GIET UNIVERSITY, GUNUPUR, ODISHA

SCHOOL OF ENGINEERING & TECHNOLOGY

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Structure of Undergraduate Engineering Program

BIOTECHNOLOGY

SL. NO.	COURSE WORK - SUBJECTS AREA	CREDITS / SEMESTER								TOTAL CREDITS
		I	II	III	IV	V	VI	VII	VIII	
1	Humanities and Social Sciences including Management Courses	3	3	2	2	-	-	2	-	**12**
2	Basic Science Courses	8	8	4	-	-	-	-	-	**20**
3	Engineering Science Courses including workshop, drawing, basics of electrical mechanical/computer etc.	10	10	4	3	-	-	-	-	**27**
4	Professional Core Courses	-	-	11	16	15	11	-	-	**53**
5	Professional Elective Courses relevant to chosen specialization / branch	-	-	-	-	3	6	6	3	**18**
6	Open subjects - Electives from other technical and/or emerging Subjects	-	-	-	-	3	3	3	6	**15**
7	Project work, Seminar and Internship in industry or elsewhere	-	-	1	-	1	-	5	8	**15**
8	Mandatory Courses [Environmental Sciences, Induction Training, Indian Constitution, Essence of Indian Traditional Knowledge]	0	0	0	0	-	-	-	-	**0**
	TOTAL	**21**	**21**	**22**	**21**	**22**	**20**	**16**	**17**	**160**

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I Semester [First Year]

Branch/Course Common to all branches of UG Engineering & Technology

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Basic Science Courses		Mathematics-I	3	1	0	4
2	Basic Science Courses		Physics / Chemistry	3	0	2	4
3	Engineering Science Courses		Engineering Mechanics	3	1	0	`4
4	Engineering Science Courses		Programming for Problem Solving	2	0	4	4
5	Humanities and Social Sciences including Management Courses		English	2	0	2	3
6	Engineering Science Courses		Engineering Graphics & Design / Workshop/Manufacturing Practices	1	0	2	2
7	Mandatory Courses		Induction Program	-	-	-	0
			Total Credits:	**14**	**2**	**10**	**21**

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II Semester [First Year]

Branch/Course Common to all branches of UG Engineering & Technology

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Basic Science Courses		Basics of Biology	3	1	0	4
2	Basic Science Courses		Physics / Chemistry	3	0	2	4
3	Engineering Science Courses		Basic Electrical & Electronics Engineering	3	0	2	`4
4	Engineering Science Courses		Data Structure & Algorithms	2	0	4	4
5	Humanities and Social Sciences including Management Courses		English	2	0	2	3
6	Engineering Science Courses		Engineering Graphics & Design / Workshop/Manufacturing Practices	1	0	2	2
7	Mandatory Courses		NCC/NSS/Yoga	-	-	-	0
			Total Credits:	**14**	**1**	**12**	**21**

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III Semester [Second Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Basic Science Courses		Mathematics-III	3	1	0	4
2	Engineering Science Courses		Object Oriented Programming	3	0	2	4
3	Professional Core Courses		Basics of Biology	3	0	0	3
4	Professional Core Courses		Biochemistry	3	0	2	4
5	Professional Core Courses		Microbiology	3	0	2	4
6	Humanities and Social Sciences including Management Courses		Organizational Behavior / Optimization In Engineering	2	0	0	2
7	Project		Summer Industry Internship	-	-	2	1
8	Mandatory Courses		Constitution of India / Essence of Indian Traditional Knowledge	-	-	-	0
			Total Credits:	**17**	**1**	**8**	**22**

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IV Semester [Second Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Engineering Science Courses		Database Management Systems	3	0	0	3
2	Professional Core Courses		Molecular Biology	3	0	2	4
3	Professional Core Courses		Biostatistics	3	0	2	4
4	Professional Core Courses		Bio-analytical Techniques	3	0	2	4
5	Professional Core Courses		Upstream Process Engineering	3	0	2	4
6	Humanities and Social Sciences including Management Courses		Optimization In Engineering Organizational Behavior	2	0	0	2
7	Mandatory Courses		Environmental Sciences	-	-	-	0
			Total Credits:	**17**	**0**	**8**	**21**

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V Semester [Third Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Core Courses		Genetic Engineering and r-DNA Technology	3	0	2	4
2	Professional Core Courses		Immunology and Immunotechnology	3	0	2	4
3	Professional Core Courses		Biochemical Reaction Engineering	3	0	0	3
4	Professional Core Courses		Bioreactor Design and Analysis	3	0	2	4
5	Professional Elective Courses		Industrial Microbiology and Enzyme Technology Fermentation Technology Bio-kinetics and Thermodynamics	3	0	0	3
6	Open Elective Courses		Process Dynamic and Control Process Utility and Industrial Safety IOT for Engineering Applications Process Dynamic and Control	3	0	0	3
7	Project		Industry Internship	-	-	2	1
			Total Credits:	**18**	**0**	**8**	**22**

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VI Semester [Third Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Core Courses		Plant Biotechnology	3	0	2	4
2	Professional Core Courses		Bioinformatics	3	0	2	4
3	Professional Core Courses		Downstream Process Engineering	3	0	0	3
4	Professional Elective Courses		Environmental Biotechnology Bioprocess Engineering Proteomics and Genomics	3	0	0	3
5	Professional Elective Courses		Nano Bitechnology Structural Biology Biosensor & Dignostics	3	0	0	3
6	Open Elective Courses		Biochemical Reaction Engineering Industrial Instrumentation AIR & Noise Pollution	3	0	0	3
			Total Credits:	**18**	**0**	**4**	**20**

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VII Semester [Fourth Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Elective Courses		Food Biotechnology Animal Biotechnology Biosystem Engineering	3	0	0	3
2	Professional Elective Courses		Medical and Pharmaceutical Biotechnology Biomaterial Protein Engineering	3	0	0	3
3	Open Elective Courses		Green Technology Municipal Solid Waste Management Fuel and Energy Technology	3	0	0	3
4	Humanities and Social Sciences including Management Courses		Marketing Management Engineering Economics and Costing Entrepreneurship Development Human Resource Management	2	0	0	2
5	Project		Industry Internship	-	-	2	1
6	Project		Project Work-I	0	0	8	4
			Total Credits:	**11**	**0**	**10**	**16**

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VIII Semester [Fourth Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Elective Courses		IPR, Bioethics and Biosafety Bioprocess Engineering and Technology Bioprocess Optimization	3	0	0	3
2	Open Elective Courses		Bio Medical Instrumentation Integrated solid waste management	3	0	0	3
3	Open Elective Courses		Industrial Safety & Hazard Management Bio Medical Instrumentation	3	0	0	3
4	Project		Project Work-II & Dissertation	0	0	12	6
5	Project		Seminar and Comprehensive Viva-Voce	0	0	4	2
			Total Credits:	**9**	**0**	**16**	**17**

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Course Title						
Subject Code	**Engineering Mathematics-III**	L	T	P	C	QP
BBSBS3040		**3**	**1**	**0**	**4**	**A**

Course Educational Objectives:

Prerequisite: Fundamentals of complex numbers, probability and calculus

CEO1: To test the nature of complex function

CEO2: To identify the different methods for complex integration

CEO3: To analyze error by using different methods.

CEO4: To know about different types of probability distributions.

Course Outcomes (Towards the end of the course students will be able to :

CO1	To know Analytic function and their properties.
CO2	To Evaluate Real Integrals by using residue integration method.
CO3	To apply numerical methods in Engineering Mathematical Problems
CO4	To investigate Probability distribution problems and least square method to fit a curve and to evaluate the correlation coefficient and regression lines for the data.

Mapping of course outcomes with programme outcomes

CO-PO & PSO Mapping

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

UNIT I **[12 Hours]**

Complex Analysis:

Analytic function, Cauchy-Riemann equations, Harmonic Function, Complex integration: Line integral, Cauchy's integral theorem, Cauchy's integral formula.

UNIT II **[8 Hours]**

Taylor's series, Laurent's series, Singularities and zeros, Residues, Cauchy Residue theorem, Evaluation of real integrals .

UNIT-III **[10 Hours]**

Numerical methods:

Errors, Solving of algebraic and transcendental equations by using fixed point iteration and Newton-Raphson's method. : Newton divided different interpolation, Lagrange interpolation, Newton's forward and backward interpolation. Numerical Differentiation, Numerical integration: The trapezoidal rule, The simpson's rules, Ordinary differential equation: Modified Euler's method, Runge-kutta methods.

UNIT-1V **[18 Hours]**

PROBABILITY:

Random variables, Probability distributions, Mean and variance of distribution,
Binomial, Poisson and uniform distributions, Normal distribution,
Random sampling, Estimation of Parameters (maximum likely hood method),Confidence intervals, Testing of hypothesis ,Acceptance sampling ,Regression and correlation analysis, fitting of straight line by least square method.

Prescribed Books:

1. Advanced Engineering Mathematics by E. Kreyszig, Tenth Edition, Willey
2. Numerical Methods by jain and Iyengar.

Reference:-

1. Higher Engineering Mathematics by BS Grewal : Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by B.V.Ramana, McGraw Hills Education
3. Numerical Methods by Dutta and Jena.

Subject Code	Name of the Subject	L	T	P	C	QP
BCSES3051	**OOPS Through JAVA**	3	1	0	4	A

Course Educational Objectives

CEO1	The model of object oriented programming: abstract data types, encapsulation, inheritance and polymorphism
CEO2	Fundamental features of an object oriented language like Java: object classes and interfaces, exceptions and libraries of object collections
CEO3	How to take the statement of a business problem and from this determine suitable logic for solving the problem; then be able to proceed to code that logic as a program written in Java.
CEO4	How to test, document and prepare a professional looking package for each business project using java doc.

Course Outcomes: *Upon successful completion of this course, students should be able to:*

CO1	Analyze ,formulate and model problems using concepts of object oriented analysis and design and implement using Java.
CO2	Write programs using basic data types and strings, using loops, Array.
CO3	Analyze the problems and resolve run-time errors with Multithreading and Exception Handling techniques
CO4	Understand the power of generics and Collections Framework and Java.io package

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES											
	PO1	PO2	PO	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1										
CO2	3	2	2									
CO3	2	2	2									
CO4	2	1	2									

SYLLABUS

Unit – I **[12Hours]**

An introduction Object Oriented Programming, Features of Object Oriented Programming Introduction to Java. Difference between C/C++ and Java, Features of Java, First Java Program, Writing the java program, Compiling the program, JVM and its significance in executing a program?, Architecture of JVM. Understanding, Java Tokens, Datatypes, Operators, Control Structures and Arrays, Conditional Statements, Loops/ Iterators, Jumping Statements, Java Arrays, Multidimensional Arrays, Taking Input from keyboard, Command Line Arguments, Using Scanner Class, Using Buffered Reader class.

Unit - II **[12Hours]**

Laplace Transform & its Application: Introduction to Laplace Transform, Laplace transform of some basic functions, Laplace transform of periodic functions, Inverse Laplace transform, Application of Laplace transform: Circuit Analysis (Steady State and Transient).

