide a thorough understanding of diversity of the antibodies and the different antigen and antibody reactions used for diagnosis of the various diseases.
3.	To provide students with a deep insight about the different immunological diseases.
4.	To teach our students to have a concrete knowledge about the types of vaccines and how are they made.
5.	To acquire in-depth knowledge of immunology, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

Course Outcomes

After the completion of this course, students will be able to:

CO1	To apply knowledge of immunology, inculcate a knowledge of various issues related to immunology eg. vaccines etc. and immunological techniques.
CO2	To design and conduct experiments, as well as to analyze and interpret data of different immunological methods.
CO3	To identify, formulate, and solve problems arisen due to the inefficient functioning of the immune system.
CO4	To use the techniques, skills, and modern tools necessary for detection of the immunological diseases, design a immunology research project, collect and analyze data, and interpret results
CO5	to demonstrate knowledge and understanding of the engineering principles and apply these to manage projects work are cognition of the need for and an ability to engage in life-long learning

(BE208) Biology of Immune System

Module-1: Basic Concepts in Immunology: [8L]
The immune system, innate and acquired immune system, components of immune system, role of humoral and cell-mediated immunity, Antibodies, the genetic basis of antibody diversity, structure-function, immunoglobulin classes. Polyclonal and Monoclonal antibodies, Catalytic antibodies.

Module-2: Antigen-Antibody Interaction: **[8L]**
Structure and properties of antigens, biological aspects of antibody-antigen interaction. Identification and measurement of antibodies and antigens, Radial Immuno diffusion, Ouchterlony, Double diffusion, Immuno-electrophoresis, Radio Immunoassay, ELISA, Western blot, Immunofluorescence, Comet Assay.

Module-3: Immunological Response: [8L]
Immune response, effector mechanisms, cytokines- Role of Cytokines in the Regulation of B Cells, Components of the Complement System.

Module-4: Major Histocompatibility Complex: [8L]
Immunology of Transplantation, Immunology of Graft Rejection, MHC proteins, types, Concept and types of vaccines.

Module-5: Immunological disorders: [8L]
Immunological disorders and Hypersensitivity: Immunodeficiency and autoimmunity, Types of hypersensitivity.

Text books:

T1. Kuby Immunology. W. H. Freeman & Co.
T2. Jareway et al, Immunology, the immune system in health and disease
T3. Cellular and molecular immunology, by Abul Abbas, Andrew Lichtman, and Jordan Pober. W. B. Saunders

Reference books:

R1. Roitt, Essential Immunology

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

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	20
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	10			
End Sem Examination Marks	√	√	√	√	√
Assignment*		√	√	√	√
Quiz I	√	√	√		
Quiz II				√	√

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	B	c	d	e	f	g	h	i	j	k	l
1	3	3										
2	3		3	3	3							
3	3				3		2					
4		3		3			2	2				
5						2			2	2		1

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD3, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD3, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **BE 209**
Course title: **Fluid mechanics & heat transfer**
Pre-requisite(s): **Nil**
Co- requisite(s): **Nil**
Credits: 3 **L: 3 T: 0 P: 0**
Class schedule per week: 03
Class: **B. Tech**
Semester / Level: **IV**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	To acquire a sound knowledge on fluid properties
2.	Dynamic characteristics of fluid flow for through pipes
3.	Flow measurement devices
4.	To learn heat transfer by conduction, convection and radiation

Course Outcomes

After the completion of this course, students will be:

1.	Understand the fundamental properties of fluids
2.	Analyze flow of fluid through pipe
3.	Understand and select flow meter(s) used in chemical process industries
4.	Understand the fundamentals of heat transfer mechanism

(BE209) Fluid Mechanics and Heat Transfer

Module-1: Basic Equations of Fluid Flow: **[8L]**
Fluid-Flow Phenomena, Newtonian and non-Newtonian fluids, Turbulence and its nature, Reynolds number and transition from laminar to turbulent flow, flow in boundary layers, boundary layer formation in straight tubes, continuity equation, Bernoulli equation with and without fluid friction, pump work in Bernoulli equation.

Module-2: Flow of Incompressible Fluids: **[8L]**
Fluid flow in pipes, friction factor, laminar flow in pipes, Hagen-Poiseuille equation, turbulent flow in pipes and closed channels, effect of roughness, friction factor charts, Reynolds numbers and friction factor relationship, friction losses from sudden expansion and contraction of cross section, flow measuring devices such as venturimeter, orifice meter, pitot tube and rotameter.

Module-3: Heat Transfer by Conduction in Solids: **[8L]**
Fourier's Law, thermal conductivity, Steady state conduction, compound resistance in series, heat flow through a cylinder, one dimensional unsteady state heat conduction.

Module-4: Heat Transfer by Convection: **[8L]**
Thermal boundary layer, Heat transfer by forced convection in laminar and in turbulent flows, heat transfer by natural convection in laminar flow, heat transfer from condensing vapors, film wise and dropwise condensation.

Module-5: Radiation Heat Transfer: **[8L]**
Fundamental facts concerning radiation, emission of radiation, black body radiation, absorption of radiation by opaque solids, Kirchhoff's Law, radiation between surfaces, view factors, combined heat transfer by conduction-convection and radiation.

Text Books :

T1. McCabe, Smith and Harriot, Unit Operation of Chemical Engineering
T2. Fox and McDonald, Introduction to fluid mechanics
T3. Hollman, Heat transfer, 8th Ed.
T4. Geankoplis, Transport processes and unit operations

Reference books:

R1. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999.
R2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering " Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998.

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	Yes
Tutorials/Assignments	Yes
Seminars	Yes
Mini projects/Projects	
Laboratory experiments/teaching aids	
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	Yes
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	20
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5	CO6
Mid Sem Examination Marks	√	√				√
End Sem Examination Marks	√	√	√	√	√	√

Assignment*		√	√	√	√	√
Quiz I	√	√	√			
Quiz II				√	√	√

Indirect Assessment –

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	B	c	d	e	f	g	h	i	j	k	l
1	3	3	3	3	3	2						
2		3	3	3	3							
3		3	3					2	2	2		
4		3	3	3	3	2				2	2	

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1,2,3,4	CD1
CD2	Tutorials/Assignments	CO2,3	CD1 and CD8
CD3	Seminars	CO2	CD1 and CD2
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **BE210**
Course title: **Thermodynamics of Chemical & Biological Systems**
Pre-requisite(s): **NIL**
Co- requisite(s):- **NIL**
Credits: 3 **L: 03 T:0 P:0**
Class schedule per week: 03
Class: **B. Tech**
Semester / Level: **IV**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	To design, calculate and different thermodynamic parameters of chemical and biological system and interpreting experimental data.
2.	To understand the concept basic of thermodynamics principle and energy conversion and discrimination of analytical data
3.	To develop expertise and learn major concepts on applications of thermodynamics on chemical as well as biological systems.
4.	To develop knowledge pertaining to analyze thermodynamic basics for any biological pathway.
5.	Students will be able to understand the solution theory.
6.	To expand skills in the scientific method of planning, developing, conducting, reviewing and reporting experiments.
7.	A clear understanding of thermodynamics concepts prepares a student for making a career as R&D expert/ analyst/ quality control manager/ product development manager etc.
8.	Students are able to search, select, organize and present information related to thermodynamics of any complex chemical and biological system.

Course Outcomes

After the completion of this course, students will be:

CO1	An ability to design, calculate and different thermodynamic parameters of chemical and biological system and interpreting experimental data.
CO2	An ability to analyze a system, component, or process to performing research in chemical/biological system and addressing the challenges associated with the complex chemical/biological system. Know how to meet the desired needs within realistic constraints, such as, economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
CO3	An ability to apply the knowledge of various types of industrially used complex solution, metabolic pathways and enzymes modelling.
CO4	An ability to understand, design and application of the processes of molecular transition, energy analysis of any system.
CO5	An ability to prepare a student for careers in higher education, as well as in pharmaceutical and biotechnology industries in governmental and private agencies in multidisciplinary teams. An ability to identify, formulate, and solve engineering problems.

(BE210) Thermodynamics of Chemical & Biological Systems

Module-I: **[8L]**

Continuum and Macrose approach, Systems, control volume, intensive and extensive properties, Thermodynamic equilibrium, State of system, state diagram, path and process, Zeroth law Thermodynamics, concept of temperature, Heat and work conversion, Specific Heats.

Module-II: **[8L]**

Thermodynamic properties of pure substances in solid, Liquid and vapour phases, Equations of state, Thermodynamic property table and charts. First law of Thermodynamics: Energy and its forms, Enthalpy, Compressibilities and expansion coefficient, First law applied to control volumes (Open System) – Steady & Unsteady flow analysis. Typical applications.

Module-III: **[8L]**

Corollaries of Second Law – Reversible and irreversible processes, Thermodynamic (absolute) temperature scale, Inequality of Clausius and concept of Entropy. Cycles:Vapour power cycles – Carnot, Rankine, Air-Stand Cycles –Diesel Cycles.

Module- IV: **[8L]**

Vapour compression refrigeration cycle. Gibbs – Duhem equation, phase rule, single component phase equilibria. Thermodynamics of solutions. Ideal and non-ideal solutions. Estimation and determination of activity coefficients, Chemical Homogenous and heterogeneous reaction systems.

Module-V: **[8L]**

Thermodynamic analysis of Classical and non-equilibrium biochemical reactions: Glycolysis cycle, TCA cycle, Helix-coil transition, coupled reaction.

Books Recommended:

Text Books

T1. P.K. Nag, Thermodynamics

T2. Wylen, Fundamentals of classical thermodynamics.

T3. Denbigh, Principles of chemical equilibria

Reference books:
R1. Dodge, Chemical engineering thermodynamics

R1. Stephanoponlos et al, Metabolic engineering, Principles and Methodologies.

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids

Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	20
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	√	√	√	√
End Sem Examination Marks	√	√	√	√	√
Assignment*		√	√	√	√
Quiz I	√	√	√		
Quiz II				√	√

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	L
1	√	√		√	√	√	√		√	√		
2		√	√		√		√	√	√	√		
3	√	√		√	√	√	√	√	√	√		
4	√	√		√	√	√	√	√		√		√
5	√	√		√	√	√	√	√		√	√	√

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD8, CD9
CD4	Mini projects/Projects	CO4	CD1, CD2, CD3, CD8, CD9
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD3, CD8, CD9
CD6	Industrial/guest lectures		

CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **BE215 R1**
Course title: **Cellular Electrophysiology**
Pre-requisite(s): **Basic on cell biology**
Co- requisite(s): **Basic electrical measurement**
Credits: 3 **L: 3 T: 0 P: 0**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **IV**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	To impart knowledge for interdisciplinary, applied engineering and technology.
2.	To understand basic cellular electrical characteristics.
3.	To learn and correlate the technicality associated with cell electrophysiology with electrical components and circuits.
4.	To record and analyse the electrophysiological characteristics of living system.

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the generation of cell potentials.
CO2	Learn and apply the cellular electrical activities with basic electrical components.
CO3	Analyse the electrical model of generation and transmission of action potentials.
CO4	Evaluate the electrophysiological characteristics of living system.
CO5	Understand and create a model of dynamics of receptor physiology in diseases.

(BE215R1) Cellular Electrophysiology

Module-1: Introduction: [8L]

General anatomy of excitable cells/tissues; Ion movements in excitable cells and tissues; General concept of resting potential, depolarization, repolarization, and action potentials in terms of ionic movements; Types of electrical potentials generated in different types of excitable cells; General concept of voltage and current clamping; Types of recording systems used in cellular electrophysiology.

Module-2: Basic laws of cell electrophysiology: [8L]

Physical laws involved in ionic movement in excitable cells; Nernst-Plank equation; Nernst equation; Ion distribution and gradient maintenance; Active and passive transport of ions; Donnan equilibrium; Movement of ions across biological membrane; Goldman-Hodgkin-Katz (GHK) model and equation; Diversity of voltage gated ion channels.

Module-3: Electrical Circuit Analogy: [8L]

Equivalent circuit representation of biological membrane; Membrane conductance; Ionic conductance; Parallel conductance model and circuit representation of passive properties of cell; Generalized graph of voltage-current relationship; Functional and nonlinear properties of excitable cells.

Module-4: Nonlinear properties and is model: [8L]

Active conductance (nonlinear properties of excitable cells) and their electrical circuit representations; Hodgkin-Huxley's analysis; Fundamentals of synaptic transmission.

Module-5: Engineering applications: [8L]

Integrated action potentials in terms of bioelectrophysiology; Important biosignals (ECG, EMG, EEG) and their diagnostic importance; Types of signals and noises; Equivalent circuit for electrode-body interface; Fundamentals of man-machine interface.

Text Books:

T1. Guyton, A.C. Medical physiology. 8th/9th Intnl Edn., Philadelphia, W.B. Saunders, 2001/2006.
T2. Kandel, E. R, Shwartz, J. H. Principles of Neural Science. New York: Elsevier/North-Halland, 1991.
T3. Johnston, D., Wu, S. Foundations of cellular neurophysiology. Cambridge: MIT Press, 1995.

Reference Books:

R1. Khandpur, R. S. Handbook for Biomedical Instrumentation. 3rd edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

1. Conducting presentations in group and writing reports
2. Giving assignments to the students on some relevant topics

POs met are: a, b, c, f

Topics beyond syllabus/Advanced topics/Design

1. Lecture on specialised techniques in electrophysiological recordings

2. Lecture on specialized electrophysiological devices

POs met through Topics beyond syllabus/Advanced topics/Design

POs met are: f, g

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors (CD1)
Tutorials/Assignments (CD2)

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	20
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	10			
End Sem Examination Marks	√	√	√	√	√
Assignment*		√	√	√	√
Quiz I	√	√	√		
Quiz II				√	√

Indirect Assessment –

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Course Outcome #	Program Outcomes											
	A	b	c	d	e	f	g	h	i	j	k	l
1	3		3									
2	3	3										
3	3		3		3							
4	3	3	3			2						
5		3	3			2	2					

Mapping Between Cos and Course Delivery (CD) methods

Mapping Between Cos and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors		CO1, CO2, CO3, CO4	CD1
CD2	Tutorials/Assignments		CO5	CD1 and CD2
CD5	Laboratory experiments/teaching aids		CO4, CO5	CD5

COURSE INFORMATION SHEET

Course code: **BE 216**
Course title: **Enzyme Technology**
Pre-requisite(s):
Co- requisite(s):
Credits: 3 **L: 3 T: 0 P:0**
Class schedule per week: **3**
Class: **B.Tech.**
Semester / Level: **IV**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	To learn the fundamental principles of enzyme technology.
2.	To impart the knowledge on enzyme kinetics and its application in industrial bioprocess development.
3.	To understand the use of enzyme as tool in the field of pharmaceutics and agriculture.

Course Outcomes

After the completion of this course, students will be able:

CO1	To apply the engineering principles to produce, purify and manipulate the enzyme for various industrial processes.
CO2	To comprehend the various methods of clinical practices and green chemical process and can design the sustainable bioprocess using the enzymes.
CO3	To analyze a research problem and write clear, step-by-step instructions for conducting experiments or testing hypothesis.

(BE216) Enzyme Technology

Module-1: Introduction to Enzymes and Enzyme Models: [8L]
Chemical nature and properties of enzymes. Energy of activation, Enzyme activity, types of enzyme specificities, enzyme substrate reactions. Lock and key hypothesis induced fit hypothesis, Multi-substrate reactions, Allosteric enzymes, Isoenzymes, Multienzyme complex, and multifunctional enzymes.