Two Port Network Functions& Responses: z, y, ABCD and h-parameters, Reciprocity and Symmetry, Interrelation of two-port parameters, Interconnection of two-port networks. Network Functions: Significance of Poles and Zeros, Restriction on location of Poles and Zeros, Time domain behaviour from Pole-Zero plots.
Unit – III **[12 Hours]** Fourier Series& its Application: Fourier series, Fourier analysis and evaluation of coefficients, Steady state response of network to periodic signals, Fourier transform and convergence, Fourier transform of some functions. Passive Filter: Brief idea about network filters (Low pass, High pass, Band pass and Band elimination) and their frequency response
Unit – IV **[12 Hours]** Network Synthesis: Realizability concept, Hurwitz property, positive realness, properties of positive real functions, Synthesis of R-L, R-C and L-C driving point functions in Foster and Cauer forms. Network Topology: Graph of a network, Concept of tree, Incidence matrix, Tie-set matrix, Cut-set matrix, Formulation and solution of network equilibrium equations on loop and node basis
Teaching Methods: Chalk& Board/ PPT/Video Lectures
Text Book: 1. Programming in Java. Second Edition. Oxford Higher Education. (Sachin Malhotra/ Saurav Choudhary) 2. Core Java For Beginners. (Rashmi Kanta Das), Vikas Publication
Reference Book: 3. JAVA Complete Reference (9th Edition) HerbaltSchelidt

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Title of the subject						
Subject Code		L	T	P	C	QP
BBTPC3020	**Basics of Biology**	**3**	**1**	**-**	**4**	**A**

Course Educational Objective

CEO1: To introduce the basic knowledge of biology and its application

CEO2: To understand the functions of cell , cell division and principle of inheritance in living system

Course Outcomes: On successful completion of the course students will be able to:

CO1	Students will obtain knowledge of cell structure, function of cellular organelles, membranes, and biological molecules.
CO2	The undergraduate will understand the inter and intra molecular communication
CO3	Student have an idea about genetic diseases
CO4	Student will know the developmental aspects of plant and animals

UNIT:1 **15 Hours**

Structure & Chemical composition of cells: ultra structure of Cell (Prokaryotic and Eukaryotic), Cell Wall & Cell Membrane, Cell organelles: structure and function, Nucleus, cell inclusions, Molecular organization of chromosome (Nucleosome concept).

UNIT:2 **15 Hours**

Cell Cycle, Cell Divisions- Mitosis and Meiosis, Membrane transport & trafficking, mechanisms of protein sorting and targeting, intercellular communication and associated signaling pathways, cancer cell Biology (Cause, Cell Characteristics).

UNIT:3 **15Hours**

Principles of Inheritance: Chromosome theory of Heredity, Mendelism, Non-Mendelian Gene Interactions (Epistasis, Lethality, Pleiotropy), Polygenes and multiple allele, Allelic Complementation, Cytoplasmic Inheritance, Linkage and Crossing over, Chromosome mapping, Mutation and Chromosomal Aberration, Transposable elements, Genetic diseases in Human(Colour blindness, Haemophillia).

UNIT:4 **15 Hours**

Origin, evolution and diversification of life, natural selection, Types of selection (stabilizing, directional etc), Principles breeding in plants and animals. Population Genetics: Hardy-Weinberg's law, Genetic Equilibrium, Changes in gene frequency, gene flow, Genetic Drift, Effect of evolutionary forces on genetic equilibrium of a population. Developmental genetic with reference to Arabidopsis and Drosophila.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books : 1. Cell Biology, Genetics, Molecular Biology, Evolution & Ecology by P S Verma and VK Agrawal, S. Chand
2.Cell biology and Genetics by P K Gupta Rastogi Publication

Ref. Books :
1. Molecular Biology of the Cell 4th Edition Bruce Alberts
2.The Cell A Molecular Approach Geoffrey M Cooper. Boston University 2nd edition

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPC3020	**Biochemistry**	**3**	**1**	**-**	**4**	**A**

Course Educational Objective

CEO1: To provide the knowledge on macromolecules present in the cell.

CEO2: To have an idea about enzymes and their functions.

Course outcomes: At the end of the course, the student will be able to:

CO1	Obtain knowledge about the structure/function of biomolecules such as Carbohydrates, Proteins, Amino acids and Lipids.
CO2	Learn the basic structure of nucleic acidsandprinciple of bioenergetics.
CO3	Demonstrate the fundamentals of biochemical principles such as cellular metabolism, metabolic pathways and the regulation of biological/biochemical processes.
CO4	understand the different types of enzymes, hormones, vitamins, minerals and their functions.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	1	2	-	-	-	-	-	-	-	-
CO2	1	2	1	1	-	-	-	-	-	-	-	-
CO3	2	-	2	3	-	-	-	-	-	-	-	1
CO4	2	1	-	2	1	-	-	-	-	-	-	-
Avg.	2.4	2.4										

UNIT:1 **[11 Hours]**

Structure and Function of Carbohydrates: Monosaccharide, Oligosaccharides, Polysaccharides (Starch, Glycogen, Cellulose), Optical Isomerism, Structure and Function of Lipids: Saturated and Unsaturated Fatty Acids, Triacylglycerols, Phosphoglycerides, Sphingolipids, Waxes and Sterol. Structure and Function of Proteins: Amino acids, Peptide bond, Hierarchy of protein architecture, Ramachandran Plot.

UNIT:2 **[11 Hours]**

Structure and Function of Nucleic Acids: DNA, RNA, Double Helix Model of DNA, Denaturation and Renaturation of DNA. Structure and function of Hormones, Minerals and Vitamins. Principle of Bioenergetics: Bioenergetics and Thermodynamics, Phosphoryl group transfer and energy currency-ATP; Biological Oxidation and reduction reactions.

UNIT:3 **[12 Hours]**

Metabolism-I: Introduction to metabolic processes; Metabolism of Carbohydrates: Glycolysis, TCA Cycle, ETS and Oxidative Phosphorylation, Gluconeogenesis,Metabolism of Lipids: Anabolism (Saturated), Catabolism (α- Oxidation, β-Oxidation) and Energetics of lipid metabolism; Metabolism of Nucleic Acids: Catabolism and anabolism of purine and pyrimidine nucleotides. Photosynthesis: Light reaction and dark

reaction.
UNIT:4 **[11 Hours]** Metabolism-II: Metabolism of proteins: Biosynthesis of amino acids (role of precursors); Enzymes: Properties of Enzyme, Classification of Enzymes, Mechanism of enzyme action, Kinetics of enzyme action, Activation energy, Enzyme Inhibition, Coenzymes
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books: 1. Principle of Bio-Chemistry – Lehinger, Nelson and Cox 2. Biochemistry of Biochemistry by L. Stryer 3.Fundamentals of Biochemistry by A.C Deb
Ref. Books: 1. Fundamentals of Biochemistry – Voet&Voet 2. Biochemistry, Rastogi, Tata McGraw Hill. 3. Fundamental of Biochemistry, Jain and Jain

Title of the subject					
Subject Code	L	T	P	C	QP
BBTPC3030 Microbiology	**3**	**1**	**-**	**4**	**A**

Course Educational Objective

CEO1: To make the student learn about origin and evolution of microbes

CEO2: To make the student understand regarding structure and function of different microbial groups

Course outcomes: At the end of the course, the student will be able to:

CO1: Gain the knowledge about classifications, culture and identification of important microorganisms.

CO2:Understand the microbial growth, reproduction and process of nitrogen fixation.

CO3:Obtain the knowledge about food microbiology, human pathogens and their life cycle.

CO4:Learn about the antibiotics and microbiology of different environment.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	1	-	-	2	-	-	-	-	-
CO2	2	-	2	2	-	-	-	-	-	-	-	1
CO3	1	2	-	1	1	-	-	-	-	-	-	-
CO4	2	-	-	-	2	-	2	2	-	-	-	-

UNIT:1 **[11 Hours]**

Discovery of microorganisms, Theory of spontaneous generation, Identification of Microorganisms - A general account, Introduction to Microbial Kingdom- Bacteria, Viruses, Fungi,Classical and Modern approaches of microbial taxonomy; Classification of bacteria, fungi and Viruses; Methods of Microbiology- Culture media, Sterilization, Establishment of pure culture, Staining of bacteria (Gram's, Acid Fast, Capsule),

UNIT:2 **[12 Hours]**

Microbial growth and metabolism: Pattern of bacterial growth, Growth kinetics, Monod's Equation, Synchronous Growth and its Kinetics, Continuous culture and its growth kinetics, Cyanobacteria and nitrogen fixation, Microbial genetics: Organization of bacterial and viral genome, Plasmids ,Genetic transfer in bacteria (Transformation, Conjugation and Transduction), DNA repair mechanisms in bacteria, Transposons, Mutation in Microorganisms, Ames test for Mutagenesis

UNIT:3 **[12 Hours]**

Food Microbiology: Microbiology of foods, Types of microbes associated with food spoilage, Food preservation methods, Food poisioning, Microbiology of Milk and dairy products.Medical Microbiology: disease causing bacteria, virus and fungi; Basic concepts, action of pathogens, human pathogenic viruses and

bacteria, Gram-positive and Gram- negative Bacilli of medical importance. Miscellaneous bacterial agents of disease; DNA and RNA viruses and their diseases, Fungal diseases. Life cycle of some important pathogens like- Malaria, hepatitis, filaria,

UNIT:4 **[10 Hours]**

Antibiotics-classification & mode of action, Therapeutic index. Environmental Microbiology: Microbiology of water, Microbiology of Air, Baceriological analysis of water, Microbiology of extreme environments (Halobacteria, Methanogens, Thermofiles).

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1.A text book by Micro biology by R.C.Dubey and D.K. Maheshwari, .S.Chand
2. Prescott's Micro biology by Michael J.Pelczar, JR, E.C.S.Chan, Noel R.Krieg. Indian edition

Ref. Books
:1. Prescott's Micro biology by JoanneM.Willey, Linda M.Sherwood and Christopher J. Woolverton.
2. A text book by Micro biology by Naveen Kango, I.K.International Publishing House Pvt. ltd.

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Title of the subject						
Subject Code		L	T	P	C	QP
BMGHS5062	**Organizational Behavior**	**2**	**0**	**0**	**2**	A

Course Educational Objective	
CEO1: To provide knowledge in organizational behavior.	
CEO2: To provide knowledge on leadership quality and managerial skill.	
Course outcomes: At the end of the course, the student will be able to	
CO1	Understand the importance of organization and its sustenance.
CO2	Have knowledge on theories of motivation and perception.
CO3	Know the culture of organization.
CO4	Understand the importance of organizational change.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1													
CO2	3	2	2												
CO3	2	2	2												
CO4	2	1	2												
Avg.	2.4	2.4													

UNIT:1 **[12 Hours]**

Fundamental of OB: Definition, scope and importance of OB, relationship between OB and the individual, evolution of OB, Theoretical framework (cognitive), behaviouristic and social cognitive, limitations of OB.

Attitude:importance of attitude in an organization, right attitude, components of attitude, relationship between behaviour and attitude, developing emotional intelligence at theworkplace, job attitude, barriers to change attitude.

Personality and values: definition and importance of personality for performance, the Myers- Briggs types indicator and the big five personality model, significant personality traits suitable to the workplace (personality and job – fit theory), personality tests and their practical applications.

Perception: meaning and concept of perception, factor Influencing perception, selective perception, attribution theory, perceptual process, social perception (stereotyping and hello effect).

Motivation: Definition& concept of motive & motivation, the content theories of motivation (Maslow's need hierarchy 7 Her berg's two factor model theory), the process (vroom's expectancy theory & porter (Lawler model), contemtary theories—equity theory of work motivation.

UNIT:2 **[15 Hours]**

Foundation of Group Behaviour: The meaning of Group & Group Behavior & Group Dynamic, Types of Groups, The Five –Stage model of group development.

Managing Teams: Why work teams, work teams in organization, developing work teams, team effectiveness & team building.

Leadership **:** concept of leadership, trait approach contingency leadership approach, contemtary, meaning and significance of contemtary leadership, concept of transformations leadership, contemtary theories of leadership, success stories of today's Global and Indian leaders.

UNIT:3 **[10 Hours]**

Organizational Culture: Meaning & Definition of Organizational Culture, creating & sustaining Organizational Culture, types of Organizational Culture (strong vs. weak culture, soft vs. hard culture & formal vs. informal culture), creating positive Organizational Culture, concept of workplace spiritually.

UNIT:4 **[10 Hours]**

Organizational Change: Meaning, Definition & nature of Organizational change, type of Organizational change, Forces that acts as stimulants to change.

Implementing Organizational change: how to overcome the resistance to change, approaches to managing Organizational change, Kurt Lewin's- three step model, seven stage model of change &Koter's Eight-step plan for implementing change, leading the change process, Facilitating change, dealing with individual & group resistance, intervention strategies for facilitating Organizational change, method of implementing Organizational change, developing a learning organization.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Understanding Organizational Behaviour, Parek, Oxford
2. Organizational Behaviour, K. Awathappa,HPH.

Ref. Books 1. ntroduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
2. Organizational Behaviour, Hitt, Miller, Colella, Wiley
3. Organizational Behaviour, Robbins, Judge, Sanghi, Pearson

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Title of the subject						
Subject Code		L	T	P	C	QP
BBSHS5061	**Optimization in Engineering**	**2**	**0**	**0**	**2**	A

Course Educational Objective	
CEO1: To provide basics of optimization in engineering.	
CEO2: To introduce linear and non linear programming	
Course outcomes: At the end of the course, the student will be able to	
CO1	make use of the concepts of operations research modelling approaches
CO2	Formulate and solve engineering and managerial situations as LPP.
CO3	Formulate and solve engineering and managerial situations as Transportation and Assignment problems.
CO4	Determine average queue length and waiting times of queuing models.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1													
CO2	3	2	2												
CO3	2	2	2												
CO4	2	1	2												
Avg.	2.4	2.4													

UNIT:1 **[10 Hours]**

Introduction: Historical overview of operations research, fundamentals of or Modeling Approach. Linear Programming: Basic assumptions, formulation, graphical method, simplex method, duality theory, primal-dual relationships, sensitivity analysis.

UNIT:2 **[14 Hours]**

Transportation and Assignment Problems: Specific features of transportation problem, streamlined simplex method for solving transportation problems, special features of assignment problems, Hungarian method for solving assignment problems. Integer programming: Special features, binary integer programming models, branch-and-bound technique, cutting-plane method..

UNIT:3 **[14 Hours]**

Dynamic Programming: Characteristics, principle of optimality, solution procedure, deterministic problems. Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process.

UNIT:4 **[14 Hours]**

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming Introduction to Genetic Algorithm.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
1. Taha H.A., Operations Research 9th Edition, Prentice Hall of India, New Delhi, 2010. 2.Kanti Swarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research 7thEdition, Sultan chand& Sons, New Delhi, 2005
Ref. Books 1. P. K. Gupta, D.S.Hira, "Operations Research", S.Chand and Company Ltd 2. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7thEdition, TMH, 2009. 3.Kalyanmoy Deb, "Optimization for Engineering Design", PHI Learning Pvt Ltd

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Subject Code	**Course Title**	L	T	P	C	
	Basics of Biology Lab	**0**	**0**	**2**	**2**	

Course Educational Objective

In this laboratory, students will have the opportunity to study about microscope and its parts

analyse the different stage of cell division, both mitosis and meiosis

Course outcomes: At the end of the course, the student will be able to:

CO1	understand the operation of microscope for the analysis of cells
CO2	understand the cell counting techniques
CO3	Gain the knowledge on different types of blood cells.
CO4	can understand the working principle of SEM.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	2	1	3	-	-	-	-	-	-	-	-	-	1	2	3
CO1	1	2	3	-	-	-	-	-	-	-	-	-			
CO2	2	3	1	-	-	-	-	-	-	-	-	-			
CO3	2	2	1	-	-	-	-	-	-	-	-	-			
CO4	2	1	3	-	-	-	-	-	-	-	-	-			

LIST OF EXPERIMENTS

1. Study of different parts of microscope and its use.
2. Preparation of Mitosis from Onion Root-tip cells and observation of permanent slides.
3. Preparation of meiotic cell division in grasshopper's testis
4. Cell Counting and viability study
5. To isolate the pigments from plant leaf.
6. To identify the blood cell types in human blood smear.
7. To identify the different types cells present in the leaf cross section.
8. To prepare permanent slides using the given sections like Plant and animal samples.
9. Separation of lymphocytes and granulocytes from blood sample
10. To study cellular fractionation of a homogenized rat liver via a technique called differential centrifugation.
11. Demonstration of principles underlying Scanning Electron Microscopy (SEM).

Subject Code	**Course Title**	L	T	P	C	
	Biochemistry Lab	**0**	**0**	**2**	**2**	

Course Educational Objective

In this laboratory, students will have the opportunity to do the analysis of different biomolecules through 24lectrophoretic24y and chromatographic techniques

Analysis of different Enzymatic activity and assay

Course outcomes: At the end of the course, the student will be able to:

CO1	Student can 24lectro the protein and carbohydrate by spectrophotometry
CO2	Student can be determined the quality and quantity of nucleic acid.
CO3	The undergraduate will separate the biomolecules by chromatography techniques
CO4	Students can extract and study the activity and assay of enzymes

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	3	2	2	-	-	-	-	-	-	-	-	-	1	2	3
CO1	2	2	3	-	-	-	-	-	-	-	-	-			
CO2	2	2	1	-	-	-	-	-	-	-	-	-			
CO3	3	2	1	-	-	-	-	-	-	-	-	1			
CO4	3	2	2	-	-	-	-	-	-	-	-	-			
Avg.															

LIST OF EXPERIMENTS

1. Estimation of Protein using Lowry's Method
2. Estimation of carbohydrates
3. Estimation of DNA using DPA method
4. Estimation of RNA using Orcinol Method
5. Estimation of Saponification value of fatty acids/Oil
6. Separation of Amino acids by Paper Chromatography
7. Separation of Sugars by Thin Layer Chromatography
8. Separation of Proteins by 24lectrophoretic method.
9. Extraction of enzymes from bacterial culture.
10. Assay of Enzyme activity: Amylase/Protease

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Subject Code	**Course Title**	L	T	P	C	
	Microbiology Lab	**0**	**0**	**2**	**2**	

Course Educational Objective

In this laboratory, students will have the opportunity to learn the sterilization and staining techniques know about the preparation of culture media, bacteria culture methods.

Course outcomes: At the end of the course, the student will be able to:

CO1	understand the micrometry and different staining techniques
CO2	do the preparation of media and its various method of sterilization
CO3	Isolate the microbes from natural sources and study the growth and culture technique.
CO4	Learn the antibiotic assay of microbes and different kinds of microscopy

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	3	2	2	-	-	-	-	-	-	-	-	-	1	2	3
CO1	2	2	3	-	-	-	-	-	-	-	-	-			
CO2	2	3	1	-	-	-	-	-	-	-	-	-			
CO3	2	2	3	-	-	-	-	-	-	-	-	1			
CO4	3	2	2	-	-	-	-	-	-	-	-	-			
Avg.															

LIST OF EXPERIMENTS

1. Micrometry: calibration of stage and ocular micrometer and measurement of dimension of microbial cells.
2. Staining of microbial sample (Gram's Staining, Endospore staining, Fungal staining)
3. Media preparation and sterilization (Slant, Stab and Broth culture)
4. Isolation of micro organisms from natural habitats (Air, Water, Soil & Milk)
5. Isolation of pure culture by streak plate and serial dilution method.
6. Study the bacterial growth curve using spectrophotometer and viability assessment.
7. Antibiotic assay and estimation of Zone of inhibition.
8. Chemical assay and MIC determination of antibiotics.
9. Biochemical assay of microorganisms (Starch Hydrolysis, Casein Hydrolysis and IMVIC test).
10. Microscopy: Study of Compound, Phase contrast and Fluorescence Microscopes.

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Subject Code	Name of the Laboratory	L	T	P	C	QP
	JAVA PROGRAMMING LAB.			2	2	

Pre -Requisite:

Course Outcomes

CO1	Apply the object-oriented concepts through Java language.
CO2	Demonstrate the concepts of polymorphism and inheritance.
CO3	Write Java programs to implement error handling techniques using exception handling
CO4	Develop solution for a real problem using Java programming.

CO-PO & PSO Mapping: ***Upon successful completion of this course, students should be able to:***

Cos	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1												
CO2	3	3													
CO3	3	2													
CO4	3	3	3												
Avg.															

List of Experiments

1. Introduction, Compiling & executing a java program.
2. Data types & variables, decision control structures: if, nested if etc.
3. Loop control structures: do, while, for etc.
4. Classes and objects.
5. Data abstraction & data hiding, inheritance, polymorphism.
6. Threads, exception handlings and applet programs
7. Interfaces and inner classes, wrapper classes, generics

IV Semester [Second Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Engineering Science Courses		Database Management Systems	3	0	1	3
2	Professional Core Courses		Molecular Biology	3	1	2	4
3	Professional Core Courses		Biostatistics	3	1	2	4
4	Professional Core Courses		Bio-analytical Techniques	3	1	2	4
5	Professional Core Courses		Upstream Process Engineering	3	1	2	4
6	Humanities and Social Sciences including Management Courses		Optimization In Engineering	2	0	0	2
			Organizational Behavior				
7	Mandatory Courses		Environmental Sciences	-	-	-	0
			Total Credits:	**17**	**4**	**9**	**21**

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	Name of the Subject	L	T	P	C	QP
	DATABASE MANAGEMENT SYSTEM	**3**	**0**	**0**	**3**	**A**

Course Educational Objectives

Pre -Requisite:

CEO 1	Gain a good understanding of the architecture and functioning of Database Management Systems as well as associated tools and techniques.
CEO 2	Understand and apply the principles of data modeling using Entity Relationship and develop a good database design.
CEO3	Understand the use of Structured Query Language (SQL) and its syntax
CEO4	Apply Normalization techniques to normalize a database.