Module-2: Enzyme Kinetics: [8L]
Covalent catalysis, acid base catalysis, metal ion catalysis with mechanism. Kinetics of single substrate, multi-substrate, reversible and allosteric enzymes. Enzyme inhibition-competitive, uncompetitive and noncompetitive inhibition. Enzyme deactivation kinetics, factors affecting enzyme kinetics.

Module-3: Screening, Extraction, Purification and Characterization of Enzymes: [8L]
Screening for novel biocatalysts, enzyme assay, general procedures for isolation and selection of microorganisms involved in enzyme production, high-throughput screening, strategies of extraction and purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes. Creation of tailor-made biocatalyst.

Module-4: Immobilization of Enzymes and Methods of Enzyme Stabilization: [8L]
Methods of enzyme immobilization, production and application of free and immobilized enzymes in food and feed, detergent, textiles, pulp and paper, pharmaceuticals, diagnostics. Kinetics of immobilized enzymes. Stability of enzymes: Enzyme stabilization by selection and genetic engineering, protein engineering, reaction environment rebuilding.

Module-5: Clinical and Industrial Applications of Enzymes: [8L]
Importance of enzymes in diagnostics-use of enzymes to determine the concentration of metabolites of clinical importance, Determination of enzyme activities for clinical diagnosis. Detection of inborn errors by the assay of enzymes, use of microorganisms in the production of organic chemicals, use of enzymes in industrial processes.

Text books:
T-1: Lehninger, Nelson, Cox, Principles of Biochemistry.
T-2: Enzyme by Palmer (2001); Horwood publishing series

Reference books:
R-1: Godfrey and West, Industrial enzymology

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	20
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3
Mid Sem Examination Marks	√	10	
End Sem Examination Marks	√	√	√
Assignment*		√	√
Quiz I	√	√	√
Quiz II		√	√

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	3	3	2	2			1		1
2	3	3	3	3	3	2	2	2	1	1	2	1
3	3	3	3	3	3	2	2	2	1	1	2	1

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD7
CD3	Seminars	CO3	CD1, CD2, CD8
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: BE214 R1
Course title: Natural Product Biotechnology
Pre-requisite(s): BE 204 Biochemistry and Enzyme Technology
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: IV
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	To identify the major sources of natural substances and their significance
B.	To establish an understanding of the major classes of phytochemicals, biosynthesis pathways and screening of natural products
C.	To expose students to the different methods of isolation, separation, purification and characterization of natural products
D.	To develop the understanding of different methods of production of biotech natural products at laboratory as well as industrial level

Course Outcomes

After the completion of this course, students will be:

1.	Able to know about the various sources of natural products and their importance
2.	Able to know about the major classes of phytochemicals, their biosynthesis and screening techniques
3.	Able to distinguish the different methods of isolation and analytical techniques for separation, purification and characterization of natural products
4.	Able to design the steps of production of natural products at laboratory and industrial scale

(BE214R1) Natural Product Biotechnology

Module-1: Natural Substances: [8L]
Sources and Importance; Interrelationships of major biosynthetic pathways of secondary metabolites, Classification of Phytochemicals

Module-2: Biosynthesis and Screening of Natural Products: [8L]
Glycosides -shikimic acid and phenylalanine pathways, Terpenoids-Monoterpenoids, Alkaloids-Ephedrine, Phenylpropanoids via the Shikimic Acid Pathway

Module-3: Analysis of Natural Products: [8L]
Extraction by aqueous and non-aqueous methods, purification by TLC, HPTLC, HPLC, characterization by Mass and NMR spectrometry; Plant metabolomics

Module-4: Production techniques of Natural Products-I: [8L]
Extraction (Essential oils, Pigments); Plant cell culture (Ginseng, Shikonin, Taxol)

Module-5: Production techniques of Natural Products-II: {8L]
Fermentation (Biopharmaceuticals, Nutraceuticals, Flavouring agents); Heterologous natural product biosynthesis

Text Books:
T1. Kar, A., Pharmacognosy and pharmacobiotechnology. 2nd Edition, Anshan Ltd., 2008.
T2. Agrawal S.S., Paridhavi M. Herbal drug technology. 2nd Edition, Universities Press, 2012.

Reference Books:
R1. Gahlawat, S.K., Salar, R.K., Siwach, P., Duhan, J.S., Kumar, S., Kaur, P. Plant Biotechnology: Recent Advancements and Developments. 1st Edition, Springer, Singapore, 2017.

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors ✓
Tutorials/Assignments ✓
Seminars ✓
Mini projects/Projects ✓
Laboratory experiments/teaching aids ✓
Industrial/guest lectures ✓
Industrial visits/in-plant training ✓
Self- learning such as use of NPTEL materials and internets ✓
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End Sem Examination Marks	50
Assignment / Quiz (s) (2 No.)	20
Faculty Assessment	05

Assessment Compoents	CO1	CO2	CO3	CO4

Mid Sem Examination Marks	10	15		
End Sem Examination Marks	8	12	15	15
Assignment	5	5	5	5
Faculty Assessment			2.5	2.5

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	E	f	g	h	i	j	k	l
1	3					2						
2	3	2				2						
3	3	3	2			2	2		2	2		2
4	3	3	3	2	2	2	2	2	3	2	2	2

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1, CD2, CD3
CD2	Tutorials/Assignments		CO2	CD1, CD2, CD3, CD5
CD3	Seminars		CO3	CD1, CD2, CD3, CD4, CD5, CD6, CD8
CD4	Mini projects/Projects		CO4	CD1, CD2, CD3, CD4, CD5, CD6, CD7, CD8
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE318
Course title: Bioenergy and Biofuels
Pre-requisite(s): BE 307 Bioprocess Engineering
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: IV
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	To establish an understanding of the major types of biofuels and energy, biosynthetic pathways, processing and applications.
B.	To give knowledge of Biofuel properties, specifications and guidelines.
C.	To describe production strategies for various Biofuels and to introduce them with technology development for Biofuel production.
D.	To outline principles of biomass conversion of fuels
E.	To describe Environmental assessments due to uses of biofuels-Biofuels economics
F.	To introduce students with biofuels economics

Course Outcomes

After the completion of this course, students will be:

1.	Able to know about different types of biofuels, biosynthetic pathways, processing and applications.
2.	Acquiring knowledge of biofuel properties, specifications and guidelines
3.	They will be able to evaluate the industrially important biofuel and design the technology for the same.
4.	They will be able to analyze the biofuel issues and correlate them with economic aspects.

(BE318) Bioenergy and Biofuels

Module-1: Introduction to Bioenergy & Biofuels: **[8L]**
Introduction to energy – Global energy scene – Indian energy scene – Units of energy, conversion factors, general classification of energy, energy crisis, energy alternatives. Fossil fuels and environmental issues-Introduction to Biofuels and its promises-Various types of Biofuels its classification and applications-Importance and types of feed stocks, Biomass and raw materials for Biofuels-1st 2nd and 3rd generation Biofuels.

Module-2: Biochemical Pathways and Biosynthesis of Fuels: **[8L]**
Different energy harvesting biochemical pathways & their exploitation to Biofuels –Fermentation strategies: Aerobic & Anaerobic for Biofuel production with examples-Microbial modelling and Metabolic Engineering for Biofuel Production-Algae for oil production.

Module-3: Industrial Biofuel Production: **[8L]**
Production strategies for various Biofuels: Bioethanol, Biobutanol and other alcohols, Biodiesel, Hydrogen, Methane-Raw material conversion to Biofuels: Pre-treatment methods, Enzymology for biomass utilization, Transesterification and Thermal depolarization-Experiments on biomass Pre-treatment: Mass balances and yields-Industrial scale ups, Technology development for Biofuel production.

Module-4: Biorefining and Standardization: **[8L]**
Inhibitors and detoxification: Impact on biomass conversion-Bio refining of Biofuel residues-Biofuel properties, specifications and guidelines-Biomass fuel cycle methodology-Terminal operations.

Module-5: Biofuel Economics: **[8L]**
Alternate fuels: global & Indian scenario-Feedstock economics, Biofuels demand and supply-Clean air/energy policy act-Environmental assessments -Biofuels economics and policy,Boutique fuels.

Text Books:

1. Sameer A Zogdekar, "Biofuels Introduction and Country Experiences", Published by ICFAI University Press., ISBN No. 978-8131416051, 2008.
2. David M Mousdale, "Biofuels: Biotechnology, Chemistry and Sustainable Development", Published by Taylor And Francis Group CRC Press., ISBN No.978-1439812075, 2008.
3. Alain A Vartes, Nasib Qureshi, "Biomass to Biofuels: Strategies for Global Industries", Published by John Wiley & Sons Ltd., ISBN No. 978-0470513125, 2009.

Reference Books:

1. David Pimentel, "Biofuels, Solar and Wind as Renewable Energy Systems", Published by Springer-Verlag., ISBN No. 978-9048179459, 2010.

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	✓
Tutorials/Assignments	✓
Seminars	✓
Mini projects/Projects	
Laboratory experiments/teaching aids	✓
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	✓
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05

Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Mid Sem Examination Marks	10	15		
End Sem Examination Marks	12	15	13	10
Assignment*	**3**	5	7	5

* Best of two quiz: Quiz 1-CO2 & CO3; Quiz 2: CO4 & CO5 + Seminar (5 marks): best of two

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3					2						
2	3		3		2	2						
3	3		3			2						
4	3		3			2						
5			3			2						
6		3							2	2		1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1, CD2 and CD8
CD2	Tutorials/Assignments		CO2	CD1, CD2, CD3 and CD8
CD3	Seminars		CO3	CD1, CD2, CD3 and CD8
CD4	Mini projects/Projects		CO4	CD1, CD2, CD3 and CD8
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: **BE211**
Course title: **Microbiology and Immunology Lab**
Pre-requisite(s): **Basic Knowledge of microbiology and Immunology**
Co- requisite(s):
Credits: 1.5 **L: 0 T: 0 P: 3**
Class schedule per week: **3**
Class: **B.Tech**
Semester / Level: **IV**
Branch: **Biotechnology**
Name of Teacher:

Course Objectives

This course enables the students:

A.	To learn the fundamental principles of microbiology and immunology lab practices.
B.	To impart the knowledge on microbial techniques and its application.
C.	To understand the concept of antigen-antibody interaction-based techniques & its application to detect the various disease conditions.

Course Outcomes

After the completion of this course, students will be able:

1.	To demonstrate experimental skill of microbiology and immunology as well as competence in laboratory techniques.
2.	To develop the proficiency in handling, culturing, identification of microorganism and its further uses.
3.	To demonstrate the experimental skill required to identify the antigen or antigen by various techniques.
4.	To design and conduct the research in the field of microbiology and immunology and may explore the further applications.

(BE211) Microbiology and Immunology Lab

Experiment 1: Cleanliness, media preparation, sterilization, dilution techniques and isolation of pure cultures – techniques.
Experiment 2: Staining techniques in microbiology; Identification of unknown bacteria by biochemical tests.
Experiment 3: Bacterial growth curve – serial dilution plating and turbidity measurement.
Experiment 4: Extracellular enzymatic activities of microbes.
Experiment 5: Standard qualitative analysis of water.
Experiment 6: Antibiotic sensitivity test.
Experiment 7: To detect the blood group of the given sample.
Experiment 8: To perform the Technique of Radial immunodiffusion.
Experiment 9: To learn and perform the technique of Ouchterlony Double Diffusion Technique.
Experiment 10: To perform the pregnancy test with the help of Pregnancy Kit.
Experiment 11: To learn the technique of Immunoelectrophoresis.

Experiment 12: To study the technique of Rocket Immunoelectrophoresis for determination of concentration of antigen in unknown sample.

Experiment 13: To perform widal test for detection of typhoid.

Experiment 14: To perform the sandwich Dot ELISA Test for antigen detection.

Experiment 15: To identify cells in a blood smear.

Text books:

T-1: D. K. Maheshwari and R. C. Dubey, Practical Microbiology. S. Chand.

T-2: Frank C. Hay and Olwyn M. R. Westwood, Practical Immunology. Wiley-Blackwell; 4th Revised edition

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 & Evaluation procedure Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment 60% (Distribution is as follows)	60
a) Day to day performance & Lab files	30
b) Quiz (es)	10
c) Viva	20
Semester End Examination (Distribution is as follows)	40
a) Examination Experiment Performance	30
b) Quiz	10
Total	100

Indirect Assessment –

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

COURSE INFORMATION SHEET

Course code: **BE 212**
Course title: **Fluid Mechanics & Heat Transfer Lab**
Pre-requisite(s): **BE209 Fluid Mechanics & Heat Transfer**
Co- requisite(s): **NIL**
Credits: 1.5 **L: 0 T: 0 P: 3**
Class schedule per week: 03
Class: **B. Tech**
Semester / Level: **IV**
Branch: **Biotechnology**
Name of Teacher:

This course enables the students:

1.	To acquire a sound knowledge on fluid properties
2.	Dynamic characteristics of fluid flow for through pipes
3.	Flow measurement devices
4.	To learn heat transfer by conduction, convection and radiation

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the fundamental properties of fluids
CO2	Analyze flow of fluid through pipe
CO3	Understand and select flow meter(s) used in chemical process industries
CO4	Understand the fundamentals of heat transfer mechanism

(BE212) Fluid Mechanics & Heat transfer lab

S. No	**Name of Experiments**
Experiment -1	To obtain the Reynolds number in different flow conditions.
Experiment -2	To calibrate Venturi meter and to study the variation of coefficient of discharge with the Reynolds number.
Experiment -3	To calibrate an orifice meter and to study the variation of coefficient of discharge with the Reynolds number.
Experiment -4	Calibration of Rotameter.
Experiment -5	To verify the Bernoulli's theorem experimentally.
Experiment -6	Determination of friction factor of a pipe.
Experiment -7	To study the pattern of flow in free and forced vertex.
Experiment -8	Calculate the thermal conductivity of the given liquid.
Experiment -9	Thermal conductivity of insulating powder.
Experiment -10	Calculate the heat transfer coefficient for a pipe by natural convection.
Experiment -11	Calculate the heat transfer coefficient for a pipe by forced convection.
Experiment -12	Determine the emissivity of the given material.
Experiment -13	Impact of jet on vanes (Flat and hemispherical plate).
Experiment -14	Jet pump test rig.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment 60% (Distribution is as follows) a) Day to day performance & Lab files b) Quiz (es) c) Viva	60 30 10 20
Semester End Examination (Distribution is as follows) a) Examination Experiment Performance b) Quiz	40 30 10
Total	100

Indirect Assessment –

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

COURSE INFORMATION SHEET

Course code: EE102
Course title: Electrical Engineering Laboratory
Pre-requisite(s): Physics, Fundamentals of Mathematics and Electrical Engineering.
Co- requisite(s): NIL
Credits: L:0 T:0 P: 3
Class schedule per week: 12 per week for 1.5 months
Class: BTech
Semester / Level: IV
Branch: Biotechnology
Name of Teacher:

Course Overview: Concepts of measuring instruments, AC RLC series parallel circuit operation, resonance, KVL and KCL, circuit theorems, 3-phase star and delta connections, measurement of low and high resistance of D.C. machine, measurement of power by three voltmeter, three-ammeter methods, measurement of power of 3-phase induction motor by two-wattmeter method.

Course Objectives

This course enables the students:

1	To describe students practical knowledge of active and passive elements and operation of measuring instruments
2	To demonstrate electrical circuit fundamentals and their equivalent circuit models for both 1-φ and 3- φ circuits and use circuit theorems
3	To establish voltage & current relationships with the help of phasors and correlate them to experimental results
4	1. To conclude performance of 1 – Φ AC series circuits by resonance phenomena 2. To evaluate different power measurement for both 1-φ and 3- φ circuits

Course Outcomes

After the completion of this course, students will be able to:

CO1	classify active and passive elements, explain working and use of electrical components, different types of measuring instruments;
CO2	illustrate fundamentals of operation of DC circuits, 1-φ and 3- φ circuits and also correlate the principles of DC, AC 1-φ and 3- φ circuits to rotating machines like Induction motor and D.C machine.;
CO3	measure voltage, current, power, for DC and AC circuits and also represent them in phasor notations;
CO4	analyse response of a circuit and calculate unknown circuit parameters;
CO5	recommend and justify power factor improvement method in order to save electrical energy.