Course Outcomes: *Upon successful completion of this course, students should be able to:*

CO1	***Identify*** and ***Classify*** the concepts of Database Management system, Data models and architecture of database, ER to Relational mapping concepts.
CO2	***Applying***the constraints in database using different query languages like:- relational algebra and calculus, SQL and QBE for the ***implementing*** the Data definition and data manipulate languages in Database.
CO3	***Compare*** the different normal forms to ***Apply*** normalization process to construct the consistent Database.
CO4	***Design and Develop*** the Database by inspecting concurrency control and recovery strategies to make complete Database without confliction and anomalies in concurrent access environment.

CO-PO & PSO Mapping:

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	1												
CO2	3	2	1												
CO3	2	1	1												
CO4	2	1	2												
Avg.															

SYLLABUS

UNIT:1 **[15 Hours]**

Introduction to database Systems, advantages of database system over traditional file system, Basic concepts & Definitions, Database users, Database Language, Database System Architecture, Schemas, Sub Schemas, & Instances, database constraints, 3-level database architecture, Data Abstraction, Data Independence, Mappings, Structure, Components & functions of DBMS, Data models.

UNIT:2 **[13 Hours]**

Entity relationship model, Components of ER model, Mapping E-R model to Relational schema, Relational Algebra, Tuple & Domain Relational Calculus, Relational Query Languages: SQL and QBE. Database Design:- Database development life cycle (DDLC), Automated design tools, Functional dependency and Decomposition,

Join strategies, Dependency Preservation & lossless Design, Normalization, Normal forms:1NF, 2NF,3NF, and BCNF, Multi-valued Dependencies, 4NF & 5NF. Query processing and optimization: Evaluation of Relational Algebra Expressions, Query optimization, Query cost estimation.

UNIT:3 **[10 Hours]**

Network and Object Oriented Data models, Storage Strategies: Detailed Storage Architecture, Storing Data, Magnetic Disk, RAID, Other Disks, Magnetic Tape, Storage Access, File & Record Organization, File Organizations & Indexes, Order Indices, B+ Tree Index Files, Hashing Data Dictionary.

UNIT:4 **[12 Hours]**

Transaction processing and concurrency control: Transaction concepts, properties of transaction, concurrency control, locking and Timestamp methods for concurrency control schemes. Database Recovery System, Types of Data Base failure & Types of Database Recovery, Recovery techniques, fundamental concepts on Object-Oriented Database, Object relational database, distributed database, Parallel Database, introduction to Data warehousing & Data Mining.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. Sudarshan, Korth: Database System Concepts, 6th edition, McGraw-Hill Education
2. Elmasari&Navathe: Fundamentals of Database System, Pearson Education.

Reference Books:

1. Elmasari&Navathe: Fundamentals of Database System, Pearson Education.
2. Ramakrishnan: Database Management Systems, McGraw-Hill Education.
3. Andrew S. Tanenbaum: Modern Operating Systems, 3rd Edition, Pearson Education.
4. Terry Dawson, Olaf Kirch: Linux Network Administrator's Guide, 3rd Edition O'Reilly

Title of the subject						
Subject Code		L	T	P	C	QP
	Molecular Biology	**3**	**1**	**-**	**4**	A

Course Educational Objective

CEO1: To provide the general knowledge on cell, cell cellular organs, and their function.

CEO2: To provide detailed knowledge about gene expression.

Course outcomes: At the end of the course, the student will be able to:

CO1	understand the organization and complexity of genome.
CO2	understand the mechanism of DNA replication, DNA repair and DNA recombination.
CO3	emphasize the molecular mechanism of transcription, protein synthesis and gene regulation in various organisms.
CO4	articulate applications of molecular biology in the modern world.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	1	2	-	-	-	-	-	-	-	-			
CO2	3	2	2	1	-	-	-	-	-	-	-	-			
CO3	2	-	2	3	-	-	-	-	-	-	-	2			
CO4	1	2	1	2	-	-	-	-	-	-	-	-			
Avg.	2.4	2.4													

UNIT:1 **[10 Hours]**

Genome Organization: Prokaryotes and Eukaryotes, Nuclear genome and Organellar genome, DNA as the genetic material, Central dogma of molecular biology, Genome complexity, C- value Paradox, Cot curve analysis, Repetitive DNA, satellite DNA;Cistron, Recon, Muton; Variants of gene- Split genes, pseudo genes, Overlapping genes and selfish DNA.

UNIT:2 **[11 Hours]**

DNA Replication: Models of DNA replication, Enzymology of DNA replication, Process of DNA replication, DNA replication at the telomere, Replication of Mitochondrial and Chloroplast genome, DNA repair, Homologous recombination and Holliday junction.

UNIT:3 **[10 Hours]**

Transcription: Transcription machinery (prokaryotes and eukaryotes), Transcription factors, Transcription process, m-RNA processing (Pre and Post transcriptional processing), m-RNA stability and nuclear transport, m-RNA editing.

UNIT:4 **[11 Hours]**

Translation: Genetic code, Translation machinery (t-RNA, Aminoacyl t-RNA synthetase, Ribosome), Translation process, Post translational modification of protein. Regulation of Gene expression: Constitutive and Induced gene expression, Operon model (Lac-operon and Trp- operon), Gene silencing, DNA

methylation, Introduction to recombinant DNA technology.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books: 1.Molecular Biology of CellByLodish and Baltimore 2. Molecular Biology by Frefelder. 3. Gene VII by Benjamin Lewin
Ref. Books 1MolecularBiology. By Turner. 2.Molecular "Biology of Gene" – Watson 3. Genome by T.A Brown

Title of the subject

Subject Code		L	T	P	C	QP
	Biostatistics	3	1	-	4	A

Course Educational Objective

CEO1:To provide the basic knowledge on importance of biostatistics

CEO2:Analyses of biological data with various biostatistical tools to draw relevant conclusion

Course outcomes: At the end of the course, the student will be able to:

CO1	Get the concept on biological variables
CO2	learn the technique of analysis of data
CO3	have an idea about the distribution of data in natural condition
CO4	Design of experiment and draw samples without any biasness

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	2	-	3	-	-	-	-	-	-	-	2		
CO2	2	2	-	3	-	-	-	-	-	-	-	1	2		
CO3	3	-	2	2	1	-	-	-	-	-	-	-	3		
CO4	1	2	2	1	-	-	-	-	-	-	-	-	1		
Avg.	2.4	2.4													

UNIT:1 **[12 Hours]**

Introduction and definition of Biostatistics; Concept of variables in biological systems.
Collection, Classification, tabulation graphical and diagrammatic representation of numerical data; Measures of central tendency: Mean, Median and Mode and their relationship; Measures ofdispersion: Range, Quartile deviation, Mean deviation, Standard deviation, Concept of standarderror, Coefficient of variation, Skewness and Kurtosis.

UNIT:2 **[11 Hours]**

Probability: Random experiment, events, sample space, mutually exclusive events, independentand dependent events; Various definitions of probability, addition and multiplication theoremsof probability, Random variables (discrete and continuous), Probability density functions andits properties; Probability distributions: normal, Binomial, Poisson and their application.

UNIT:3 **[12 Hours]**

Concept of populations and sample. Simple random sampling without replacement. Definition ofSimple random sample; Designing of Experiments-Random block design and Split plot design;Correlation and Regression, linear regression.

UNIT:4 **[11 Hours]** Analysis of variance: One- way and two-way classifications with single observation per cell. Duncan's multiple range test; Tests of significance: Chi-square, student's t, z and f-distributions, their properties and uses.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books: 1. Biostatistics by P. N. Arora and P.N. Malhan, Himalaya Publishing house 1. 2. Introduction to biostatistics by P.K.Banerjee, S.Chand
Ref. Books: 1.Introduction to Biostatistics and Research methods by P. S. S. Sundar Rao and J. Richard, PHI publication 2. Biostatistics BY Manju Pandey , Euro span Publisher.

Title of the subject						
Subject Code		L	T	P	C	QP
	Bio-analytical Techniques	**3**	**1**	**-**	**4**	A

Title of the subject	
CEO1: To provide knowledge about bio instruments and their working principle.	
CEO2: To learn the use of instruments and their application in research.	
Course outcomes: At the end of the course, the student will be able to:	
CO1	understand the working principle of spectroscopic and microscopic techniques like Mass s spectroscopy, NMR, IR, ESR and Electron microscopy..
CO2	acquire knowledge on various analytical techniques and instruments used for the separation and analysis of bimolecules.
CO3	learn and design different chromatographic techniques for separation of biological products.
CO4	understand the application of radioactivity in the analysis of biomolecules

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	2	-	1	-	-	-	-	-	-	-			
CO2	3	-	-	2	2	1	-	-	-	-	-	-			
CO3	1	2	2	-	3	-	-	-	-	-	-	-			
CO4	2	1	-	2	-	-	-	-	-	-	-	1			
Avg.															

UNIT:1 **[11 Hours]**

Spectroscopic techniques: Spectroscopic methods to study physicochemical properties ofBiomolecules,UV-Vis, IR, FTIR, Fluorescence, Mass Spectroscopy, NMR, ESR and X-ray crystallography. Principles of electron microscopy, preparation of samples, TEM and SEM.

UNIT:2 **[12 Hours]**

Electrophoresis: General principle of electrophoresis, support media (agarose and polyacrylamide gels), Agarose gel electrophoresis electrophoresis of proteins by SDS-PAGE, native PAGE, gradient gels, isoelectric focusing, two dimensional PAGE, Blotting Techniques: Southern, Northern and Western blot analysis. Polymerase Chain Reaction (PCR).Centrifugation: Basic principles of sedimentation (RCF), Types of centrifuge and centrifugation

UNIT:3 **[12 Hours]**

Chromatography: Principles of chromatography, distribution coefficient, retention time, Chromatographic methods for macromolecular separation- Paper, TLC and column chromatography, Partition chromatography, ion exchange chromatography, gel exclusion chromatography, affinity chromatography, normal phase and reversed phase chromatography, HPLC, Gas Chromatography

UNIT:4 **[10 Hours]** Radioisotope Techniques: Radioactivity activity detection methods based on ionization (Geiger- Muller monitor), excitation (solid and liquid scintillation counting), autoradiography, safety aspects of handling radioactive material.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books: 1. Principles and Techniques of Biochemistry and Molecular Biology, Wilson K. and Walker J., Cambridge University Press (2005) 6th ed. 2. Biochemical Method-A Concise guide for students and researchers, Pingoud A., UrbankeC., Hoggett J. and Jeltsch A. Wiley-VCH Publishers.
Ref. Books: 1. Bioseparations: Science and Engineering, Harrison, R.G., Todd, P., Rudge' S.R. and Petrides, B.B. Oxford University Press (2006). 2. Molecular Spectroscopy, McHale, J.L., Prentice Hall (1998). 3. Microscopy and Microtechniques. Marimuthu, R., MJP Publishers (2008).

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Title of the subject						
Subject Code		L	T	P	C	QP
	Upstream Process Engineering	**3**	**1**	**-**	**4**	**A**

Course Educational Objective

CEO1: To provide the knowledge on fluid mechanics and their properties

CEO2: To understand the basic law of heat transfer

Course outcomes: At the end of the course, the student will be able to:

CO1	Describe the operation, as well as constriction and exploitation characteristics of machines for mechanical operations.
CO2	Solve simple radiation heat transfer problems
CO3	Make use of empirical equations to solve forced and natural convection heat-transfer problems
CO4	Design the distillation column

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	-	2	1	-	-	-	-	-	-	-			
CO2	1	-	2	3	-	1	-	-	-	-	-	-			
CO3	-	2	2		3	-	-	-	1	-	-	-			
CO4	-	-	3	2	1	-	-	-	-	-	-	2			
Avg.															