List of Experiments:

1. **Name: Measurement of low & high resistance of DC shunt motor**
   Aim:

   (i) To measure low resistance of armature winding of DC shunt motor
   (ii) To measure high resistance of shunt field winding of DC shunt motor

2. **Name: AC series circuit**
   Aim:

(i) To obtain current & voltage distribution in AC RLC series circuit and to draw phasor diagram
(ii) To obtain power & power factor of single phase load using 3- Voltmeter method and to draw phasor diagram

3. **Name: AC parallel circuit**
   Aim:

(i) To obtain current & voltage distribution in AC RLC parallel circuit and to draw phasor diagram
(ii) To obtain power & power factor of single phase load using 3- Ammeter method and to draw phasor diagram

4. **Name: Resonance in AC RLC series circuit**
   Aim :

   (i) To obtain the condition of resonance in AC RLC series circuit
   (ii) To draw phasor diagram

5. **Name: 3 phase Star connection**
   Aim :

   (i) To establish the relation between line & phase quantity in 3 phase star connection
   (ii) To draw the phasor diagram

6. **Name: 3 phase Delta connection**
   Aim :

   (i) To establish the relation between line & phase quantity in 3 phase delta connection
   (ii) To draw phasor diagram

7. **Name: 3 phase power measurement**
   Aim :

   (i) To measure the power input to a 3 phase induction motor using 2 wattmeter method
   (ii) To draw phasor diagram

8. **Name: Self & mutual inductance**
   Aim :

   To determine self & mutual inductance of coils

9. **Name: Verification of Superposition, Thevenin's and Reciprocity theorem**
   Aim :

   (i) To verify Superposition theorem for a given circuit
   (ii) To verify Thevenin's theorem for a given circuit

10. Name: Verification of Norton's, Tellegen's and Maximum Power transfer theorem
Aim :

(i) To verify Norton's theorem for a given circuit
(ii) To verify Maximum Power transfer theorem for a given circuit

Gaps in the syllabus (to meet Industry/Profession requirements)

1. Application of principles of magnetic circuits to electrical machines like transformers, generators and motors
2. Visualize Phase sequence

POs met through Gaps in the Syllabus: 1, 2, 3, 7.

Topics beyond syllabus/Advanced topics/Design

1. Assignment : Simulation of electrical circuits with dependent/independent sources by various techniques (Mesh current/Node Voltage/Thevenin's theorem/Norton's theorem/Maximum power transfer theorem etc.) using MATLAB/PSIM/C++ softwares
2. Active/reactive power calculation for 3 – Φ circuits

POs met through Topics beyond syllabus/Advanced topics/Design: 5, 6, 7, 8, 9.

Mapping of lab experiment with Course Outcomes

Experiment	Course Outcomes				
	CO1	CO2	CO3	CO4	CO5
1	3	3	3	2	
2	3	3	3	3	2
3	3	3	3	3	2
4	3	3	3	3	2
5	3	3	3	1	
6	3	3	3	1	
7	3	3	3	2	2
8	3	3	3	3	
9	3	3	3	2	
10	3	3	3	2	

Course Delivery methods	
CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Mini projects/Projects
CD4	Laboratory experiments/teaching aids
CD5	Self- learning such as use of NPTEL materials and internets
CD6	Simulation

Course Evaluation:

Daily individual assessment through viva:	20	
Regular evaluation of fair and rough copy:	15+5=20	Progressive evaluation (60)
Regularity/Punctuality:	10	
Assignment:	10	
Practical examinations:	20	
End sem Viva-voce :	20	end evaluation (40)
TOTAL:	**100**	

Mapping of Course Outcomes onto Course Objectives

Course Outcome #	Course Objectives			
	CO1	**CO2**	**CO3**	**CO4**
1	3	3	3	3
2	3	3	3	3
3	3	3	3	3
4	3	3	3	3
5	2	3	3	3

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	3	3	3	3	L	3	3	3	3	3	3
2	3	3	3	2	2	2	2	3	3	3	3	3
3	3	3	3	2	2	2	2	2	3	3	2	3
4	3	3	3	3	3	1	2	2	3	3	2	2
5	3	3	3	3	3	2	3	3	3	3	3	3

Mapping of Course Outcomes onto Program Educational Objectives

Course Outcome #	Program Educational Objectives			
	1	2	3	4
1	3	3	2	2
2	3	3	3	
3	3	3	3	2
4	3	3	3	
5	H	H	M	M

Mapping Between COs and Course Delivery (CD) methods

Course Outcome	Course Delivery Method
CO1	CD1,CD2,CD4, CD5
CO2	CD1,CD4,CD5
CO3	CD1,CD3,CD4,CD5,CD6
CO4	CD1,CD2,CD4, CD5
CO5	CD4, CD5

Course Delivery (CD) methods		Program Outcomes (PO)											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CD1	Lecture by use of boards/LCD projectors	2	1	1	2	3	1						
CD2	Tutorials/ Assignments	2	2	2	2	3	3			3	3	1	2
CD3	Seminars												
CD4	Mini projects/Projects												
CD5	Laboratory experiments/teaching aids	3	3	3	3	3	1		2	3	2	2	3
CD6	Industrial/guest lectures												
CD7	Industrial visits/in-plant Training												
CD8	Self- learning such as use of NPTEL materials and Internets	3	3	3	3	3	3	2	3	2	3	2	2
CD9	Simulation	3	3	3		3	3			2	2		

COURSE INFORMATION SHEET

Course code: BE301
Course title: Bio-analytical techniques
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: V
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	Develop the ability to design and conduct experiments, including making measurements and interpreting experimental data from living system and addressing the problems associated with the interaction between living systems and nonliving materials.
B.	An understanding of the use of different instruments, discrimination of analytical data; and functions of different components of the selected instruments and their effects on data analysis.
C.	To develop expertise, an understanding of the range and theories of instrumental methods available in biological research/ biotechnology.
D.	To develop knowledge pertaining to the appropriate selection of instruments for the successful analysis of complex mixture.
E.	To provide an understanding of and skills in advanced methods of separation and analysis.
F.	To expand skills in the scientific method of planning, developing, conducting, reviewing and reporting experiments.
G.	A clear understanding of bioanalytical technique prepares a student for making a career as R&D expert/ analyst/ quality control manager/ product development manager etc.

H.	Students are able to search, select, organize and present information related to bioinstrumentation.

Course Outcomes

After the completion of this course, students will be:

1.	An ability to apply knowledge of mathematics, science, and engineering. An ability to design and conduct experiments, as well as to analyze and interpret data for related to domain of Bioinstrumentation.
2.	An ability to design a system, component, or process to performing research in biological system and addressing the challenges associated with the Centrifugation Techniques and Electro-kinetics. Know how to meet the desired needs within realistic constraints, such as, economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
3.	An ability to apply the knowledge of various types of industrially used Chromatographic Techniques and imaging methods; advantages and disadvantages, design criteria, molecular imaging, instrumentation and various aspects of operation.
4.	An ability to understand, design and application of the processes of Spectroscopy and Thermal Analysis
5.	An ability to prepare a student for careers in higher education, as well as in pharmaceutical and biotechnology industries in governmental and private agencies in multidisciplinary teams. An ability to identify, formulate, and solve engineering problems.

(BE301) BIOANALYTICAL TECHNIQUES

Module-I: Centrifugation Techniques and Electro-kinetics: **[8L]**
Principle, instrument and application of steady state sedimentation, density gradient centrifugation, analytical centrifugation.

Module-II: Electro-kinetics: **[8L]**
Electro-osmosis and electrophoresis, Helmholtz-Smoluchowski equation, Zeta potential, Principle, design and application of Gel electrophoresis; SDS-PAGE, gradient gels, Two dimensional gels, isoelectric focusing.

Module-III: Chromatographic Techniques: **[8L]**
Principles, design and application of column chromatography, partition and adsorption chromatography, Affinity Chromatography; Ion Exchange Chromatography, Gas Chromatography, HPLC

Module-IV: Spectroscopy -I: **[8L]**

Beers Lamberts law, Principles, Instrumentation and applications of Visible and UV Spectrophotometry; Spectroflourimetry (FRET); FTIR, NMR spectroscopy.

Module-V: Spectroscopy – II and Thermal Analysis: [8L]
Principles, Instrumentation & applications for flame emission / atomic absorption spectrophotometry and their comparative study; ICP (b) Mass spectrometry; Principles, Instrumentation and applications. Instrumentation and application of Differential scanning calorimetry and Thermogravimetry.

Books Recommended:

1. K. Wilson & K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry.
2. Willard and Merrit, Instrumental Methods and Analysis
3. Ewing GW, Instrumental Methods of Chemical analysis.

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10

Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem Exam	√	√	√	√	√
End Sem Examination Marks	√	√	√	√	√
Assignment	√	√	√	√	√

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	B	c	d	e	f	g	h	I	j	k	l
1	√	√		√	√	√	√		√	√		
2		√	√		√		√	√	√	√		
3	√	√		√	√	√	√	√	√	√		
4	√	√		√	√	√	√	√		√		√
5	√	√		√	√	√	√	√		√	√	√

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1, CD2, CD8
CD2	Tutorials/Assignments		CO2	CD1, CD2, CD3, CD8
CD3	Seminars		CO3	CD1, CD2, CD3, CD8, CD9
CD4	Mini projects/Projects		CO4	CD1, CD2, CD3, CD8, CD9

CD5	Laboratory experiments/teaching aids		CO5	CD1, CD2, CD3, CD8, CD9
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE302
Course title: Functional Genomics and rDNA Technology
Pre-requisite(s):
Co- requisite(s): None
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: BTECH.
Semester / Level: V
Branch: Biotechnology
Name of Teacher:

Course Objectives:

This course enables the students to:

A	To understand about RNA world hypothesis, application of forward and reverse

	genetics.
B	To learn the genetic engineering techniques used in genes regulation and genome editing mechanism
C	To get knowledge and design the experiments using various genome sequencing strategies, annotation, database development as well as their applications.
D	To learn about methods involved in cloning and expression of gene of interest, cloning and expression vectors and recombinant protein purification
E	To understand the use of rDNA Technology in the crop improvement, drug discovery, value added crops as well as development of recombinant proteins

Course Outcomes:

At the end of the course, a student should be able to:

CO1	explain the application of forward and reverse genetics
CO2	Use various techniques in regulating and editing the gene for the meaningful purpose
CO3	Execute and design the experiments of genome sequencing, their subsequent analysis and preparation of database
CO4	Explain and design cloning and expression strategies of a suitable cloning vectors and their uses
CO5	Explain and design cloning and expression strategies of a candidate gene, its expression in host and its purification
CO6	develop capacity to pin point the strategies used for crop improvement, development of drug and DNA vaccine, diagnostics, recombinant proteins

(BE302) Functional Genomics and rDNA Technology

Module-I: Genomic evolution: **[8L]**

The world of RNA, ribozyme, Genetics to genomics to functional genomics. Forward and reverse genetics, Antisense RNA, siRNA, RNA interference, miRNA, TALEN, CRISPR-Cas9

Module-II: Genetic engineering techniques: [8L]

Restriction and modifying enzymes, Various blotting techniques, PCR techniques, RT-PCR, qPCR, Digital PCR, Site directed mutagenesis, Genomic and cDNA libraries, Screening of libraries, Microarray

Module-III: Genome sequencing: [8L]

Overview of conventional and new sequencing technologies, Strategies used in whole genome sequencing, NGS technologies, RNAseq, Genome annotation, Candidate gene discover and data mining, Transcription factor, Development of databases and their uses

Module-IV: Cloning and expression: [8L]

Characteristics of plasmid and other cloning vectors, Artificial chromosomes, Prokaryotic and eukaryotic expression vectors, Methods of recombinant protein purification

Module-V: Applications of rDNA Technology: [8L]

Transgenic plants and animals, DNA vaccine, Gene therapy, PCR based diagnosis, Transgenics in industry, Transgenics in medicine, recombinant proteins and their uses.

Text books

1. *Principles of Genome analysis and Genomics,* 3rd Edition, By S. B. Primrose and R. L. Twyman, Blackwell publishing (2003), ISBN: 1405101202
2. *Bioinformatics and Functional Genomics,* 3rd Edition, By Jonathan Pevsner, Wiley-Blackwell (2015), ISBN: 978-1-118-58178-0.
3. Functional Genomics, **Methods and Protocols by** Editors: **Kaufmann**, Michael, **Klinger**, Claudia, **Savelsbergh**, Andreas (Eds.). Springer (2017) ISBN 978-1-4939-7231-9

Reference books

1. *Principles and Practices of Plant Genomics* (Volume 3), By Chittaranjan Kole and Albert G. Abbott. CRC Press (2017): ISBN 9781138116498
2. Genome Analysis: Current Procedures and Applications by Maria S. Poptsova. Caister Academic Press (2014) ISBN: 978-1-908230-29-4.

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	√
Tutorials/Assignments	√
Seminars	√
Mini projects/Projects	
Laboratory experiments/teaching aids	√
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	√
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination Marks	25
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Teacher's Assessment	5

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Mid Sem Examination Marks	√	√				
End Sem Examination Marks	√	√	√	√	√	√
Quiz I	√	√	√			
Quiz II				√		√

Indirect Assessment –

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	I	j	k	l
1	3		3									
2	3	3	3									
3	3	2	3		3							
4	3	2				2			2	2		
5		3	3			2		2				
6				3			2					1

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD3, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD3, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: BE303
Course title: Mass Transfer Operations
Pre-requisite(s): Chemical Process Calculations (BE 206); Fluid Mechanics & Heat Transfer (BE 209)
Co- requisite(s): Bio separation Engineering (BE 307); Reaction Engineering (BE 304)
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: V
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students to:

A.	Understand the basic principles in mass transfer operations
B.	Decide among different extraction method for industrial operation
C.	Separate a component from a mixture
D.	Apply their knowledge to purify a bio molecule after production

Course Outcomes

After the completion of this course, students will be able to:

1.	Explain the basic principles involve in mass transfer operations
2.	Design a distillation column
3.	Separate bio molecules using solvent extraction method
4.	Extract soluble particle from solid using leaching method
5.	Isolate a bio-molecule by advance separation methods

(BE303) Mass Transfer Operations

Module-I: Diffusion: [8L]

Molecular diffusion in fluids; Theory of diffusion: Fick's law, analogy between heat, mass and momentum transfer; Diffusivity; Mass Transfer Coefficients; mass transfer in biological system. Vapour liquid equilibrium; Phase diagram; Roult's Law for ideal solution; relative volatility.

Module-II: Distillation: **[7L]**

Introduction to distillation, different types: azeotropic, differential, vacuum, steam, flash distillation. Distillation column: mass balance equations, McCabe-Theile Method to calculate number of ideal plate, 'q' line, feed plate location; reflux ratio, maximum, minimum and optimum reflux; minimum number of plates; plate efficiency.

Module-III: Liquid-liquid extraction: **[7L]**

Introduction to extraction; Ternary liquid equilibria: triangular graphical representation and binodal curve; single stage batch extraction; multistage continuous operation; determination of number of stages; aqueous two phase extraction.

Module-IV: Solid-liquid extraction: **[6L]**

Leaching, solid-liquid equilibria; factors influencing leaching; equipments used in solid-liquid extraction; single stage leaching; continuous multistage leaching; graphical determination of number of stages.

Module-V: Advanced Separation Processes: **[7L]**

Supercritical fluid extraction and reverse micelle extraction, Reactive extraction and distillation with case study.

Text books:

1. Warren McCabe, Julian Smith, Peter Harriott, Unit Operation of Chemical Engineering, 7th Ed., McGraw Hill Education, 2017
2. Robert Treybal, Mass Transfer Operations, 3rd Ed., McGraw Hill Education, 2017

Reference books:

1. Leonard A. Wenzel, Curtis W. Clump, Louis Maus, L. Bryce Andersen Alan S. Foust, Principles of Unit Operations, 2nd Ed., Wiley, 2008

2. B.K. Dutta, Principles of Mass Transfer and Separation Processes, 1st Ed., Prentice Hall India Learning Private Limited, 2006

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	√
Tutorials/Assignments	√
Seminars	√
Mini projects/Projects	√
Laboratory experiments/teaching aids	√
Industrial/guest lectures	√
Industrial visits/in-plant training	√
Self- learning such as use of NPTEL materials and internets	√
Simulation	√

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	10	15			
Faculty Assessment				**2.5**	**2.5**
End Sem Examination Marks	8	12	10	10	10
Assignment / Quiz (s) (2 No.)	**4**	6	4	3	3

Indirect Assessment –

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	2				2	2	2	2	3	2	1
2	3		3	3		3	2	2	2	3	2	1
3	3	3			3	3	2	2	2	3	2	1
4	3	3	3		3	3	2	2	2	3	3	1
5	3	3	3	3		3	2	2	2	3	3	1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1, 2, 3,4,5	CD1
CD2	Tutorials/Assignments		CO3, 4	CD1
CD3	Seminars		CO5	CD1 & CD2

CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE304
Course title: Reaction Engineering
Pre-requisite(s): Knowledge about Mathematics and Chemistry
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P:
Class schedule per week: 03
Class: B. Tech
Semester / Level: V
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	Introduce basic concepts of chemical kinetics like homogeneous and heterogeneous reactions, rate of reaction, order and molecularity of reaction, concentration and temperature dependency of rate of reaction
B.	Knowledge on different types of chemical reactors
C.	Design of chemical reactors under isothermal conditions
D.	Kinetics of heterogeneous reactions

Course Outcomes

After the completion of this course, students will be:

1.	Apply the principles of reaction kinetics, formulate rate equations and analyse the batch reactor data.
2.	Analyze the experimental kinetic data to select a suitable reactor for a particular application and to workout conversion and space time for different types of reactors.
3.	Evaluate selectivity, reactivity and yield for parallel and mixed reactions.
4.	Examine how far real reactors deviate from the ideal.
5	Kinetics of heterogeneous reactions

(BE304) Reaction Engineering

Module-1: Kinetics of Homogeneous Reactions: **[8L]**

Classification of reactions, reaction rate, speed of reaction, rate equation, concentration-dependent term of rate equation, rate constant, order and molecularity, representation of elementary and nonelementary reactions, kinetic models for nonelementary reactions, temperature-dependent term of a rate equation, activation energy and temperature dependency.

Module-2: Kinetic Analysis of Batch Reactor Data: **[8L]**
Integral and differential methods for analyzing kinetic data, interpretation of constant volume batch reactor, data for zero, first, second and third order reactions, half-life period, irreversible reaction in parallel and series, auto catalytic reaction.

Module-3: Kinetic Interpretation of Batch Reactor Data for Single Reactions: **[8L]**
interpretation of variable volume batch reaction data for zero, first and second order reactions, Ideal batch reactor, steady state CSTR and plug flow reactors and their use for kinetic interpretation.

Module-4: **[8L]**
Design for Single Reaction: Size comparison of single reactors, plug flow reaction in series and/or parallel, equal and different size of mixed reactor in series, finding the best system for given conversion, recycle reactor, Energy balance equations for batch, CSTR and PFR and their application to the design of reactors; Non ideality; Residence time distribution.

Module-5: **[8L]**
Reaction Catalyzed by Solids: Introduction to heterogeneous reactions, rate equation for surface kinetics, pore diffusion resistance combined with surface kinetics, porous catalyst particles, performance equations for reactors containing porous catalyst particles, experimental methods for finding rates; references to bio catalysis, immobilized enzymes.

Text Books

1. Levenspiel, O. Chemical Reaction Engineering Ed.3, John Wiley & Sons (Asia)

Reference

1. K.A. Gavhane, Chemical Reaction Engineering I, Ed 7, 2006, Nirali Prakashan
2. H.ScottFoggler, Elements of Chemical Reaction Engineering, Ed 5, 2016, Prentice Hall
3. Paulin Doran, Bioprocess Engineering Principles. Ed 2, 2013, Elsevier

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	Yes
Tutorials/Assignments	Yes
Seminars	Yes
Mini projects/Projects	
Laboratory experiments/teaching aids	
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	Yes
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End Sem Examination Marks	60
Assignment / Quiz (s)	15

Assessment Compoents	CO1	CO2	CO3	CO4	C05
Mid Sem Examination Marks	**3**	**2**			
End Sem Examination Marks	**3**	**3**	**3**	**3**	**3**
Assignment			**2**	**2**	

If satisfying< 34%=1, 34-66% =2, > 66% = 3.

Indirect Assessment –

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	K	l
1	3	3	3	3	3	2						
2		3	3	3	3							
3		3	3					1	2			
4		**3**	3	3	3	2					2	
5	x	x	x	x	x			x				

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1,2,3,4	CD1
CD2	Tutorials/Assignments		CO2,3	CD1 and CD8
CD3	Seminars		CO2	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE317
Course title: Stem Cell and Tissue Engineering
Pre-requisite(s): BE 2016 Pharmaceutical Biotechnology
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: V
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	To give an understanding of the major aspects and basic techniques in stem cells and tissue engineering including applications
B.	To describe basic cell culture technique.
C.	To give the details of design of set for tissue engineering for different cases
D.	Setting up stem cell culture and tissue engineering laboratory

Course Outcomes

After the completion of this course, students will be:

1.	To give an understand the major aspects and basic techniques in stem cells and tissue engineering including applications
2.	They will be able to design the steps of tissue production at laboratory scale.
3.	They will be able to design the laboratory required for tissue production.

Syllabus

Module-1: Basic Biology of Stem Cells: [8L]
Types & sources of stem cell with characteristics: embryonic,
adult, haematopoietic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells, induced pleuripotent stem cells. isolation & characterizations, markers & their identification.

Module-2: Stem Cell Culture Requirements: [8L]

Methods for stem cell culture, Growth factor requirements and their maintenance in culture. Feeder and feeder free cultures. Cell cycle regulators in stem cells.

Module-3: Applications of Stem Cells: **[8L]**
Neurodegenerative diseases, Spinal cord injury, Heart disease,
Diabetes, Burns and skin ulcers, muscular dystrophy, Orthopaedic applications, Eye diseases.

Module-4: Tissue Engineering: **[8L]**
Biomaterials/Biopolymers used in Tissue Engineering, Concepts in scaffold based tissue engineering, tissue engineering approaches to stem cell-based therapies.

Module-5: Stem Cell Culture and Tissue Engineering Facility: **[8L]**
Setting up stem cell culture and tissue engineering laboratory, hazards in stem cell storage & transplantation, Skin and Musculoskeletal applications of tissue engineering.

Recommended Books:
1. R. Lanza, J. Gearhart *et al* (Ed), Essential of Stem Cell Biology, 2009, Elsevier Academic press.
2. Satish Totey, Kaushik D. Deb, Stem Cell Technologies: Basics and Applications
3. J. J. Mao, G. Vunjak-Novakovic *et al* (Eds), Translational Approaches In Tissue Engineering & Regenerative Medicine. (2008), Artech House, INC Publications.
Reference Books:
1. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two- Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult &Fetal Stem Cells, 2012, Academic Press.

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	✓
Tutorials/Assignments	✓
Seminars	✓
Mini projects/Projects	✓
Laboratory experiments/teaching aids	✓
Industrial/guest lectures	✓
Industrial visits/in-plant training	

Self- learning such as use of NPTEL materials and internets	
Simulation	

:

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3
Mid Sem Examination Marks	10	15	
Faculty Assessment		**2.5**	**2.5**
End Sem Examination Marks	20	20	10
Assignment / Quiz (s) (2 No.)	**10**	6	4

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3				2		2				1
2	3	3	3	3	3	3						1
3	3	3	3			2						1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1, CD2, CD3, CD4, CD6 and CD8
CD2	Tutorials/Assignments		CO2	CD1, CD2, CD3, CD4, CD6 and CD8
CD3	Seminars		CO3	CD1, CD2, CD3, CD4, CD6, CD7 and CD8
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE213
Course title: Pharmaceutical Biotechnology
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: V
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	Understand the basic concepts involved in biopharmaceutical drug production, genomics and gene therapy
B.	Knowledge about therapeutic effects and side effect of biopharmaceuticals. Knowledge about new drug development procedures, drug approval, ADMET of drugs

C.	Appreciate and understand the manufacturing and quality control of drugs and legal steps involved in progressing a new drug to market
D.	Demonstrate knowledge and understanding of currently relevant and newly emerging aspects of pharmaceutical biotechnology

Course Outcomes

After the completion of this course, students will be:

1.	Students will have a basic understanding of the scientific method. explain the strategies and various steps of new drug discovery process
2.	Able to explain the concept of genomics, gene therapy, pharmacogenomics and pharmacodynamic
3.	Apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals like vaccines, proteins and hormones.
4.	Carry out the quality control procedures in the production of various biopharmaceuticals. Explain the economics and regulatory aspects in the development of pharmaceuticals.

Module-1: Molecular Biotechnology: **[8L]**
Genomics and its impact on medicine. Molecular medicine, Rational drug design.

Module-2: Gene Testing & Diagnostics: **[8L]**
Gene testing, pharmacogenomics, Molecular diagnostics.

Module-3 **[8L]**
Cancer Biology & Gene therapy: Oncogenes, tumor suppressor genes, growth factors, Genetic diseases and DNA based diagnosis of genetic diseases. Gene therapy.

Module-4: **[8L]**
Formulation of Biotech Products: Microbiological consideration, use of excipients, Drug delivery methods, Shelf life of biopharmaceuticals, pharmacodynamics of protein therapeutics.

Module-5: **[8L]**
Genetically Engineered Pharmaceuticals: Insulins, Growth Hormones, Vaccines, Interferons & interleukins, Tissue type plasminogen activator, Economic aspects in pharmaceutical biotechnology.

Books Recommended:
Maulik and Patel, Molecular Biotechnology – Therapeutic applications and strategies.
Zito, Pharmaceutical Biotechnology
Crommelin & Sindelar, Pharmaceutical Biotechnology

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training

Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3	CO4	
Mid Sem Examination Marks	10	10	**5**		**25%**
Faculty assessment			**2.5**	**2.5**	**5%**
Assignment	**5**	**5**	**5**	**5**	**20%**
End Sem Examination Marks	**10**	**20**	10	10	**50%**
					100%

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	A	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3									
2	3	3		3	3	3	2					
3			3	3	3	3	2	2				
4							2	2				3

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1
CD2	Tutorials/Assignments		CO2	CD1
CD3	Seminars		CO3	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE305
Course title: Molecular Biology & rDNA Technology lab
Pre-requisite(s): NIL
Co- requisite(s): Nil
Credits: 1.5 L: 0 T: 0 P: 3
Class schedule per week: 03
Class: B. Tech
Semester / Level: V
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students to:

A.	This is a research based course in which student will learn to apply molecular biology techniques (focused on nucleic acids) in the laboratory to ask scientific questions.
B.	Students will learn principles and practice of basic bacterial culture techniques, transformation, agarose gel electrophoresis, nucleic acid purification (plasmid and genomic DNA, RNA), nucleic acid quantification.
C.	DNA restriction digestion and analysis, Southern hybridization, library construction, polymerase chain reaction (PCR), and basics of computer-based DNA sequence analysis and data acquisition over the internet.
D.	In addition, students will learn about the nature and selection of DNA cloning vectors, restriction enzymes, modifying enzymes, polymerases, and other reagents used in molecular biology.
E.	Students will examine aspects of bioinformatics and genomics, and newer/advanced

	molecular technologies such as next-generation sequencing. Student will apply newly learned molecular techniques toward solving real biological research questions.

Course Outcomes

After the completion of this course, students will be able to:

1.	List and explain safety issues and proper practices associated with standard molecular techniques, including bacterial culture, electrophoresis, and nucleic acid purification and detection chemistry.
2.	Demonstrate and practice principles of bacterial culture, sterile technique, transformation, and DNA and RNA purification and quantification.
3.	Understand the nature of molecular biological hypothesis and testing, how molecular analysis answers scientific questions.
4.	Use the application of various standard bioinformatic techniques to experimental planning and analysis, including sequence accessing and manipulation, BLAST, multiple sequence alignment, PCR primer design, etc.
5.	Understand the many variations on PCR and when to use them, and how to troubleshoot a PCR protocol by selecting parameters.
6.	Independently plan, execute and document a basic DNA cloning experiment involving PCR amplification.

(BE305) Molecular Biology & rDNA Technology lab

Sl. No.	Name of the Experiments
1.	Isolation of DNA from Bacteria and plant tissue
2.	Isolation of Plasmid DNA from Bacteria
3.	Agarose gel electrophoresis of isolated DNA
4.	Use of BLAST and other bioinformatics tools like MSA
5.	Primer designing for PCR experiment
6.	PCR of the selected DNA template

7.	Cloning of the amplified product in suitable host cell using plasmid vector

Books Recommended:

1. Laboratory Manual for Analytical Biochemistry and Separation techniques (2000) by P. Palanivelu, Madural Kamaraj University.
2. Sambrrok, J. and Russell, D.W. (2003). Molecular Cloning-A laboratory Manual (3 rd Edition, Vol.1, 2 and 3), Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.9.David Mount (2001)
3. Bioinformatics. Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press.10.Rashidi, H.H. and Buehler, L.K. (2002).
4. Bioinformatics Basis: Applications in Biological Science and Medicine. CRC Press, London.11.Primrose et al. (2005) Principles of gene manipulation, Black Well Science, London.

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	√
Tutorials/Assignments	√
Seminars	√
Mini projects/Projects	
Laboratory experiments/teaching aids	√
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	√
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment 60% (Distribution is as follows) a) Day to day performance & Lab files b) Quiz (es) c) Viva	60 30 10 20
Semester End Examination (Distribution is as follows) a) Examination Experiment Performance b) Quiz	40 30 10
Total	100

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3		3									
2	3	3	3	3	3							
3	3	3	3		3	2			2			1

4	3					2			2	2		
5		3	3			2		2				
6				3			2			2		1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1, CD2, CD3, CD8
CD2	Tutorials/Assignments		CO2	CD1, CD2, CD3, CD8
CD3	Seminars		CO3	CD1, CD2, CD3, CD8
CD4	Mini projects/Projects		CO4	CD1, CD2, CD3, CD8
CD5	Laboratory experiments/teaching aids		CO1, CO2, CO3, CO4, CO5	CD1, CD2, CD3, CD8
CD6	Industrial/guest lectures		CO5	
CD7	Industrial visits/in-plant training		CO4, CO5	
CD8	Self- learning such as use of NPTEL materials and internets		CO1 and CO2	
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE306
Course title: Bio-analytical Lab
Pre-requisite(s): BE301
Co- requisite(s): NIL
Credits: 1.5 **L: 0 T: 0 P: 3**
Class schedule per week: 12 per week for 1.5 months
Class: B.Tech.
Semester / Level: V Sem
Branch: Biotechnology
Name of Teacher:

Course Outcomes
After the completion of this course, students will be able to:

1.	Apply knowledge of mathematics, science, and engineering to understand molecular phenomena.
2.	An ability to design and conduct experiments, as well as to analyze and interpret data for related to domain of Bioinstrumentation. Evaluate the limitations of and troubleshoot theoretical approaches.
3.	Design a system, component, or process to performing research in biological system and addressing the challenges associated with the Centrifugation Techniques and Electro-kinetics. Know how to meet the desired needs within realistic constraints, such as, economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4.	Use the techniques, skills, and modern tools necessary for detection of the validation of new biomolecules and its interaction and analysis of data, and interpretation of results.
5.	Demonstrate knowledge and understanding of the engineering principles and knowledge of various types of industrially used Chromatographic Techniques and imaging methods; advantages and disadvantages, design criteria, molecular imaging, instrumentation and various aspects of operation.
6.	Validation, compatibility and an ability to understand, design and application of the processes of Spectroscopy and Thermal Analysis
7.	Independently execute an experiment using the standard methods and techniques in molecular biology, with the appropriate analysis and interpretation of results obtained. An ability to prepare a student for careers in higher education, as well as in pharmaceutical and biotechnology industries in governmental and private agencies in multidisciplinary teams. An ability to identify, formulate, and solve engineering problems.