UNIT:1 **[10 Hours]**

Processing of particulates Properties and handling of particulate solids, size reduction equipments- working principles of crusher, grinder and pulveriser, screening and particle size distribution.

UNIT:2 **[10 Hours]**

Methods of analysis and description - fluid as a continuum, Classification of fluid. Fluid statics – basic equation - equilibrium of fluid element – Hydrostatic Pressure, Pressure measuring Devices. Flow in boundary layers. Its formation & growth in tubes & plates. Basic equations of fluid flow continuity, momentum & Bernoulli's equation. Flow measuring devices; Venturi, Orifice, Pitot tube &Rotameter.

UNIT:3 **[10 Hours]**

Heat transfer, basic laws of heat transfer, Conduction: The Fourier heat conduction equation, Steady-state one dimensional heat conduction through plane wall, cylindrical wall, spherical wall and composite structures. Heat transfer from extended surfaces, critical insulation of thickness. Introduction to convection: Natural and forced convection, Natural Convection: Grashoff number, natural convection from vertical and horizontal surfaces. Forced convection, The convective heat transfer coefficient, Types of heat exchangers, log-mean temperature difference, energy balances, overall heat transfer coefficients

UNIT:4 **[12 Hours]**

Introduction to Mass transfer operations, moleculardiffusion in fluids, binary solutions, Fick's law, equation of continuity, steady state equimolal counter current diffusion, Stefan-Maxwell equation, diffusivity of gases and liquids,application of molecular diffusion, mass transfer coefficients, in laminar and turbulent flow, Interphase mass transfer, Film theory, Penetration theory, surface-renewal theories, analogy between mass, heat and momentum transfer. Relative volatility, ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporization, partial condensation, differential distillation steam distillation, azeotropic and extractive distillation. Continuous distillation

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books: 1.McCabe, Smith and Harriot, Unit Operations of Chemical Engineering
2. Foust et al, Principles of Unit Operations.

Ref. Books: 1. Badger and Banchero. Introduction to Chemical Engineering.
2. Foust, Wenzel, Clump, Maus and Andersen, Principles of Unit Operations.

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Title of the subject						
Subject Code		L	T	P	C	QP
	Optimization in Engineering	**2**	**0**	**0**	**2**	A

Course Educational Objective	
CEO1: To provide basics of optimization in engineering.	
CEO2: To introduce linear and non linear programming	
Course outcomes: At the end of the course, the student will be able to	
CO1	make use of the concepts of operations research modelling approaches
CO2	Formulate and solve engineering and managerial situations as LPP.
CO3	Formulate and solve engineering and managerial situations as Transportation and Assignment problems.
CO4	Determine average queue length and waiting times of queuing models.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1													
CO2	3	2	2												
CO3	2	2	2												
CO4	2	1	2												
Avg.	2.4	2.4													

UNIT:1 **[10 Hours]**

Introduction: Historical overview of operations research, fundamentals of or Modeling Approach. Linear Programming: Basic assumptions, formulation, graphical method, simplex method, duality theory, primal-dual relationships, sensitivity analysis.

UNIT:2 **[14 Hours]**

Transportation and Assignment Problems: Specific features of transportation problem, streamlined simplex method for solving transportation problems, special features of assignment problems, Hungarian method for solving assignment problems. Integer programming: Special features, binary integer programming models, branch-and-bound technique, cutting-plane method..

UNIT:3 **[14 Hours]**

Dynamic Programming: Characteristics, principle of optimality, solution procedure, deterministic problems. Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process.

UNIT:4 **[14 Hours]**

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming Introduction to Genetic Algorithm.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

1. Taha H.A., Operations Research 9th Edition, Prentice Hall of India, New Delhi, 2010.

2.Kanti Swarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research 7thEdition, Sultan chand& Sons, New Delhi, 2005

Ref. Books

1. P. K. Gupta, D.S.Hira, "Operations Research", S.Chand and Company Ltd

2. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7thEdition, TMH, 2009.

3.Kalyanmoy Deb, "Optimization for Engineering Design", PHI Learning Pvt Ltd

Title of the subject						
Subject Code		L	T	P	C	QP
BMGHS5062	**Organizational Behavior**	**2**	**0**	**0**	**2**	A

Course Educational Objective	
CEO1: To provide knowledge in organizational behavior.	
CEO2: To provide knowledge on leadership quality and managerial skill.	
Course outcomes: At the end of the course, the student will be able to	
CO1	Understand the importance of organization and its sustenance.
CO2	Have knowledge on theories of motivation and perception.
CO3	Know the culture of organization.
CO4	Understand the importance of organizational change.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1													
CO2	3	2	2												
CO3	2	2	2												
CO4	2	1	2												
Avg.	2.4	2.4													

UNIT:1 **[12 Hours]**

Fundamental of OB: Definition, scope and importance of OB, relationship between OB and the individual, evolution of OB, Theoretical framework (cognitive), behaviouristic and social cognitive, limitations of OB.

Attitude:importance of attitude in an organization, right attitude, components of attitude, relationship between behaviour and attitude, developing emotional intelligence at theworkplace, job attitude, barriers to change attitude.

Personality and values: definition and importance of personality for performance, the Myers- Briggs types indicator and the big five personality model, significant personality traits suitable to the workplace (personality and job – fit theory), personality tests and their practical applications.

Perception: meaning and concept of perception, factor Influencing perception, selective perception, attribution theory, perceptual process, social perception (stereotyping and hello effect).

Motivation: Definition& concept of motive & motivation, the content theories of motivation (Maslow's need hierarchy 7 Her berg's two factor model theory), the process (vroom's expectancy theory & porter (Lawler model), contemtary theories—equity theory of work motivation.

UNIT:2 **[15 Hours]**

Foundation of Group Behaviour: The meaning of Group & Group Behavior & Group Dynamic, Types of Groups, The Five –Stage model of group development.

Managing Teams: Why work teams, work teams in organization, developing work teams, team effectiveness & team building.

Leadership **:** concept of leadership, trait approach contingency leadership approach, contemtary, meaning and significance of contemtary leadership, concept of transformations leadership, contemtary theories of

leadership, success stories of today's Global and Indian leaders.

UNIT:3 **[10 Hours]**

Organizational Culture: Meaning & Definition of Organizational Culture, creating & sustaining Organizational Culture, types of Organizational Culture (strong vs. weak culture, soft vs. hard culture & formal vs. informal culture), creating positive Organizational Culture, concept of workplace spiritually.

UNIT:4 **[10 Hours]**

Organizational Change: Meaning, Definition & nature of Organizational change, type of Organizational change, Forces that acts as stimulants to change.

Implementing Organizational change: how to overcome the resistance to change, approaches to managing Organizational change, Kurt Lewin's- three step model, seven stage model of change &Koter's Eight-step plan for implementing change, leading the change process, Facilitating change, dealing with individual & group resistance, intervention strategies for facilitating Organizational change, method of implementing Organizational change, developing a learning organization.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Understanding Organizational Behaviour, Parek, Oxford

3. *Organizational Behaviour, K. Awathappa,HPH.*

Ref. Books 1. ntroduction to Organizational Behaviour, Moorhead, Griffin, Cengage.

4. *Organizational Behaviour, Hitt, Miller, Colella, Wiley*
5. *Organizational Behaviour, Robbins, Judge, Sanghi, Pearson*

Title of the subject						
Subject Code		L	T	P	C	QP
	ENVIRONMENTAL SCIENCES	**3**	**0**	**0**	**0**	**A**

Course Educational Objective

CEO1: Graduates can pursue higher education and Research and Development for solving real world problems

CEO2: Graduates will have leadership qualities with social consciousness and ethics.

Course Outcome	
CO1	Explain the structure and function of ecosystem and realize its importance for maintaining ecological balance.
CO2	Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
CO3	Describe the major pollutants environmental problems and control devices for environmental management and sustainable development
CO4	Analyze different types of environmental hazards and their management
CO5	Describe the importance of environmental safety.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	4	5	6	7	8	9	10	11	12			
CO2						1	2								
CO3						2	2								
CO4						1	2								
Avg.						2	2								

UNIT:1 **[14 Hours]**

Ecological Concepts: Biotic components, Ecosystem Process: Energy, Food Chain, Water cycle, Oxygen cycle, Nitrogen cycle etc., Environmental gradients, Tolerance levels of environment factor, Indian Environmental Law. Chemistry in Environmental Engineering: Atmospheric chemistry, Soil chemistry. Noise pollution- Noise standards, measurement and control.

UNIT:2 **[14 Hours]**

Waste Water Treatment: DO and BOD, Waste water treatment process: pretreatment, primary and secondary treatment of waste water, Activated sludge treatment: Anaerobic digestion, Reactor configurations and methane production.

Air Pollution: Air pollution and pollutants, criteria pollutants, non-criteria pollutants,Acid deposition, Global climate change –greenhouse gases, Air pollution meteorology, Atmospheric dispersion, Industrial Air Emission Control, Flue gas desulphurization, NOx removal, Fugitive emissions.

UNIT:3 **[8 Hours]**

Solid Waste Management, Source, classification and composition of MSW: Separation, storage and transportation, Reuse and recycling, Waste Minimization Techniques. Hazardous Waste Management, Hazardous waste and their generation, transportation and treatment: Incinerators, Inorganic waste treatment.

E.I.A., Environmental auditing.

UNIT:4 **[8 Hours]**

Occuptional Safety and Health Acts, Safety procedures, Type of Accidents, Chemical and Heat Burns, Prevention of Accidents involving Hazardous substances, Human error. Hazard Control Measures in steel industry, Petroleum Refinery, Pharmaceutical industry. Fire Prevention -Detection, Extinguishing Fire, Safety Management- Safety Handling and Storage of Hazardous Materials, Corrosive Substances, Hydrocarbons and Wastes. Personal Protective Equipments.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books: 1. Environmental Engineering, Irwin/ McGraw Hill International Edition, 1997, G. Kiely

2.Environmental Engineering , Prof. B.K. Mohapatra, Seven Seas Publication, Cuttack

3. *Environmental Engineering and Safety , Raut & Sen, Scientific Publishers.*

Ref. Books: 1. Environmental Engineering, Arcadio P. Sincero & Gergoria A. Sincero PHI Publication

2. Environmental Science, Curringham & Saigo, TMH

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Subject Code	Name of the Laboratory	L	T	P	C	QP
BCSES3152	**DATABASE MANAGEMENT SYSTEM LAB.**	**0**	**0**	**2**	**1**	**A**

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	***Implement*** the concept of Entity-Relationship (E-R) model from specified information and to transform into to relational model.
CO2	***Apply*** the different types of Constraints in relational database and defines the database.
CO3	***Compares*** the different types of manipulation and access methods of data from database.
CO4	***Analyze*** and simple database application that demonstrates understanding of all the above, working as a team.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	1												
CO2	3	2	1												
CO3	2	1	1												
CO4	2	1	2												
Avg.															