(BE306) Bio-analytical Lab

Experiment 1:	Demonstration and Experiment on Gas Chromatography
Experiment 2:	Demonstration and Experiment on Liquid Chromatography
Experiment 3:	Mass analysis of molecules using Mass Spectrometry
Experiment 4:	Measurements of absorbance and transmittance using UV/VIS spectrophotometry
Experiment 5:	Material characterization using DSC
Experiment 6:	Material characterization using TGA
Experiment 7:	Material separation using ultracentrifuge (AUC)
Experiment 8:	Demonstration and Experiment on GEL Electrophoresis
Experiment 9:	Demonstration and Experiment on SEM
Experiment 10:	Analysis of AES/AAS using ICP-OES

Books

1. **K. Wilson & K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry.**
2. **Willard and Merrit, Instrumental Methods and Analysis**
3. **Ewing GW, Instrumental Methods of Chemical analysis.**

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment 60% (Distribution is as follows) a) Day to day performance & Lab files b) Quiz (es) c) Viva	60 30 10 20
Semester End Examination (Distribution is as follows) a) Examination Experiment Performance b) Quiz	40 30 10
Total	100

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3		3	3	2	2		2	2		
2		3	3		3		2	2	2	2		
3	3	3		3	3			2	2	1		
4		3		3	3	2				2		1
5	3	3		3			2	2		1	2	1
6		3		3	3	2		2	2	1		
7		3	3	3				2		1	2	1

COURSE INFORMATION SHEET

Course code: BE307
Course title: Bioprocess Engineering
Pre-requisite(s): BE101 Biological Science for Engineers, BE303 Mass Transfer Operations
Co- requisite(s):
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	to understand the process of microbial growth and synthesis of bioproducts, methods of measurements of growth and mass balance of the bioprocess
B.	about media constituents, formulations and sterilization, types of sterilizes and role of filers on sterilization
C.	Provide knowledge of kinetics of enzymes both in free and in immobilized state
D.	Gain knowledge about the mode of reactor operation and significance of CFD in bioprocessing

Course Outcomes

After the completion of this course, students will be:

1.	Able to explain the kinetics of cell biomass accumulation and product formation, analysis of data and interpretation
2.	Competent to identify and design sterilizers for removal of microbial contaminants
3.	Learn the biocatalysis and significance of immobilization
4.	Able to operate bioreactor as per microbial need and able to work in multidisciplinary team
5	Capable of identifying the crucial pathways in bioprocess regulation

BE307 Bioprocess Engineering

Module-1: Cell Growth and Product Formation: [7L]

Cell growth and bio-product formation kinetics, Quantification of cell growth, growth patterns and kinetics in batch culture, environmental factors affecting growth kinetics, heat generation by microbial growth, unstructured non segregated model, models for transient behaviour

Module-2: Mass Balance and Yield Concepts: [7L]
Yield and maintenance coefficients, calculation based on elemental balances, degree of reduction, theoretical predictions of yield coefficients

Module-3: Sterilization: [7L]
Media and air sterilization, Sterilization equipment, Kinetics of death, Batch and continuous sterilization of media, Role of membrane filters for sterilization of media and air

Module-4: Enzyme Immobilization: [7L]
Kinetics of free and immobilized enzymes, Immobilized enzyme reactors and Diffusion limitations

Module-5: Operating considerations for bioreactors: [7L]
Batch, fed-batch and continuous bioreactors, ideal plug flow tubular reactors, Concepts of computational fluid dynamics in bio-processing

Text Books Recommended:
1. Shuler and Kargi, Bioprocess Engineering – Basic Concepts. Prentice Hall PTR, 2002
2. Doran, Bioprocess Engineering Principles, Academic Press, 1995
3. Bailey and Ollis, Biochemical Engineering Fundamentals, 1986

Reference Books:
1. Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2001.
2. Roger Harrison et al., Bioseparations Science and Engineering, Oxford University Press, 2003.

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors-	Yes
Tutorials/Assignments-	Yes
Seminars	

Mini projects/Projects	
Laboratory experiments/teaching aids	
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	Yes
Simulation-	Yes

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	√	√		
Faculty Assessment		√			
End Sem Examination Marks	√	√	√	√	√
Assignment		√	√		

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcomes	Program Outcomes											
	a	b	c	d	e	f	G	h	i	J	k	l
1	3	3	3		3							1
2	3		3		3	2	2		2			1
3		3	3	3			2	2	2		2	1
4					3	2		2		2	2	1
5	3		3	3	3	2			2		2	1

If satisfying< 34%=1, 34-66% =2, > 66% = 3.

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1,2,3,4,5	CD1
CD2	Tutorials/Assignments		CO2, 3	CD1, CD8
CD3	Seminars		CO4, 5	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE308
Course title: Bioseparation Engineering
Pre-requisite(s):
Co- requisite(s): BE307 Bioprocess Engineering
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:
Course Objectives

This course enables the students:

A.	To understand outline of recovery processes, removal of biomass including solids matters by filtration, centrifugation and sedimentation etc and learn the techniques of cell disruption, their limitations and applications
B.	To gain knowledge regarding principles, methods and applications of different methods for extraction of desired product from the clarified fermentation broth
C.	About the concept of various chromatographic techniques for separation and identification of targeted compound
D.	Provide the information of finishing operations and quality control related issues for the purified product

Course Outcomes

After the completion of this course, students will be:

1.	Able to develop the ability to design and conduct experiments related to separation of targeted products, as well as analyze and interpret data
2.	Able to work in multidisciplinary teams
3.	Learn various techniques, skills, and modern engineering tools necessary for bioseparation engineering practice
4.	Competent enough to propose the separation process for extraction of bio-products from biological systems

(BE308) Bioseparation Engineering

Module -1: Principle of Separation Based on Size and Shape: [8L]
Pre-treatment, Sedimentation, Filtration, Centrifugation, Coagulation and flocculation, Disruption of living cells to release the intracellular products: Mechanical and Non-mechanical methods with their limitations and applications.

Module -2: Separation of Soluble Products: **[8L]**
Adsorption, Adsorption isotherm. Liquid-liquid extraction, Aqueous two phase extraction and Precipitation.

Module -3: Membrane Based Separation: **[8L]**
Dialysis, Reverse osmosis, Ultrafiltration and microfiltration, Cross-flow ultrafiltration and Electro-dialysis.

Module -4: Chromatography: [8L]
Adsorption chromatography, Gel-filtration, Ion-exchange Chromatography, Affinity Chromatography, High Pressure Liquid Chromatography and Hydrophobic Chromatography.

Module -5: Finishing Operations: [8L]
Crystallization, drying of product and packaging.

Text 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., Pearson Education India, 2015

Reference Books:

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): 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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors-	Yes
Tutorials/Assignments-	Yes
Seminars	
Mini projects/Projects	
Laboratory experiments/teaching aids-	Yes
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	Yes
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Compoents	CO1	CO2	CO3	CO4
Mid Sem Examination Marks	√	√		
End Sem Examination Marks	√	√	√	√
Assignment		√	√	

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcomes	Program Outcomes											
	A	b	c	d	e	f	g	h	i	j	k	L
1	3	3	3				2					1
2	3	3			3			1	2	2		1
3	3	3	3	3	3	2	2	2	2	2	2	1
4	3	3		3	3	2	2			2	1	1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO 1, 2, 3, 4, 5	CD1
CD2	Tutorials/Assignments		CO 2, 3	CD1, CD8
CD3	Seminars		CO 3, 4, 5	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE403
Course title: Plant & Agriculture Biotechnology
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students to :

A.	Learn the fundamentals of culturing plant cells and tissues, culture environment.
B.	Gain knowledge of plant totipotency nature and its applications.
C.	Understand cell proliferation, differentiation, and learn media formulation
D.	Describe the phenomenon of Organogenesis, embryogenesis and somaclonal variation.
E.	Acquire knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.
F.	Impart knowledge of plant protoplast isolation, purification and culturing and understand its applications.
E.	Gain concept regarding crop improvement techniques.

Course Outcomes

After the completion of this course, students will be able to:

1.	Acquire the knowledge about the techniques of Plant Tissue Culture, Lab. organization & measures adopted for aseptic manipulation and nutritional requirements of cultured tissues.
2.	Apply knowledge for large scale clonal propagation of plants through various micropropagation techniques, and Production of secondary metabolites under *in vitro* conditions.
3.	Develop skill in raising transgenics resistant to biotic & abiotic stresses & quality

	characteristics and their role in crop improvement.
4.	Design and implement experimental procedures using relevant techniques
5.	Work effectively individually or in a group of disciplinarians or a multidisciplinary setting
6.	Apply and effectively communicate scientific reasoning and data analysis in both written and oral forums.
7.	Understand and practice the ethics surrounding scientific research.
8.	Understanding of societal and environmental issues and deriving a solution to a problem

(BE403) Plant & Agriculture Biotechnology

Module-1: In Vitro culture: **[8L]**
Basics about equipment's and laboratory set up, culture media components, types of culture media, gelling agents, plant growth regulators, contaminants, sterilization techniques, benefits and limitations, lab safety aspects.

Module-2: Callus and Suspension Culture: **[8L]**
Types of explants, maintenance and growth pattern of callus, initiation and growth curve of suspension culture, Production of secondary metabolites, Bioreactors, Long-term storage of cultures.

Module-3: Micropropagation: **[8L]**
Principles and methods of micropropagation, stages of micropropagation, Organogenesis, Embryogenesis, Artificial Seeds, Somaclonal variation, Production and use of haploids, commercial micropropagation.

Module-4: Protoplast, Embryo and Endosperm culture: **[8L]**
Isolation and regeneration of protoplast, Protoplast fusion and somatic hybridization, Cytoplasmic hybridization, Principles and application of embryo and endosperm culture, Apomixis.

Module-5: Crop Improvement: **[8L]**
Development of crops adaptable to stresses using *Agrobacterium* and particle bombardment mediated transformation, gene silencing and hairy root culture, Plants as factories for biopharmaceuticals, Use of nanotechnology in Agricultural sciences, Precision agriculture, Value addition in crops and sustainable agriculture.

Books Recommended:

Text Books:

1. M. K. Razdan: An introduction to plant tissue culture. Science Publishers (2003) 2nd ed.
2. Timir Baran Jha and Biswajit Ghosh: Plant Tissue Culture: Basic and Applied
3. Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Oxford University Press (2008) 2nd ed.

Reference Book:

4. A. Mizrahi, Biotechnology in agriculture

5. S. Natesh, Biotechnology in agriculture
6. Dixon and Gonzales, Plant cell culture – a practical approach.
7. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell Publishing (2006) 7th ed.

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Compoents	CO1	CO2	CO3	CO4	CO5	CO6
Mid Sem Examination Marks	15	10				
Faculty Assessment	2	2	1			

End Sem Examination Marks	8	8	10	10	12	12
Assignment + seminar *(two quizzes)	5	5	5	5		

CO1 &CO2 for quiz 1.CO3 & CO4 for quiz 2

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3											
2	3	3	3	3	3		2					
3	3	3	3		3	2						
4	3		3			2				2	2	
5		3	3			2		2	2	2	2	
6				3			2			2		
7							2	2	2	2		1
8										2	1	1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1, CD2, CD3, CD8

CD2	Tutorials/Assignments		CO2	CD1, CD2, CD3, CD8
CD3	Seminars		CO3	CD1, CD2, CD3, CD8
CD4	Mini projects/Projects		CO4	CD1, CD2, CD3, CD8
CD5	Laboratory experiments/teaching aids		CO5	CD1, CD2, CD3, CD8
CD6	Industrial/guest lectures		CO6	CD1, CD2,CD3, CD8
CD7	Industrial visits/in-plant training		CO7	CD1, CD2, CD3, CD8
CD8	Self- learning such as use of NPTEL materials and internets		CO8	CD1, CD2, CD3, CD8
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE309
Course title: Fermentation Engineering
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	The course introduces the basic principles of Fermentation Technology which involves various strategies for strain selection and improvement, media formulation, sterilization, inoculums development, various fermenter configurations and mode of operations.
B.	Agitation and mixing characteristics in fermentation
C.	Knowledge about heat transfer in fermenters
D.	Fermentation process and equipment design concepts

Course Outcomes

After the completion of this course, students will be:

1.	To apply chemical engineering principles to fermentation processes
2.	The inocula development and improvement of cultures and the evaluation of fermentation processes.
3.	The fermenter configuration and mode of operations
4.	Heat transfer in Fermenters
5	The industrial applications of fermentation technology

(BE309) Fermentation Engineering

Module 1: **Introduction:** **[8L]**
Introduction to Industrial Fermentation process; Historical overview of industrial fermentation products; Biochemistry of Fermentation – Bacterial, Fungal and Yeast Fermentation; Comparison between traditional and modern methods of fermentation; Industrially useful microorganisms and its products.

Module 2: **Integration of Bio Reactors on Industrial Fermentation Processes:** **[8L]**
Classification of fermentors; fermentor operation (batch, fed-batch, continuous); Conventional and non-conventional fermenters; equipment characteristics

Module 3: **Fluid Flow, Mass Transfer, Agitation and Mixing in Fermenters**: **[8L]**
Agitation and mixing characteristics in fermentation, Power requirement, Influence of power input on oxygen transfer. Rheology: Viscosity and shear stress. Newtonian and non-Newtonian fluids. Rheology of fermentation broths. Flow patterns in stirred tanks. Quantification of mixing phenomena in stirred vessels; Oxygen transfer in fermentation; Relationship between OTR, volumetric mass transfer coefficient and hydrodynamic parameters in bioreactors at several levels with consideration to rheology

Module 4: **Heat Transfer in Fermenters:** **[8L]**

Heat transfer characteristics in fermentation; Types of heat exchangers; heat exchangers in large scale fermentation production; internal cooling; jacket cooling; film cooling; refrigerants used for fermentation cooling; heat exchangers design concepts

Module 5: **Fermentation Process and Equipment Design Concepts: [8L]**
Pharmaceutical fermentation equipment; Case studies – Fermentation for pharmaceutical products; Simulation of pharmaceutical manufacturing processes using software

Text Books:

1. Bioprocess Engineering Principles 2nd Edition, by Paulin Doran, eBook ISBN: 9780080917702; Paperback ISBN: 9780122208515; Academic Press 2012

Reference Books:

1. Fundamental Bioengineering Volume 1 Ed : John Villadsen; Advanced Biotechnology Series; Series Editors: S. Y. Lee, J. Nielsen, G. Stephanopoulos; Print ISBN: 978-3-527-33674-6 ; ePDF ISBN: 978-3-527-69746-5; Wiley - VCH 2016
2. Fermentation and Biochemical Engineering Handbook (Third Edition) *Edited by:Celeste C. Todaro and Henry C. Vogel* ISBN: 978-1-4557-2553-3; Elsevier 2014.

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	Yes
Tutorials/Assignments	Yes
Seminars	Yes
Mini projects/Projects	
Laboratory experiments/teaching aids	
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	Yes
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Compoents	CO1	CO2	CO3	CO4	C05
Assignment			√	√	
Faculty Assessment	√				
Mid Sem Examination Marks	√	√			
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	L
1	3	3	3	3	3	3						
2	3	3	3	3	3							
3	3	3	3					2	2	2		
4	3	3	3	3	3					2	2	1
5	3		3	3	3	3		2	2	2	2	1

If satisfying< 34%=1, 34-66% =2, > 66% = 3.

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery**

				Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1,2,3,4,5	CD1
CD2	Tutorials/Assignments		CO2,3	CD1 and CD8
CD3	Seminars		CO2	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation		CO5	

COURSE INFORMATION SHEET

Course code: BE312
Course title: Biomaterials
Pre-requisite(s): BE204 Biochemistry and Enzyme Technology
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	To gain knowledge about the fundamental concepts in biomaterial science, their specific properties
B.	Understand material selection, classes of biomaterials used in medicine and structure-function relationship
C.	Explain basic principles of biocompatibility and implant performance List different strategies to modify and/or design materials that are biocompatible
D.	Explain what biodegradability is and how it affects biomaterial design
E	To get familiarized with biomaterials used in different medical applications and their testing techniques

Course Outcomes

After the completion of this course, students will be:

1.	Able to understand the fundamental concepts, properties and handling of biomaterial
2.	Understand major classes of materials used in medicine: metals, ceramics and polymers with specific medical requirement
3.	Understand mechanism of biological response to implanted biomaterials and ability to improvise strategies for designing biocompatible biomaterials
4.	Understand biodegradation of biomaterials: intentional and un-intentional degradation mechanisms and ability to improvise strategies for designing biodegradable biomaterials
5	Knowledge of techniques to modify biomaterial surfaces to control the biological response and instrumentations to examine surface chemistry

6	Ability to apply fundamental principles for designing and testing biomaterials for specific medical application. Familiarize themselves with biomaterials potentialities and be able to apprehend and explain use of biomaterials in different medical applications.

(BE312) Biomaterials

Module-1: Fundamentals of Biomaterials Science: [8L]
Functional requirements of biomaterials and tissue replacement, Salient properties of important material classes, Property requirement of biomaterials, Disinfection and sterilization of biomaterials.

Module-2: Materials Used in Medicine: [8L]
Metals, polymers, ceramics, gels, hybrids, basic properties, medical requirements and clinical significance.

Module-3: Biological Response to Biomaterials: [8L]
Biocompatibility and hemocompatibility, foreign body response to implanted biomaterials, Immune response to foreign materials.

Module-4: Bioresorbable and Biodegradable Biomaterials: [8L]
Ceramics and their clinical significance, Biodegradables polymers, biodegradation of biomaterials, techniques to modify biomaterial surfaces to control the biological response and instrumentations to examine surface chemistry.

Module-5: Biomaterial Applications: [8L]
Biomaterials used in different medical applications (e.g., soft and hard tissue replacements, cardiovascular, drug delivery, biosensors, and tissue engineering). In-vitro cytocompatibility testing of biomaterials.

Text Books Recommended:

1. *Biomaterials Science, An Intoduction to Materials in medicine*, eds. Ratner, B.D. et al. 2nd Ed. 2004

2. Biomaterials: The Intersection of Biology and Materials Science by J.S. Temenoff and A.G. Mikos, Pearson Prentice Hall, 2008.

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	√
Tutorials/Assignments	√
Seminars	√
Mini projects/Projects	√

Laboratory experiments/teaching aids	
Industrial/guest lectures	√
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	√
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Compoents	CO1	CO2	CO3	CO4	CO5	CO6
Mid Sem Examination Marks	**10**	**10**	**5**			
Faculty Assessment	**1**	**2**	**2**			
End Sem Examination Marks		**10**	**10**	**10**	**10**	**10**
Assignment	**5**	**5**	**5**	**5**		

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3											
2	3	3										
3	3		3	3	3							

4	3		3	3	3							
5	3				3	2						
6				3	3		2		2			1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1
CD2	Tutorials/Assignments		CO2	CD1
CD3	Seminars		CO3	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE321
Course title: Cheminformatics
Pre-requisite(s): BE204 Biochemistry and Enzyme Technology, BE205 Basics of Bioinformatics, BE304 Reaction Engineering
Co- requisite(s): Knowledge of computer database
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	An ability to work on basic science as well as biotech/pharmaceutical industry in multidisciplinary teams and independently.
B.	Learn various aspects to design and validate new drug-like molecules, measurements and interpreting experimental data from biological system and addressing the challenges associated with the interaction between small molecules and body system.
C.	Grab the theoretical knowledge, parameters for searching and designing pharmacophore model for a particular disease related protein in biological research/ biotechnology/ pharmaceutical in industry and research lab.

D.	Enable students to understand the processes associated with quantative structure activity Relationship (QSAR), COMFA, virtual screening, ADMET and combinatorial chemistry
E.	A master degree in this field prepares a student for careers in biotech/ pharmaceutical research in different domains including industry.

Course Outcomes

After the completion of this course, students will be:

1.	An ability to apply knowledge and to design, analyze and conduct experiments, related to domain of drug designing.
2.	An ability to validate new drug-like molecules. Know how to meet the desired needs within realistic constraints, such as, economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
3.	An ability to apply the knowledge to find various parameters for searching and designing pharmacophore model for a particular disease related protein in biological research/ biotechnology/ pharmaceutical in industry and research lab.
4.	An ability to understand the processes associated with quantative structure activity Relationship (QSAR), COMFA, virtual screening, ADMET and combinatorial chemistry.
5.	A Master degree in this field prepares a student for careers in higher education, as well as in pharmaceutical and biotechnology industries in governmental and private agencies. An ability to function in multidisciplinary teams. An ability to identify, formulate, and solve engineering problems.

(BE321) Cheminformatics

Module 1: **[8L]**

Introduction to chemoinformatics, Common public domain databases used in chemoinformatics research, Computer representation and searching of chemical structures: 2D and 3D molecular structures, Graph theoretical representations of molecules and substructure searching, Conformation generation for small Molecules, Distance keys.

Module 2: **[8L]**

Concept of 3D pharmacophore and methods for deriving 3D pharmacophores, Pharmacological properties and global properties of small molecules, Lipinski's rule

Module 3: **[8L]**

Molecular descriptors: Different 2D and 3D descriptors, Concept of chemical similarity and distance metrices- using 2D and 3D descriptors, Quantative structure activity Relationship (QSAR): 2D and 3D QSAR, QSPR, COMFA

Module 4: **[8L]**

Data mining techniques for high throughput screening data, Chemical compound libraries and virtual screening, Protein ligand docking and scoring

Module 5: **[8L]**

Computational prediction of ADMET properties, Design of virtual combinatorial libraries

Text Books:

Andrew R. Leach, Valerie J. Gillet, An Introduction to Chemoinformatics. Publisher:Springer; 1st edition (May 1, 2003) Language: English ISBN-10: 1402013477 ISBN-13: 978- 1402013478

Reference books:

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Two Quiz (s)	20
End Sem Examination Marks	50
Assignment	05
Mid sem	25

Assessment Components	CO1	CO2	CO3	CO4	CO5
Two Quiz (s)	08	08	10	10	08
End Sem Examination Marks	08	08	10	10	09
Assignment	08	08	07	08	08
Mid Sem	07	09	08	05	05

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	2	j	k	l
1	3	3		3	3	2	2		2	2		
2		3	3		3		2	2	2	2		
3	3	3		3	3	2	2	2	2	2		
4	3	3		3	3	2	2	2		2		2
5	3	3		3	3	2	2	2		2	2	2

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course**	**Course**

			Outcome	Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1, CD2, CD8
CD2	Tutorials/Assignments		CO2	CD1, CD2, CD3, CD8
CD3	Seminars		CO3	CD1, CD2, CD3, CD8, CD9
CD4	Mini projects/Projects		CO4	CD1, CD2, CD3, CD8, CD9
CD5	Laboratory experiments/teaching aids		CO5	CD1, CD2, CD3, CD8, CD9
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE315
Course title: Food Science and Technology
Pre-requisite(s): BE204 Biochemistry and Enzyme Technology
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech

Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	To develop an understanding of food composition, concept of balanced diet
B.	To describe microbial interactions and their significance in food principles of preservation,
C.	To outline principles of food processing and preservation methods used in the control of microorganisms and apply this understanding for the prevention /control of food spoilage
D.	To establish information related to food quality, analysis and food safety laws
E.	To think critically regarding a topic and deliver scientific principles to both scientists and non-scientists related to food industry

Course Outcomes

After the completion of this course, students will be:

1.	Identify the importance of different types of food in balanced diet and diet planning
2.	Assess the beneficial or detrimental ways in which microorganisms have an impact on food
3.	Evaluate the different techniques used in food processing and preservation
4.	Determine food quality by food analysis as per food safety laws and standards.
5.	Compare and contrast foods types available in the market and design new product development strategies
6.	Apply the scientific method by stating a question; researching the topic; collecting, analyzing, and presenting data and communicate with both specialist and non-specialist audiences using genres commonly used in food industry

(BE315) Food Science & Technology

Module-1: **[8L]**

Food groups and their classification. Concept of balanced diet, malnutrition, recommended dietary allowances (RDAs) for various age groups according to their physiological status for specific nutrients and energy. Diet Planning;

Macronutrients, micronutrients, enzymes and pigments in food, their role and importance in processing and food consumption. Food Rheology, Application of rheology in food system.

Module-2: **[8L]**

Food Microbiology: Fermented foods, Microbial growth in food (important factors). Food spoilage by micro-organisms**,** Food-borne illness**,** Classification of foods on the basis of spoilage.

Module-3: **[8L]**

Food Processing and Preservation: Traditional processing methods: different cooking, smoking, baking, frying methods and types with advantages and disadvantages. Principles of preservation in correlation to increase the shelf life of food, Protein engineering in food technology: Objectives, methods, limitations and applications

Module-4: **[8L]**

Food Safety Laws and Standards: Food quality & analysis: Pre and Post-harvest factors in food quality, Physical, Chemical and Microbiological factors of quality, proximate analysis of foods, Sample and sample preparation in foods. Food laws: Voluntary and Mandatory food laws in India. Food Certification Agencies.

Module-5: **[8L]**

Impetus in Food Industry: New Product Development, strategies, planning for marketing, Process designing of food. Different metals used in cooking of food from traditional to plastic and storage of food with advantages and disadvantages. Foods types available in the market need of their innovation, advantages and disadvantages

Text books:

1. G.F. Stewart, Introduction to Food Science and Technology, 2nd Ed., Academic Press, 2012
2. Frazier William C and Westhoff, Dennis C. Food Microbiology, 5th Ed.,TMH Education, 2017

Reference books:

1. Sunetra Roday, Food Science and Nutrition, 2nd Edition, Oxford, 2012
2. Bhat & Rao, Food safety, The Bangalore Printing And, 1997

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	✓
Tutorials/Assignments	✓
Seminars	✓

Mini projects/Projects	
Laboratory experiments/teaching aids	
Industrial/guest lectures	
Industrial visits/in-plant training	✓
Self- learning such as use of NPTEL materials and internets	✓
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Compoents	CO1	CO2	CO3	CO4	CO5	CO6
Mid Sem Examination Marks	10	10	5			5
End Sem Examination Marks	5	10	5	10	10	10
Assignment /Quizes-2	5	5	5	5		

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	G	h	i	j	k	l
1	3	3	3				2					
2	3	3		3			2			2		
3	3	3	3			2	2					
4	3	3			3	2		2		2		
5	3	3	3			2		2	2		2	
6		3		3			3	2	2			1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1 and CD8
CD2	Tutorials/Assignments		CO2	CD1, CD3 and CD8
CD3	Seminars		CO3	CD1, CD3, CD7 and CD8
CD4	Mini projects/Projects		CO4	CD1 and CD8
CD5	Laboratory experiments/teaching aids		CO5	CD1 and CD8
CD6	Industrial/guest lectures		CO6	CD1, CD3 and CD8
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE319
Course title: Bioelectronics-Concept & Instrumentation
Pre-requisite(s): EE101 Basic Electrical Engineering
Co- requisite(s): BE215 Cellular Electrophysiology
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	To impart knowledge for interdisciplinary, applied engineering and technology.
B.	With respect to design consideration, to understand the standard structure of biomedical instrumentation systems.
C.	To learn the technicality associated with instrumentation and design of basic biosignal and imaging equipment.
D.	To understand the engineering aspects for safety and hazards associated with biomedical instruments.

Course Outcomes

After the completion of this course, students will be:

1.	Understand the general physiology for man-machine interaction in medical environment.
2.	Understand the fundamentals of the concept and design of biomedical equipment.
3.	Understand the importance of medical data transmission for better healthcare.
4.	Analyse the electrical hazards associated with medical equipment so that the safety equipment can be devised or suggested.

5.	Work in an interdisciplinary team.

BE319 Bioelectronics-Concept & Instrumentation

Module-1: General Physiology **[8L]**

Physiology of cardiac system, pulmonary system, urinary system, nervous system and muscles. Generation and propagation of action potentials in muscle, heart and nervous system.

Module-2: Electrophysiological Devices **[8L]**

Electrocardiograph; Electromyograph; Electroencephalograph; Phonocardiograph; Plethysmograph; Pulmonary function test devices; Blood pressure and flow measurement.

Module-3: Assistive, Therapeutic and Surgical Devices **[8L]**

Pacemaker; Defibrillator; Anesthesia machine; Ventilator; Heart-Lung machine; Hemodialysis machine; Audiometry and Hearing aids; Nerve and Muscle stimulators; Therapeutic and Surgical diathermies.

Module-4: Medical Imaging Systems **[8L]**

Generation of X-ray; X-ray imaging device; Catheterization system; Computer Assisted Tomography; Generations of Computer Assisted Tomography System; Ultrasound and Doppler equipment; Magnetic Resonance Imaging device; Functional Imaging with Gamma camera; Single Photon Emission Tomography; Positron Emission Tomography.

Module-5: Biotelemetry Systems **[8L]**

Antennas for biomedical application; Physiological telemetry; Radio Telemetry system; Portable telemetry system; Land-line telemetry system.

Text Books:

1. Textbook of Medical Physiology by A. C. Guyton, 8th edition, Prism Indian Publication, Bangalore, 1991.
2. Handbook for Biomedical instrumentation by R. S. Khandpur, 3rd edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014.
3. Medical instrumentation, Application &Design by J. G. Webstar, 4th edition, Wiley Student Edition, New Delhi, 2009.
4. Introduction to Biomedical Equipment Technology by J. J. Kar and J. M. Brown, 4th edition, Pearson India Education Services Pvt. Ltd., Noida, 2016.