List of Experiments:

1. Use of SQL syntax: insertion, deletion, join, updation using SQL.
2. Programs on join statements and SQL queries including where clause.
3. Programs on procedures and functions.
4. Programs on database triggers.
5. Programs on packages.
6. Programs on data recovery using check point technique.
7. Concurrency control problem using lock operations.
8. Programs on ODBC using either VC++.
9. Programs on JDBC.
10. Programs on embedded SQL using C / C++ as host language.

Additional Assignments:

1. Use of NoSQL database like Mongo DB.
2. Programs on connectivity to Mongo DB using MEAN.
3. Programs on connectivity to Mongo-DB using Python.
4. Programs on connectivity to Mongo DB using PHP.

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Subject Code	**Course Title**	L	T	P	C	QP
	Molecular Biology Lab	**0**	**0**	**2**	**2**	**A**

Course Educational Objective

In this laboratory, students will have the opportunity to isolate the nucleic acids from various organisms.

Students can estimate the amount of DNA and RNA isolated by spectrophotometry

Course outcomes: At the end of the course, the student will be able to:

CO1	Isolatethe nucleic acid from different organisms.
CO2	Learn the separation of macromolecule using electrophoresis.
CO3	Know the quantification of biomolecules.
CO4	Understand the restriction digestion and molecular mapping.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	-	-	-	-	-	-	-	-	-			
CO2	3	2	-	-	-	-	-	-	-	-		1			
CO3	1	2	3	-	-	-	-	-	-	-	-	-			
CO4	2	1	3		-	-	-	-	-	-	-	-			
Avg.															

LIST OF EXPERIMENTS

1. Isolation, purification of DNA from plant sample and its yield estimation.
2. Isolation, purification of DNA from blood sample and its quantification using UV spectrophotometer.
3. Isolation, purification of DNA from bacterial sample and its quality assessment.
4. Isolation of plasmid DNA from bacteria and estimation its size using agarose gel electrophoresis.
5. Effect of gel concentration on solidification and migration of DNA sample
6. Restriction digestion of supplied DNA sample and estimate the molecular weight of the fragments resulted.
7. Elution of the DNA from the supplied gel and assess the integrity of the fragments.
8. Isolation and purification of RNA from plant/yeast sample and its quantification using UV spectrophotometer..
9. Isolation and purification of protein from the supplied sample and its quantification using UV spectrophotometer.

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Subject Code	**Course Title**	L	T	P	C	QP
	Biostatistics Lab	**0**	**0**	**2**	**2**	**A**

Course Educational Objective

In this laboratory, students will to study the important of Biostatistics in various biotechnological experiments

Student can analysis and decision making in biological experiment.

Course outcomes: At the end of the course, the student will be able to:

CO1	understand the importance and application of biostatistics.
CO2	learn how to represent the biological data for analysis
CO3	know the comparison of data and application of null hypothesis.
CO4	gain the practical knowledge on ANOVA and correlation of coefficient.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	-	-	-	-	-	-	-	-	-			
CO2	2	3	2	-	-	-	-	-	-	-	-	-			
CO3	2	2	3		-	-	-	-	-	-	-	2			
CO4	3	1	3	-	-	-	-	-	-	-	-	-			
Avg.															

LIST OF EXPERIMENT

1. Introduction to biostatistics and measurement.
2. Construct and interpret graphical displays such as histograms, bar charts, ogive etc.
3. Collection of sample data and opening sample data sets.
4. Measures of central tendency
5. Measures of dispersion.
6. Hypothesis testing; Students t-test and interpreting confidence level.
7. Hypothesis testing; Chi-square test and interpreting confidence level.
8. Analysis of variance (ANOVA)
9. analysis of biological data with correlation coefficient

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Subject Code	**Course Title**	L	T	P	C	QP
	Bio-analytical Techniques Lab	**0**	**0**	**2**	**2**	**A**

Pre -Requisite: Mechanics of Solid

Course Educational Objective

In this laboratory, students will have the opportunity to study the various bioinstruments.

Separation and quantification of biomolecules using various biophysical methods.

Course outcomes: At the end of the course, the student will be able to:

CO1	study the spectrophotometric analysis of DNA and protein
CO2	learn the denaturation of protein and nucleic acid and their estimation.
CO3	understand the techniques of electrophoresis.
CO4	have basic idea on operation of HPLC, GC, DSC, FTIR and Electron microscopy (SEM/TEM).

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3	-	-	-	-	-	-	-	-	-			
CO2	3	2	2	-	-	-	-	-	-	-	-	-			
CO3	2	3	3	-	-	-	-	-	-	-	-	-			
CO4	3	2	2	-	-	-	-	-	-	-	-	-			
Avg.															

LIST OF EXPERIMENT

1. UV-Visible spectroscopy: UV – spectrophotometric analysis of DNA and protein samples/
2. Determine λmax of DNA, protein, bromophenol blue solutions by wavelengthscan
3. Denaturation of proteins and nucleic acids.
4. chromatographic analysis of chlorophyll
5. 2D-TLC analysis of amino acids
6. Use of viscometer in protein analysis
7. Comparison of Coomassie brilliant blue and silver staining methods for visualizing protein bands in SDS-PAGE
8. Comparison of ethidium bromide and silver staining methods for visualisation of small DNA fragments analyzed by native PAGE
9. Fluorescence spectroscopy (demonstration)
10. GC & HPLC (demonstration)

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Subject Code	**Course Title**	L	T	P	C	QP
	Upstream Process Engineering Lab	**0**	**0**	**2**	**2**	**A**

Course Educational Objective

1.In this laboratory, students will have the opportunity to know the techniques of upstream processing.

2.The machines and equipment used to determine experimental data include closed conduit using Venturimeter, Orifice meter, Rotameter.

Course outcomes: At the end of the course, the student will be able to:

CO1	understand the flow regime and construction of friction factor.
CO2	know the Pressure drop for flow by various theories.
CO3	Determine the various heat and mass transfer coefficient.
CO4	understand the operation of various reactors.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	3	-	-	-	-	-	-	-	-	-			
CO2	3	3	2	-	-	-	-	-	-	-	-	-			
CO3	2	3	2	-	-	-	-	-	-	-	-	-			
CO4	3	3	2	-	-	-	-	-	-	-	-	-			
Avg.															

LIST OF EXPERIMENT

1. Experiments on Reynold's Apparatus-Determination of flow regime and construction of friction factor against NRe.
2. Experiments on flow measuring devices - in closed conduit using (a) Venturimeter, (b) Orifice meter (c) Rotameter.
3. Study and verification of conservation of energy of a flowing liquid in a Bernoulli's apparatus.
4. Determination of Pressure drop for flow through packed bed & verification of Ergun Equation, Kozeny-Karman equation, Blake-Plummer Equation.
5. To Determine the Overall heat transfer coefficient of a concentric pipe heat exchanger based on the inside diameter of the tube.
6. To calculate the heat loss in a lagged pipe made of various insulating materials.
7. Determination of volumetric mass transfer coefficient (Kla) of gas-liquid system.
8. Determination of mixing time in stirred tank reactor.
9. To determine the coefficient of absorption/adsorption in packed bed columns.
10. To separate the solute from one phase to another (aqueous to solvent) phase by liquid-liquidextraction.

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V Semester [Third Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Core Courses		Genetic Engineering and r-DNA Technology	3	0	2	4
2	Professional Core Courses		Immunology and Immunotechnology	3	0	2	4
3	Professional Core Courses		Biochemical Reaction Engineering	3	0	0	3
4	Professional Core Courses		Bioreactor Design and Analysis	3	0	2	4
5	Professional Elective Courses		Industrial Microbiology and Enzyme Technology Fermentation Technology Bio-kinetics and Thermodynamics	3	0	0	3
6	Open Elective Courses			3	0	0	3
7	Project		Summer Industry Internship	-	-	2	1
			Total Credits:	**18**	**0**	**8**	**22**

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Title of the subject

Subject Code		**L**	**T**	**P**	**C**	**QP**
	Genetic Engineering and r-DNA Technology	**3**	**1**	**-**	**4**	**A**

Course Educational Objective

CEO1: To introduce the basic of Genetic Engineering and its application

CEO2: To understand the functions gene transfer to organisms

Course outcomes: At the end of the course, the student will be able to:

CO1	obtain knowledge in digestion of DNA, vector system for cloning and expression.
CO2	understand the cloning strategies and expression of recombinant molecules
CO3	aware of gene, genome sequencing and DNA finger printing techniques.
CO4	acquire knowledge in molecular markers, genome mapping and apply genetic engineering principles for biotechnological and biomedical applications.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	-	2	1	-	-	-	-	-	-	-			
CO2	-	1	2	2	3	-	-	-	-	-	-	-			
CO3	-	-	3	2	1	-	-	1	-	-	-	-			
CO4	2	-	-	1	-	-	2	-	-	-	-	2			
Avg.															

UNIT:1 **[15 Hours]**

Basic principle of DNA isolation and purification; Restriction endonuclease, Ligase and other modifying enzymes; DNA& RNA Markers, Linker, Adapter and MCS; Gene cloning vectors-Plasmid, bacteriophage, cosmid, BAC, YAC; Expression vectors: basic concept, bacteria and yeast based expression vector.

UNIT:2 **[13 Hours]**

Basic concept of gene cloning;Gene library- genomic and c-DNA, contig library; Polymerase Chainreaction, Cloning of interacting gene: two hybrid and three hybrid assay;Cloning of differentially expressed gene; DNA micro arrays and Chips - principle andManufacturing process.

UNIT:3 **[12 Hours]**

DNA finger printing and DNA foot printing; DNA Sequencing; Site-directed mutagenesis; Expression of heterologous gene; In vitro transcription and translation; Gene knock out strategies; RNA interference: Antisense RNA, si RNA and mi RNA; RibozymeTechnology.

UNIT:4 **[15 Hours]**

Molecular markers- Types (RFLP, RAPD, AFLP, SCAR, SSR, SNP, EST), Principle and methodology; Application of molecular markers: in diagnostics, gene tagging, gene mapping, Physical mapping of the genome. Genome analysis using 16S rRNA typing/ sequencing, Genome. Projects: Human, Rice; Gene therapy and its applications; DNA vaccines and rDNAproducts;Genetic engineering

regulations and safety guidelines.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books 1. Principles of Mol. Biology - OS Prim Rose *2. Genetic Engineering by B D Singh, Rastogi Publication*
Ref. Books: 1. Molecular Biology. By Turner *2.Molecular "Biology of Gene" – Watson*

Title of the subject

Subject Code		L	T	P	C	QP
	Immunology & Immuno technology	**3**	**1**	**-**	**4**	**A**

Course Educational Objective

CEO1: To study about the process of immunity and organs and cells of lymphoid system.

CEO2: To study about complement system, major histocompatibility Hybridoma technology and various immune responses.

Course outcomes: At the end of the course, the student will be able to:

CO1	Obtain knowledge in immunology, the structure and function of lymphoid organs and cells.
CO2	Have knowledge in Major histocompatibility, antibody diversityand complement response in the blood.
CO3	understand immune response,hypersensitive reactions, and organ transplantations and also obtain knowledge in various auto immune diseases.
CO4	Know in the development of vaccines and immunological techniques.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	-	2	-	-	-	-	-	-	-	-			
CO2	-	2	-	1	-	3	-	-	-	-	-	-			
CO3	-	-	-	2	1	3	-	-	-	-	-	-			
CO4	-	-	-	3	-	2	-	-	-	-	-	1			
Avg.															

UNIT:1 **[11 Hours]**

Basic concepts of immunology: Immunity, types of immunity, humoral and cell mediated immunity, Cells of immune system and Haematopoiesis, Lymphoid organs, Primary and secondary lymphoid organs, antigen-properties of antigen,antigenity,immunogencity, immunoglobulin and antibodies.

UNIT:2 **[13 Hours]**

Major Histocompatibility Complex (MHC), Antigen processing and presentation, synthesis and secretion of antibody, Molecular basis of antibody diversity, polyclonal, monoclonal antibody and Hybridoma Technology, complement system, antigen-antibody reaction.

UNIT:3 **[11 Hours]**

Immuneresponseand tolerance: Regulation of immune response, immune tolerance, Hypersensitivity, autoimmunity,Transplantationimmunology,Immuno- deficiency and immuno- proliferate diseases. Dysfunctions of immune system and their modulation, Approaches for correcting immune dysfunction, Vaccinology.

UNIT:4 **[10 Hours]**

Immunobiotechnology: Vaccines, viral, bacterial peptides, genetically engineered production of lymphokines, second generation generation antibodies. Immunological techniques: immunodiffusion, immunoprecipitation, agglutination and ELISA
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books: 1. Immunology: Lydyard, P.M., Whelan, A., Fanger, M.W., 1st Ed., Viva Books. 2. Essential Immunology: Roitt, I.M., 9th Ed.(1997) Blackwell Scientific, Oxford, UK.
Ref. Books: 1. Immunology: Kuby, J. 3rd Ed. (1997) Freeman W. H., oxford. 2. Immunotechnology by A Khan, Pearson Publication.

Subject code	**Title of the subject**	L	T	P	C	QP
	BIO-CHEMICAL REACTION ENGINEERING	3	0	0	3	**A**

Course Educational Objective

CEO1:To enhance skills in the areas of biochemical processes, to provide the fundamental background of biological systems, bio

CEO2:To provide the fundamental background of biological systems, bio-chemical engineering, environmental engineering, advanced bioprocess engineering, biologically mediated processes and waste treatment.

Pre-Requisites (If any)-Chemical Engg Process caluculation, Matchmatics, Chemical Engg. Reaction Engg

Course Outcome: Upon successful completion of this course, students should be able to:

CO1	Describe the bioprocess monitoring/control.
CO2	Design of ideal reactors for single and complex reactions and non-isothermal reactors.
CO3	Illustrate operation and choice of bioreactor.
CO4	Explain heat & mass transfer and scale up of bioprocesses.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	1	2	-	-	-	-	-	-	-	-			
CO2	1	-	1	3	-	-	-	-	-		-	2			
CO3	-	2	3	2	1	-	-	-		-	-	-			
CO4	-	-	2	1	2	1	-	-	-	-	-	-			
Avg.															

Unit:1 **[10hours]**

Material Balance & Energy Balances: Mathematical requisites – use of log-log and semi-log graph paper, triangular diagram, graphical differentiation and graphical integration, material balance without chemical reaction, material balance with chemical reaction, energy balance; enthalpy changes, heat of reaction and its temperature dependence, heats of solution and mixing, adiabatic flame temperature, use of psychometric charts.

Unit:2 **[10hours]**

Kinetics of homogeneous reactions: 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.

Unit:3 **[13hours]**

Kinetic analysis of batch reactor data: 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. Kinetic interpretation of batch reactor data for single reactions: 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. 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, Design of multiple reactions in batch, CSTR and PFR.

Unit:4 **[12hours]**

Biochemical reaction systems: Cell and enzyme fermentation, Monod's model of growth kinetics. Kinetics of Enzyme catalyzed reactions for free and immobilized enzymes. – derivation of Michaelis-Menten equation, Briggs-haldane relationship, the determination and significance of kinetic constants, Lineweaver-burk and Eadie-Hofstee plot, principles of enzyme inhibition – Competitive, noncompetitive and uncompetitiveMichaelish-Menten kinetics, inhibition by foreign substances, kinetics of competitive and noncompetitive inhibitions, microbial fermentation, batch fermentor and mixed flow fermentor, kinetic expressions of fermentation.

Teaching Mentod (s):Chalk& Board/PPT/Video Lecture

Text Books

1.Chemical process Principles (Part I & II), Houge, Watson & Ragatz, Asian Student Edition Asia Publishing House

2.Basic Principles and Calculations in Chemical Engineering, Himmelbalu, Prentice Hall (l) 6th Ed.

Ref. Books

1.Levenspiel, O., Chemical Reaction Engineering, Wiley Eastern Ltd.

2:Smith& Vanes, Thermodynamics for Chemical Engineers, MGH.

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Title of the subject						
Subject Code		L	T	P	C	QP
	Bioreactor Design and Analysis	**3**	**1**	**0**	**4**	A

Pre -Requisite:

Course Educational Objective

CEO1:To understand the importance of bioprocess engineering and the role of bioprocess engineer and the importance of regulatory constraints.

CEO2:To understand the instrumentation and control of bioreactors their scale up aspects etc.

Course outcomes: At the end of the course, the student will be able to

CO1	learn the principle and operation of different types of bioreactors.
CO2	understand the conditions for both ideal and non-ideal bioreactors.
CO3	know about mass transfer in biochemical processes carried out in different bioreactors.
CO4	acquire basic concept in bioreactor design and modeling and simulation of fermentation process.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	1	2	1	-	-	-	-	-	-	-			
CO2	-	2	2	2	1	-	-	-	-	-	-	-			
CO3	-	-	2	3	2	-	-	-	-	-	-	1			
CO4	-	-	-	2	1	2	-	-	2	-	-	-			
Avg.															

UNIT:1 **[12 Hours]**

Principles and concepts: Recapitulation of the principles of Kinetics for chemical and Bio-chemical Reactions. Fundamentals of homogeneous reactions for batch / semi-batch, plug low reactor (PFR), continuous stirred rank reactors (CSTR), fluidized bed reactor, bubble column, air lift fermenteretc, stirred tank/mixed reactors, adiabatic and programmed reactors. Unconventional bioreactors: Hollow fiber reactor, membrane reactor, perfusion reactor for animal and plantcell culture

UNIT:2 **[10 Hours]**

Bioreactor Analysis: Analysis of ideal bioreactors: Fed-Batch reactors, Enzyme catalyzed reactions in CSTRs, CSTR reactors with Recycle and wall growth, Ideal Plug-Flow Tubular reactor. Analysis of Non-ideal Reactor. Concept of ideal and non-ideal reactor; residence time distribution;models of non-ideal reactors – plug flow reactor for microbial processes.

UNIT:3 **[11 Hours]**

Mass transfer in biochemical processes; Multiphase bioreactors – packed bed with immobilized enzymes or microbial cells; three – phase fluidized bed trickling bed reactor; Design and analysis of the above reactor systems; Gas liquid reactors, Reactor stability.

UNIT:4 **[12 Hours]**

Bioreactor Design: Design considerations: oxygen transfer, heat transfer, rheology, mixing. Scale up and scale down concepts. Bioprocess control and computer coupled bioreactors; Growth and product formation by recombinant cells. Mechanical fittings in a bioreactor: vessel, agitation system materials, piping and valves for biotechnology. Instrumentation and control of bioprocesses: Bioreactor sensor, online sensors for cell properties, off-line analytical methods; Biosensors. Bioreactor design calculation.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. *Bailey and Ollis, "Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.). 1986. Press.*
2. *Scragg.A.H "Bioreactors in Biotechnology"- A Practical approach*

Ref. Books

1. *Bailey &Olis, Biochemical Engg. Fudamentals, MGH.,1990*
2. *Levenspiel, O., Chemical Reaction Engineering, Wiley Eastern Ltd.*
3. *Lydersen, D'Elia, Nelson, Bioprocess engineering: Systems and equipment.*

Title of the subject						
Subject Code		L	T	P	C	QP
	Industrial Microbiology and Enzyme Technology	**3**	**0**	**0**	**3**	A

Course Educational Objective

CEO1:To study about fermentation process and to study the culturing of micro organisms and maintenance of cultures.

CEO2:To study about the preparation of alcohol using yeast cells and sugars by fermentation process.

Course outcomes: At the end of the course, the student will be able to:

CO1	obtain knowledge in microbial growth, kinetic and fermentation technology.
CO2	obtain knowledge in the production of commercially important products by using fermentation technology.
CO3	learn the formulation and selection of media, strain development and improvement.
CO4	obtain knowledge in themethods of enzyme stabilization and its applications

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	2	1	1	-	-	-	-	-	-	-			
CO2	2	1	2	3	-	-	-	-	-	-	-	-			
CO3	-	2	3	2	2	-	-	-	-	-	-	-			
CO4	-	-	1	3	2	-	2	-	-	-	-	2			
Avg.															

UNIT:1 **[12 Hours]**

Microbial Processes and fermentation technology: Introduction to fermentation technology, Microbial growth and product formation kinetics in batch, continuous and feed batch fermentation, Large scale production: submerged, solid and semi-solid fermentation,

UNIT:2 **[10 Hours]**

A brief outline of microbial processes for the production of some commercially important Organic acids (e.g. Citric acid); Amino acid (Glutamic acid); and Alcohol (ethanol, 2, 3- butanediol). Antibiotics (beta-lactams, penicillin's and cephalosporin's), enzymes (Proteases, Lipases),polysaccharides(cellulose, starch**)**; lipids(Triglycerides, Steroids); recombinant protein (Insulin), production of vaccines (Hepatitis-B).

UNIT:3 **[12 Hours]**

Commercial media and strain development: Media selection and development for industrial production, Isolation, selection, characterization of microorganisms, stock culture, development of inoculum, strain improvement: induced mutation, over producing decontrolled mutants, genetically engineered strain and fermentation.

UNIT:4 **[10 Hours]**

Stability of enzyme: Enzyme stabilization by selection and genetic engineering, protein engineering. Application of enzymes in industry, analytical purpose and medical therapy. Application of Biocatalyst,

Group transfer redox, Elimination, isomarization and rearrengement, C-C bond cleavage, Reaction environment rebuilding, chemical modification, intramolecular cross linking and immobilization.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books 1. Principle of Fermentation Technology , P.F. Stanbury, A. Whitaker and S.J. Hall, Elsevier 2. Industrial Microbilogy, Prescot and Dunn,
Ref. Books 1. Biochemical Engineering and Biotechnology Handbook, Atkinson, B and Marituna, F., The Nature Press, Macmillan Publ. Ltd. 2. Biochemical Engineering Fundamentals, Bailey &Olis. MGH.