Reference Books:

1. Biomedical Engineering and Instrumentation, Basic Concepts and Applications by J. D. Bronzino, 1st Edison, PWS Publishers, Boston, 1986.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

1. Conducting presentations in group and writing reports
2. Giving assignments to the students on some relevant topics
3. Industrial visits

POs met are: a, b, c, f

Topics beyond syllabus/Advanced topics/Design

1. Lecture on brain-computer interaction
2. Lecture on specialized imaging devices

POs met through Topics beyond syllabus/Advanced topics/Design

POs met are: f, g

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors (CD1)
Tutorials/Assignments (CD2)

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

AssessmentCompoents	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	√		√	√
End Sem Examination Marks	√	√	√	√	√
Assignment	√	√	√	√	√

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Course Outcome	Program Outcomes											
	a	b	c	d	e	f	g	h	i	J	k	l
i		3		2				1				
ii	3	3	3	3						3		3
iii	3	3	3	3						3		3
iv	3	3				2	2					1
v					3		2		3		2	3

Mapping Between Cos and Course Delivery (CD) methods

Mapping Between Cos and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors		CO1, CO2, CO3,CO4	CD1
CD2	Tutorials/Assignments		CO5	CD1 and CD2
CD5	Laboratory experiments/teaching aids		CO2	CD5

COURSE INFORMATION SHEET

Course code: BE310
Course title: Bioprocess Engineering Lab
Pre-requisite(s):
Co- requisite(s): Nil
Credits: 1.5 L: 0 T: 0 P: 3
Class schedule per week: 2
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students to:

A.	establish an understanding of the growth characteristics of microorganism in liquid culturing conditions.
B.	To familiarize students with different methods parts of fermeter and fermentation process.
C.	give them knowledge about preparation of standard plots for estimation of desired product and residual components.
D.	expose students for analysis of mass balance related with kinetics of enzyme/ cells at laboratory as well as industrial level.

Course Outcomes

After the completion of this course, students will be:

1.	Able to understand the role of media and constituents for growth and their effect
2.	Able to know about different phases of growth in batch mode cultivation
3.	Capable of knowing the role of calibration process like pH, DO etc in fermentation systems
4.	They will be able to analyze the mass balance after completion of process
5.	They will be able to design the steps of kinetic study of enzymes both at free state and immobilized state at laboratory and industrial scale

BE310 Bioprocess Engineering Lab

S. No:	Name of Experiments
Experiment 1:	Study of different culture systems and media
Experiment 2:	Shake Flask Culture
Experiment 3:	Bioreactor parts and accessories
Experiment 4:	Calibration of pH electrode and DO probe
Experiment 5:	To prepare standard plot of protein
Experiment 6:	To prepare standard plot of ammonia
Experiment 7:	To prepare standard plot of sugar
Experiment 8:	Growth of microorganisms and mass balance
Experiment 9:	Immobilization of enzymes by entrapment
Experiment 10:	Kinetic study of enzymes

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	✓
Tutorials/Assignments	✓
Seminars	
Mini projects/Projects	
Laboratory experiments/teaching aids	✓
Industrial/guest lectures	
Industrial visits/in-plant training	✓
Self- learning such as use of NPTEL materials and internets	

Simulation	✓

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment 60% (Distribution is as follows) **a) Day to day performance & Lab files** **b) Quiz (es)** **c) Viva**	**60** **30** **10** **20**
Semester End Examination (Distribution is as follows) **a) Examination Experiment Performance** **b) Quiz**	**40** **30** **10**
Total	**100**

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes											
	A	b	c	d	e	f	g	h	i	j	k	l
1	**3**	**3**				**3**						
2	**3**	**3**		**3**		**3**	2					1
3	**3**	**3**	**3**		2	**3**		2				1
4	**3**	**3**	**3**	**3**		**3**			2			
5	**3**	**3**	**3**	**3**		**3**	2	2	2		2	1

COURSE INFORMATION SHEET

Course code: **BE311**
Course title: **Mass Transfer and Bioseparation Engg. Lab**
Pre-requisite(s): **BE303**
Co- requisite(s): **NIL**
Credits: 1.5 **L: 0 T: 0 P: 3**
Class schedule per week: 03
Class: **B. Tech**
Semester / Level: **VI**
Branch: **Biotechnology**
Name of Teacher:

This course enables the students:

1.	To acquire a sound knowledge on mass transfer operations
2.	To understand bio-separation processes
3.	Heat and mass transfer equipments
4.	To learn solid-liquid mass transfer

Course Outcomes

After the completion of this course, students will be:

CO1	Analyze the fundamental properties mass transfer and bio-separation
CO2	Perform liquid-liquid separation by distillation
CO3	Separate proteins by adsorption, precipitation, and extraction
CO4	Execute the operations of extraction and drying

BE311 Mass Transfer and Bioseparation Engineering Lab

S. No:	Name of Experiments	CO	PO
Experiment -1	To study operation of sieve shaker.	1	a, b. c, l
Experiment -2	Studies on performance of ball mill.	1,2	c, d, e, l
Experiment -3	To study different parameters on solid-liquid extraction.	2,3	a, c, e, l
Experiment -4	To plot drying curve under fluidized bed condition.	3,4	f, i, k, l
Experiment -5	To determine drying rate of rotary dryer.	1,2,3	a, e, g, l
Experiment -6	To perform the operation of plate and frame filter press and evaluation of specific cake and medium resistance.	1,4	c, f, h, k, l
Experiment -7	To study operation of rotavapour.	3,4	c, h, m, l
Experiment -8	To study the performance of rotary drum filter.	2,3	b, e, j, l

Experiment -9	To study the precipitation process.	1,2,3	a, d, g, i, l
Experiment -10	To perform binary distillation in a bubble cap column	1,2	b, e, j, l
Experiment -11	To perform batch rectification in a packed distillation column	1,2	c, d, e, l
Experiment -12	To perform Adsorption with chemical reaction in a packed bed	2,3	a, c, e, l
Experiment -13	To perform Vapour in air diffusion	3,4	f, i, k, l
Experiment -14	To perform Mass transfer with or without chemical reaction	1,2,3	a, e, g, l
Experiment -15	To perform Heat transfer in agitated jacketed vessel	1,4	c, f, h, k, l
Experiment -16	To study of drop wise and film wise conduction	3,4	c, h, m, l
Experiment -17	To Study packed bed reactor	2,3	b, e, j, l
Experiment -18	To perform plate and frame type heat exchanger	1,2,3	a, d, g, i, l
Experiment -19	To perform fluidized bed reactor	1,2	c, d, e, l

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment 60% (Distribution is as follows) a) Day to day performance & Lab files b) Quiz (es) c) Viva	 60 30 10 20
Semester End Examination (Distribution is as follows) a) Examination Experiment Performance b) Quiz	40 30 10
Total	100

Assessment Components	CO1	CO2	CO3	CO4
Progressive evaluation Marks	3	3	2	2
End SEM Examination Marks	3	3	3	3
Quiz (s)	3	3	3	2

If satisfying < 34% = 1, 34-66% = 2, > 66% = 3

Indirect Assessment

5 Student Feedback on Faculty

5 Student Feedback on Course Outcome

COURSE INFORMATION SHEET

Course code: BE404
Course title: Plant Cell Technology Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P:3
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI
Branch: Biotechnology
Name of Teacher:

Course Description
This course provides knowledge of and expertise in plant tissue culture theory and practice. This course has a vocational focus and introduces students to the theory and practice of plant tissue culture with their role and applications in biotechnology.

The topics covered in this course include media preparation, sterile techniques, aseptic handling, initiation and routine maintenance of cells in culture, common contaminants of plant cell culture, and understanding of some of the applications of cell culture technology e.g. somatic cell and protoplast fusion vector mediated genetic transformations.

Pre-requisite Courses
Knowledge of and practical skills in plant and animal anatomy and physiology

Course Objectives:

On successful completion of this course you should be able to:

1. Explain major components of cell and tissue culture media, e.g. minerals, growth factors, hormones, and what governs the choice of components.
2. Explain steps taken to establish and optimize media for different species without the aid of texts.
3. Perform the common cell culture techniques, e.g. callus culture, Embryo culture and embryogenesis in plants.
4. Competently perform laboratory procedures and demonstrate practical application and conceptual knowledge of cell and plant tissue culture for biotechnology investigations and applications.

Course outcomes

1. **Understanding Science:** Articulate the methods of science and explain why current scientific knowledge is contestable and testable through further inquiry.

2. **Scientific knowledge:** Demonstrate a depth and breadth of knowledge and understanding of biological sciences.
3. **Inquiry and problem solving:** Analyse and solve problems in biotechnology by collecting, accurately recording, interpreting, and drawing conclusions from scientific data.
4. **Personal and professional responsibility:** work responsibly, safely, legally and ethically in an individual and team context.

Mapping of Cos with POs

S. No:	Name of Experiments	CO	PO
Experiment 1:	Demonstration of various instruments/equipment used in the PCT lab.	1,2	a, b, c
Experiment 2:	Preparation of Culture Media	1,2,3	a, b, c, g, i, j
Experiment 3:	Sterilization of Culture Media	2, 3,4	a, b, c,d,e, j, k
Experiment 4:	Sterilization of explant and its inoculation in culture media	3, 4	a, b, c, d,e, j, k,
Experiment 5:	Growth pattern analysis of inoculated explant	1,2,3,4	a, b, c, g, i, j, k,
Experiment 6:	Development and propagation of cell suspension culture	2,3,4	a, b, f,h, i, k, l
Experiment 7:	Preparation of synthetic seeds by encapsulation of somatic embryos in Alginate Beads	2,3,4	a, b, c,d, e, f, k,l,
Experiment 8:	Agrobacterium mediated transformation for hairy root culture.	1,2,3,4	a, b, c,d, e, f, k,l
Experiment 9:	Isolation of protoplasts, plating and regeneration	1,2,3,4	a, b, c,d, e, f, k,l

Book:

O.L. Gamborg and G. C. Phillips (Eds.): Plant Cell, Tissue and organ Culture: Fundamental methods. A Springer Lab Manual.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment 60% (Distribution is as follows) a) Day to day performance & Lab files b) Quiz (es) c) Viva	60 30 10 20
Semester End Examination (Distribution is as follows) a) Examination Experiment Performance b) Quiz	40 30 10
Total	100

Indirect Assessment –

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

COURSE INFORMATION SHEET

Course code: BE402
Course title: Bioreactor and Bioprocess Design
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 04
Class: B. Tech
Semester / Level: VII
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	The course imparts advanced knowledge on bioreactor design for efficient utilization of the principles in bioprocess technology
B.	Mixing time in agitated tanks
C.	Instrumentation and control of bioprocesses
D.	Simulations in bioprocesses

Course Outcomes

After the completion of this course, students will be:

1.	Basic concepts of bioreactor design.
2.	Non- ideal mixing and models for non -ideal reactors
3.	Scale up consideration for bioreactors
4.	Methods and strategies for fermentation control
5	Modelling and simulation of fermentation processes

(BE402) Bioreactor and Bioprocess Design

Module-1: **[8L]**

Important Considerations for Bioreactors Design: oxygen transfer, heat transfer, rheology, mixing, mechanical fittings in a bioreactor, vessel, agitation system materials, welds, valves, piping

Module-2: **[8L]**

Reactors with Non-ideal Mixing: Mixing time in agitated tanks, Residence time distributions, Models for non-ideal reactors, Agitation and oxygen transfer rate, Kla determination

Module-3: **[8L]**

Scale Up and Scale Down Concepts: Criteria for bioreactors, Power consumption in gaseous and non gaseous systems, Case study

Module-4: **[8L]**

Instrumentation and control of bioprocesses, Physical and chemical sensors, off-line analytical methods, Control of heat exchanger, distillation column and bioreactor systems

Module-5: **[8L]**

Study of anaerobic & aerobic processes, Ethanol production, Acetone-Butanol production, citric acid production and penicillin production, Introduction to simulation of bioprocesses

Text Books:

1. Shuler and Kargi, Bioprocess Engineering – Basic Concepts. Prentice Hall PTR, 2002
2. Doran, Bioprocess Engineering Principles, Academic Press, 1995
3. Bailey and Ollis, Biochemical Engineering Fundamentals, 1986
4. Bioseparations: Principles and Techniques, B. Sivasankar, Prentice Hall, 2005

Reference Books:

1. Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2001.
2. Roger Harrison et al., Bioseparations Science and Engineering, Oxford University Press, 2003.
3. Bioseparations: Downstream Processing for Biotechnology, Paul A. Belter, E. L. Cussler Wei-Shou Hu, Wiley India, Pvt Ltd., 1988

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 Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	Yes
Tutorials/Assignments	Yes
Seminars	Yes
Mini projects/Projects	
Laboratory experiments/teaching aids	
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	Yes
Simulation	Yes

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Compoents	CO1	CO2	CO3	CO4	C05
Mid Sem Examination Marks	√	√			
End Sem Examination Marks	√	√	√	√	√
Assignment			√	√	

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	3	3	2						1
2	3	3	3	3	3							1
3		3	3					2	2	2		1
4		3	3	3	3	2				2	2	1
5			3	3	3	2	2		2			1
												1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1,2,3,4,5	CD1
CD2	Tutorials/Assignments		CO2,3	CD1, CD8 and CD9
CD3	Seminars		CO2	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE407
Course title: Nanobiotechnology
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03

Class: B. Tech
Semester / Level: VII
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	To gain knowledge about the concepts, diverse applications of nanobiotechnology and its interdisciplinary aspect.
B.	To learn the principle phenomena governing the nanoscale effect on material properties and their applicability
C.	To familiarize the students with native bionanomaterials in living cells, their working and interaction with nanomaterials and how these principles can be applied to design new bionanomaterials and devices.
D.	To gain a working knowledge in nanotechnology techniques (synthesis, fabrication, characterization) and acquire the ability to use them to solve problems in bioengineering and biomedicine.
E	To correlate the impact of nanoscience and nanotechnology in a global, economic, environmental, and societal context.
F	To identify career paths at the interface of nanotechnology, biotechnology, environmental and agricultural engineering, medicine and research.

Course Outcomes

After the completion of this course, students will be:

1.	Understand the fundamentals of nanoscience, nanotechnology and biology that are converging to create the new area of nanobiotechnology
2.	Recognize the structural and functional principles of Bio-nanotechnology and their significance in designing nanomaterials and nanodevices
3.	Acquire the knowledge on different nano-fabarication methods and characterization techniques for nanomaterials. Employ bionanomaterials for analysis and sensing techniques
4.	Familiarize themselves with nanobiotechnology potentialities and be able to apprehend and explain use of nanomaterials in different biomedical applications. Ability to recognize the potential concerns and measures to be taken

(BE407) Nanobiotechnology

Module-1: **[8L]**

Introduction to Nanobiotechnology: Definitions and concept of Nanobiotechnology & Historical background, Nanoscale phenomena & Properties, Nanoscale visualization and characterization techniques.

Module-2: **[8L]**

Nano-Materials in Biosystems: Lipid bilayers, liposomes, polysaccharides Peptides, nucleic acids, Biomolecular Structure and Stability, Self assembly, self organization, Limitations of natural biomolecules, Cell – Nanostructure interactions.

Module-3: **[8L]**

Engineered Nanomaterials: Classification based on dimensionality, synthesis, properties and applications of Carbon nanomaterials, Metal nanoparticles, Fluorescent nanomaterials (Quantum dots), Dendrimers, DNA-Gold nanoconjugates.

Module-4: **[8L]**

Biogenic Nanoparticles: Overview and concept of biological nanoparticle production from plants and microbes, Methods of nanoparticle production, Advantages & Limitations to consider, applications of biological nanoparticles.

Module-5: **[8L]**

Emerging Nanotechnologies: Nano labels, biosensors, nanomedicine, bioimaging, Drug delivery, Regenerative medicines, Nanotoxicology challenges, case study.

Books Recommended:

Text books:

Niemeyer and Mirkin ed. Nanobiotechnology: concepts, applications & perspectives,
Jain, KK. Nanobiotechnology in molecular diagnostics: current techniques and applications

Reference books:

T. Pradeep, "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012
David S Goodsell, "*Bionanotechnology*", John Wiley & Sons, 2004

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3	CO4	
Mid Sem Examination Marks	√	√	√	√	**25%**
End Sem Examination Marks	√	√	√	√	**60%**
Assignment	√	√	√	√	**15%**

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	B	c	d	e	f	g	h	i	j	k	l

1	3	3										
2			3	3								
3					2	2						
4							2	2	2	2		1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1
CD2	Tutorials/Assignments		CO2	CD1
CD3	Seminars		CO3	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE313
Course title: Metabolic Engineering
Pre-requisite(s): BE202 Cell and Molecular Biology, BE204 Biochemistry and Enzyme Technology
Co- requisite(s):
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	Students will understand about cellular metabolism, their coordination and regulation
B.	Will get knowledge about metabolic kinetics, mass balances and metabolic regulation identifications
C.	To impart knowledge about the programming and cell capability and metabolic flux analysis
D.	To establish an understanding about metabolic control and pathways analysis, modelling and various application

Course Outcomes

After the completion of this course, students will be:

1.	able to understand about detailed cellular metabolism, coordination and their regulation
2.	Know about kinetics and mass balances for transient cases as well as flux analysis
3.	Able to understand about various pathways involved in metabolic control analysis
4.	Able to design different models and algorithm as well as understand about detailed application

(BE313) Metabolic Engineering

Module-1: **[8L]**

Cellular Metabolism: Overview of cellular metabolism, Fueling Metabolism, Supply of biomass precursors, Coordination of metabolic reactions, Metabolic strategies and regulation.

Module-2: **[8L]**

Metabolic Networks: Kinetics, mass balances for the steady state, mass balances for the transient case, Metabolic regulation identification.

Module-3: **[8L]**

Metabolic Flux Analysis: Linear programming, Cell capability analysis, Genome scale, Isotope labeling, Metabolic flux analysis and its applications,

Module-4: **[8L]**

Metabolic Control Analysis: Determination of flux control coefficient, Metabolic control analysis in linear and branched pathways, Analysis of metabolic control and the structure

Module-5: **[8L]**

Metabolic Network Design and Application: Metabolic pathway modeling, Metabolic pathway synthesis algorithms, Application in pharmaceuticals, Chemical bioprocess, Food technology, Environmental bioremediation.

Text Books:

1. Metabolic Engineering: Principles and Methodologies. Edited by G. Stephanopoulos, A.A. Aristidou, J. S. Neilson. (1998) Academic Press, San Diego, CA.

2. Metabolic Engineering Edited by S. Y. Lee & E.T. Papoutsakis (1999) Marcel Dekker, New York, pp.423.

***References*:**

1. Biochemistry by J. M. Berg, J. L. Tymoczko and LubertStryer (2002) Fifth Edition, W.H. Freeman, New York.
2. Understanding the Control of Metabolism by David Fell (1997) Portland Press, London,.
3. Modeling Metabolism with Mathematica. P. J. Mulquiney and P. W. Kuchel, CRC Press, 2003.
4. Pathway Analysis and Optimization in Metabolic Engineering. N. V. Torres and E. O. Voit, Cambridge University Press, 2002.

Gaps in the syllabus (to meet Industry/Profession requirements): Nil

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	Yes
Tutorials/Assignments	Yes
Seminars	Yes
Mini projects/Projects	
Laboratory experiments/teaching aids	
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	Yes
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3	CO4
Mid Sem Examination Marks	√	√		
End Sem Examination Marks	√	√	√	√
Assignment */Quiz *	√	√	√	√

* two quizzes: Quiz 1- CO1 & CO2; Quiz 2-CO3 & CO4

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcomes	Program Outcomes											
	A	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3		3		2				2	1
2	3	3			3			2		2	2	1
3	3		3			2		2	2	2	2	1
4	3			3		2	2			2	2	1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1, 2, 3, 4	CD1
CD2	Tutorials/Assignments/Quiz		CO1, 2, 4, 4	CD1 and CD8
CD3	Seminars		CO1, 2, 3, 4	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE316
Course title: Bioinformatics Algorithms
Pre-requisite(s): BE205
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII
Branch: Biotechnology
Name of Teacher:

Course Objectives

This course enables the students:

A.	An ability to work on basic science as well as biotech/pharmaceutical industry in multidisciplinary teams and independently.
B.	Learn various aspects to design and validate algorithms for bio-sequence analysis and interpreting experimental data from biological system and addressing the challenges associated with the interaction between different biomolecules.
C.	Grab the theoretical knowledge, parameters for searching and designing algorithm Design Paradigms, Motif Finding & Genome Rearrangements for a particular disease related Gene in biological research/ biotechnology/ pharmaceutical in industry and research lab.
D.	Enable students to understand the processes associated with DBMS architecture, Machine learning techniques and Bigdata analysis related to computational Biology.
E.	An UG degree in this field prepares a student for careers in biotech/ pharmaceutical research in different domains including industry.

Course Outcomes

After the completion of this course, students will be:

1.	An ability to apply knowledge and to design, analyse and conduct experiments, related to domain of Bioinformatics.
2.	An ability to validate new Bio-sequences. Know how to meet the desired needs within realistic constraints, such as, economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
3.	An ability to apply the knowledge to find various parameters for searching and designing metabolic pathway, genomics, proteomics for a particular disease related protein/Gene in biological research/ biotechnology/ pharmaceutical in industry and research lab.
4.	An ability to understand the processes associated with DBMS architecture, Machine learning techniques and Bigdata analysis related to computational Biology.
5.	An ability to design the processes conserved domain search and sequence comparison
6.	A UG degree in this field prepares a student for careers in higher education, as well as in pharmaceutical and biotechnology industries in governmental and private agencies. An ability to function in multidisciplinary teams. An ability to identify, formulate, and solve engineering problems.

(BE316) Bioinformatics Algorithms

Module-1: **[8L]**

Database System Versus File Systems: Characteristics of Database, Database Concepts, Schemas & Instances, Database users and Administrators, DBMS architecture. Biological Literature Information access, storage and retrieval systems- Primary and secondary databases of genomics, trascriptomics, proteomics and metabolomics. Knowledge on freeware and commercial software.

Module-2: **[8L]**

Introduction, Sorting, Searching, Complexity of algorithms: worst case, average case and amortized complexity, Algorithm Design Paradigms, Big-O and Theta notations.

Module-3: **[8L]**

Mapping Algorithms: Motif-Search Trees, Finding Motifs, Finding a Median String. Greedy Algorithm : Motif Finding & Genome Rearrangements, Sorting by Reversals. Approximation Algorithms

Module-4: **[8L]**

DNA Sequence comparison: Manhattan Tourist Problem – Edit Distance and Alignments – Longest Commons Subsequences – Global Sequence Alignment – Scoring Alignment – Local Sequence Alignment – Alignment with Gap Penalties – Multiple Alignment-Gene Predictions – Approaches to Gene Prediction - Spiced Alignment – Divide and Conquer Algorithms.

Module 5: **[8L]**

Machine learning techniques: ANN and Genetic Algorithm. Applications in Biotechnology

Text books:

1. T.H. Cormen, C.E. Leiserson, and R.L. Rivest, Introduction to Algorithms, The MIT Press, Cambridge, Massachusetts, USA, 1990
2. Neil C. Jones and Pavel A. Pevzner, An Introduction to Bioinformatics Algorithms, MIT Press, First Indian Reprint 2005.
3. Gary Benson Roderic page (Eds), Algorithms in Bioinformatics, Springer International Edition, First Indian Reprint 2004.

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 Delivery methods	

Lecture by use of boards/LCD projectors/OHP projectors	√
Tutorials/Assignments	√
Seminars	√
Mini projects/Projects	
Laboratory experiments/teaching aids	√
Industrial/guest lectures	
Industrial visits/in-plant training	
Self- learning such as use of NPTEL materials and internets	√
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3	CO4	CO5	CO6
Mid Sem Examination Marks	15	10				
End Sem Examination Marks	8	8	10	10	12	12
Assignment + seminar* quizzes (02)	5	5	5	5		5

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	**3**		**3**		3		**3**					
2	**3**	3	**3**			2	**3**					

3	**3**		**3**		3			2				
4	3						2		2	2		
5		**3**	**3**			2		2				
6				3			2					1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1, CD2, CD3, CD8
CD2	Tutorials/Assignments		CO2	CD1, CD2, CD3, CD8
CD3	Seminars		CO3	CD1, CD2, CD3, CD8
CD4	Mini projects/Projects		CO4	CD1, CD2, CD3, CD8
CD5	Laboratory experiments/teaching aids		CO5	CD1, CD2, CD3, CD8
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: BE412
Course title: Process Biotechnology
Pre-requisite(s): BE307 Bioprocess Engineering
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: VII/4
Branch: Biotechnology & Others
Name of Teacher:

Course Objectives

This course enables the students to:

A.	Understand the basic mechanism of bacterial growth
B.	Understand the mechanism of action of enzyme
C.	Sterilize liquid medium and air
D.	Understand the process of production of different metabolites
E.	Understand the operation principle of Bioreactors

Course Outcomes

After the completion of this course, students will be able to:

1.	Calculate kinetic parameters and yield from bacterial growth curve
2.	Determine the effect of parameters on enzyme kinetics
3.	Sterilize air and liquid medium
4.	Produce different primary and secondary metabolites
5.	Differentiate mode of operation of basic bioreactors

(BE412) Process Biotechnology

Module 1: **[8L]**

Cell growth and kinetics: Pattern of growth behaviour in batch culture, factors affecting the process of growth and model for Product formation, Mass balance, Yield prediction.

Module 2: **[8L]**

Enzyme kinetics: Introduction to enzymes, Michaelis–Menten kinetics, Linear plots. Determining rate parameters, Effect of pH and temperature, Enzyme immobilization.

Module 3: **[6L]**

Sterilization: Importance of Sterilization, Introduction and the kinetics of death, various type of sterilization equipments, role of oxygen transfer rate.

Module 4: **[8L]**

Production of primary and secondary metabolites: Bioprocesses for production of organic acids; solvents; antibiotics, proteins; polysaccharides; lipids etc.

Module 5: **[6L]**

Bioreactors, **Mode of bioreactor operation:** Batch, Fed-batch and Continuous bioreactors, Operation and control of bioreactors.

Text 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

Reference Books:

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 Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Indirect

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	√			
End Sem Examination Marks	√	√	√	√	√
Assignment			√	√	√

Assessment –

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3										1
2			3	3								1
3					2							1
4		3	3									1
5		3	3	3								1

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1, 2, 3, 4, 5	CD1
CD2	Tutorials/Assignments		CO3, 4	CD1
CD3	Seminars		CO5	CD1 and CD2
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids			
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: MT204
Course title: Constitution of India
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 2 L: 2 T:0 P:0
Class schedule per week: 02
Class: B.Tech
Semester / Level: VII
Branch: Biotechnology
Name of Teacher:

Course Objectives:

A.	To describe the importance and role of Constitution of India
B.	To explain the provisions related to social problems and issues.
C.	To explain the significance of the constitution for maintaining social unity and integrity.
D.	To describe the process for formulating and designing public policies in accordance with the constitutional provisions.

Course Outcomes

After the completion of this course, students will be:

1.	Outline the need and importance of the Indian constitution.
2.	Explain the fundamental rights and duties of the citizens of India.
3.	Relate appropriate constitutional provisions with relevant social issues
4.	Describe the role of different departments of government.
5.	Crique the Government policies and programmes designed for the society at large.

(MT204) Constitution of India

Module 1: Introduction to the Constitution of India, Salient Features of the Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

Module 2: Union and State Executives: President and Prime Minister, Council of Ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha. Governor: Role and Position, Chief Ministers and Council of ministers.

Module 3: The Indian Judicial System – The Supreme Court and The High Court's – composition, Jurisdiction and functions, The Role of the Judiciary.

Module 4: Local Government- District's Administration: Role and Importance, The Panchayatas – Gram Sabha, Constitution and Composition of Panchayatas , Constitution and Composition of Municipalities

Module 5: Miscellaneous- Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested Readings

1. The Constitution of India by " Ministry of Law India" Kindle Edition
2. Constitutional History of India by Prof.M.V.PYLEE-S.Chand Publishing
3. Indian Administration by Avasti and Avasti-Lakshmi Narain Agarwal Educational Publishers.2017 edition.
4. Introduction to the Constitution of India by D D Basu by Lexis Nexis : 20th edition.
5. Constitution of India V.N.Shukla's EBC Explorer Edition 13th ,2017

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 Delivery methods
1.Lecture by use of boards/LCD projectors/OHP projectors
2. Tutorials/Assignments
3. Seminars
4. Mini projects/Projects
5.Laboratory experiments/teaching aids
6.Industrial/guest lectures
7.Industrial visits/in-plant training
8.Self- learning such as use of NPTEL materials and internets
9.Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25

Faculty Assessment	05
Assignment / Quiz (s) (2 No.)	20
End Sem Examination Marks	50

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Sem Examination Marks	√	√			
End Sem Examination Marks	√	√	√	√	√
Assignment	√	√	√		

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	**Program Outcomes**				
	1	**2**	**3**	**4**	**5**
1	3	**1**	1	3	3
2	3	**3**	1	2	2
3	2	**2**	1	**3**	3
4	2	3	3	**2**	**2**
5	**1**	3	3	**1**	**2**

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1
CD2	Tutorials/Assignments		CO2	CD1
CD3	Seminars		CO3	CD1, CD2

CD4	Mini projects/Projects		CO4,	CD1, CD2
CD5	Laboratory experiments/teaching aids		CO5	CD1, CD3, CD6
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course Code: BE400
Course title: Research Project / Industry Internship
Pre-requisite(s):
Co- requisite(s):
Credits: 12 L:0 T:0 P: 3
Class schedule per week: 24-30 hours
Class: BTech
Semester / Level: VIII
Branch: Biotechnology
Name of Teacher: Respective Research Project / Industry Internship supervisors

Course Objectives

This course enables the students:

A.	To demonstrate a sound technical knowledge of their specific selected project topic. Able to impart knowledge for interdisciplinary, applied engineering and technology aspects.
B.	To execute problem identification, formulation and solution operations in order to conduct an engineering project.
C.	To design engineering solutions to complex problems utilising a systematic methodology.
D.	To communicate with engineers/biotechnologists and the community in a professional manner in written and oral forms.

Course Outcomes

After the completion of this course, students will be:

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.
2.	Able to collect data related to a societal and scientific issue in the area of biotechnology, analyse and interpret them.
3.	Able to identify the scientific problem, design engineering solutions for them by

	using a systematic approach.
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.
5.	Work in an interdisciplinary team.

Course Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	
Tutorials/Assignments	
Seminars	**x**
Mini projects/Projects	x
Laboratory experiments/teaching aids	x
Industrial/guest lectures	
Industrial visits/in-plant training	x
Self- learning such as use of NPTEL materials and internets	x
Simulation	x

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution
a) External Examiner	50%
b) Project Guide	25%
c) DPEC	25%
TOTAL	**100%**

Assessment Components	CO1	CO2	CO3	CO4	CO5
DPEC	√	√	√	√	√
Project Guide	√	√	√	√	√
External Examiner	√	√	√	√	√

Indirect Assessment –

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

Mapping between Objectives and Outcomes

Course Outcome	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	2	3	1	1	1	1	3	1	
2	3	3	3	3	3	1	1	1	1	1	1	3
3	3	3	3	3	3	2	3	1	3	1	3	3
4	3	3	3	3	3	3	3	3	3	1	3	1
5	2					3	3	3	3	2	2	3

Mapping Between COs and Course Delivery (CD) methods

Mapping Between Cos and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors		CO1, CO2, CO3,CO4	CD1
CD2	Tutorials/Assignments		CO5	CD1 and CD2
CD5	Laboratory experiments/teaching aids		CO2	CD5