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Title of the subject						
Subject Code		L	T	P	C	QP
	Fermentation Technology	**3**	**0**	**0**	**3**	A

Pre -Requisite:

Course Educational Objective

CEO1: To provide knowledge on different of fermentation process

CEO2:To have theory and practicle knowledge on purification of products

Course outcomes: At the end of the course, the student will be able to:

CO1	get idea on different fermentation technologies
CO2	understand the importance on enzyme in fermentation process
CO3	Know Importance of microorganism in fermentation processes.
CO4	get knowledge of downstream processing

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	1	-	2	-	-	-	-	-	-	-			
CO2	-	2	2	1	2	-	-	-	-	-	-	-			
CO3	-	-	2	3	2	1	-	-	-	-	-	-			
CO4	-	-	-	2	1	2	2	-	-	-	-	1			
Avg.															

UNIT:1 **[8 Hours]**

Range of Fermentation processes, Microbial growth kinetics, Microbial biomass, Microbial enzymes, Microbial metabolites, Recombinant products, Batch culture, continuous culture, Microbial culture selection for fermentation processes. Media formulation and process optimization.

UNIT:2 **[10 Hours]**

Industrial production of proteases, cellulases, amylase, lipase; Process parameters that influence enzyme production during submerged and solid state fermentation, production of biofuel.

UNIT:3 10 Hours

Isolation, preservation and improvement of industrial microorganism, development of media for industrial fermentation. Development of inoculums for yeast and bacterial processes.

UNIT:4 **[10 Hours]**

Removal of microbial cells, Precipitation, filtration, centrifugation. Cell disruption, extraction and chromatography, Drying and crystallization.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1Principles of Fermentation Technology by P.F. Stanbury, A. Whitaker, and S.J Hall, Pergamon

2 Basic Fermentation Technology by S.M.Reddy, New Age International Pvt.ltd.s

Ref. Books 1Bioprocess Engineering by Bjorn K. Lydersen, et. al ,Wiley India Edition
22 Bioprocess Engineering by M.L. Shuler and F.Kargei Person

Subject Code		L	T	P	C	QP
	Bio kinetics and Thermodynamics	**3**	**-**	**-**	**3**	A

Pre -Requisite:

Course Educational Objective

CEO1: To introduce the basic of Biokinetics and its application

CEO2: To understand the functions gene transfer to energy

Course outcomes: At the end of the course, the student will be able to:

CO1	understand the theoretical concepts of thermodynamics and how it applies to energy conversion and applications in biological systems.
CO2	learn about biothermodynamics of energy used by plants and animals and thermodynamics of proteins.
CO3	understand the concept of Gibbs free energy and energy transfer in various metabolism processes.
CO4	have the idea on free energy in chemical reaction and its effect on enzyme kinetics and metabolism.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	-	1	1	1		-	-	-	-	-			
CO2	2	-	2	-	2	-	-	-	-	-	-	1			
CO3	-	2	3	2	2	-	-	-	-	-	-	-			
CO4	-	-	2	3	1	1	-	-	-	-	-	-			
Avg.															

UNIT:1 **[10 Hours]**

Basic concepts of thermodynamics: First Law of Thermodynamics, Second law of thermodynamics, Zeroth Law and Third Law of thermodynamics, Laws of thermodynamics and biology, Thermodynamics of macromolecular processes in cells, Thermodynamics of energy interactions in ecosystems, Conservation of energy.

UNIT:2 **[12 hours]**

Distribution of energy; Carbon, energy and life – Molecular level energy storage, Bio-thermodynamics of energy use by plant and animals, Methods for measuring the thermodynamic stability of membrane proteins, Protein folding, Modeling the native state ensemble of proteins using statistical thermodynamics, Energetic profiles of proteins derived from thermodynamics of the native state ensemble.

UNIT:3 **[10 Hours]**

Theory and derivation of Gibbs free energy, Free energy of reactions, Lipid membrane phase transitions, Thermodynamics of cellular metabolism, Sugar metabolism, Energy transport in ATP and NAD, Substrate recycling, DonnanEquilibrium, Enzyme-substrate interaction, Free energy of transfer of amino acids, Differences between heat engines and biological energy processes, Temperature regulation in organisms, Humidity and temperature effects on organisms, Non-equilibrium thermodynamics and life.

UNIT:4 **[10 Hours]**

Free energy analysis of chemical reactions, Chemical coupling to drive reactions in biological systems, First order and second order reactions, Collision theory, Transition state theory, Free energy of activation, Temperature and concentration effects on enzyme kinetics, Reaction mechanism of lysozyme, Kinetic identification of reaction intermediates, Sequential enzyme reactions in metabolism and analysis.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books: 1. D. J. Haynie, Biological thermodynamics, Cambridge, 2008.
2. Johnson, M.L., Holt, J.M. and Ackers, G.K., "Bio thermodynamics", Part 1 Academic Press, 2009
3.Timasheff, S.N., "Protein Hydration, Thermodynamic Binding, and Preferential Hydration, Biochemistry", 13473-13482, 2002.

Ref. Books: 1. Biochemical Engineering and Biotechnology Handbook, Atkinson, B and Marituna, F., The Nature Press, Macmillan Publ. Ltd.
2. Biochemical Engineering Fundamentals, Bailey & Olis. MGH.

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Subject Code	**Course Title**	L	T	P	C	QP
	Genetic Engineering and r-DNA Technology Lab	**0**	**0**	**2**	**2**	**A**

Course Educational Objective

In this laboratory, students will have the opportunity to study the techniques of gene cloning

Understand the basic principle and techniques of PCR and hybridization of DNA and Protein

Course outcomes: At the end of the course, the student will be able to:

CO1	know the isolation of plasmid DNA and its importance in gene cloning.
CO2	do the various ligation methods and transformation techniques.
CO3	learn the screening techniques of recombinant cells.
CO4	know the basic principle of PCR and hybridization techniques.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	-	-	-	-	-	-	-	-	-			
CO2	3	3	2	-	-	-	-	-	-	-	-	-			
CO3	1	2	3	-	-	-	-	-	-	-	--	-			
CO4	2	1	3	-	-	-	-	-	-	-	-	-			
Avg.															

LIST OF EXPERIMENTS

1. Isolation and Restriction enzyme digestion of bacterial genomic DNA
2. Isolation and Purification of plasmid DNA
3. Purification of digested DNA-column purification
4. Preparation of target DNA by linker/adapters/alkaline phosphatase treatment for cloning
5. Ligation of DNA fragment with cloning vector
6. Preparation of competent cells
7. Transformation in *E.coli* with recombinant vector
8. Isolation of recombinants and confirmation of insert DNA in vector
9. Preparation of DNA probe by nick translation /PCR
10. Amplification of DNA sample by PCR
11. Southern Hybridisation
12. Western Hybridisation
13. DNA profiling by RAPD

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Subject Code	**Course Title**	L	T	P	C	QP
	Immunology &Immunotechnology Lab	**0**	**0**	**2**	**2**	**A**

Course Educational Objective

1. In this laboratory, students will have the opportunity to learn the various techniques of Immunology

2.Various kinds of immunoprotein present in blood and their interactions with relate to disease analysis.

Course outcomes: At the end of the course, the student will be able to:

CO1	study the morphology and structure of nucleus of various blood cells.
CO2	Antigen and antibody reaction study by diffusion techniques
CO3	Blotting of blood proteins
CO4	understand the technique and mechanism of identification of blood group.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	-	-	-	-	-	-	-	-	-			
CO2	3	2	2	-	-	-	-	-	-	-	-	-			
CO3	2	2	3	-	-	-	-	-	-	-	-	-			
CO4	3	1	3	-	-	-	-	-	-	-	-	-			
Avg.															

LIST OF EXPERIMENTS

1. Preparation of blood film and identification of different leucocytes
2. Ouchterlony double diffusion technology
3. Radial immunodiffusion technology
4. Rocket immuno-electrophoresis
5. Immunoelectrophoresis
6. Dot ELISA and Sandwich ELISA
7. Immunoblotting
8. Purification of immunoglobulin from blood serum by column chromatography
9. Determination of blood group by agglutination
10. Localization of specific antigen by immunocytochemistry

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Subject Code	**Course Title**	L	T	P	C	QP
	Bioreactor Design and Analysis Lab	**0**	**0**	**2**	**2**	**A**

Course Educational Objective

In this laboratory, students will have the opportunity to study about parts, operation and standardization of bioreactor

Study about the effect of various parameters on the growth of microorganisms in controlled bioreactor conditions.

Course outcomes: At the end of the course, the student will be able to:

CO1	The student will study about the various parts and operation of bioreactor.
CO2	Effect of physical parameters on the growth of microorganisms.
CO3	The student will determine the oxygen transfer rate in bioreactor by folowing various methods.
CO4	The undergraduate will learn working of various bioreactors used in industries.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1												
CO2	3	1	2												
CO3	1	2	3												
CO4	2	1	3												
Avg.															

LIST OF EXPERIMENTS

1. Bioreactor operation – Demonstration
2. Batch, fed batch and continuous cultures a) Estimation of Monod parameters b) Pure and mixed cultures.
3. Temperature effect on growth-estimation of energy of activation and Arrhenius constant for micro-organisms.
4. Determination of Oxygen transfer rate
   KLa determination by sulphite oxidation method
   KLa determination by dynamic gassing method
   KLa determination by power correlation analysis
5. Packed bed bioreactor: study of process parameters
6. Fluidised bed reactor: study of process parameters
7. Screening of process variables single dimensional search, Blackett Burman design, design expert etc.
8. Study of rheology of fermentation broth and power determination.
9. Bioprocess control using software
10. Production of secondary metabolites by feed batch culture.

Subject Code		L	T	P	C	QP
	Plant Biotechnology	3	1	-	4	A

Course Educational Objective

CEO1: To provide the practical oriented theory on plant tissue culture

CEO2: To have knowledge on gene transfer to plants

Course outcomes: At the end of the course, the student will be able to

CO1	acquire knowledge in various types of plant tissue culture techniques and various components of plant tissue culture media, e.g. minerals, growth factors and hormones.
CO2	understand the importance of Micro propagation and somatic hybridization.
CO3	learn the technology of plant transformation including vector and vector less gene transfer methods.
CO4	acquire knowledge in biosynthesis of plant primary and secondary metabolites and their importance.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	-	2	2	-	1	-	-	-	-	-			
CO2	-	-	1	2	1	-	-	-	1	-	-	-			
CO3	-	2	3	2	-	-	-	-	-	-	-	1			
CO4	-	-	2	2	1	-	2	2	-	-	-	-			
Avg.															

UNIT:1 **[10 Hours]**

Concept of totipotency and plasticity of plant cell; Tissue culure media- preparation, composition and plant growth regulators; Initiation and establishment of culture: Explant preparation, Callus culture, Single cell culture, Suspension culture, Microspore culture, Embryo rescue.

UNIT:2 **[10 Hours]**

Micropropagation: Organogenesis, Somatic embryogenesis, Artificial seed; Protoplast technology: Isolation and culture of protoplast, Somatic hybridization, Screening and selection of somatic hybrid.

UNIT:3 **[12 Hours]**

Concept of genetic transformation: Vector based (*Agrobacterium*, Virus) and Direct transformation (Gene gun, Electroporation, Microinjection, etc.); Application of genetic transformation: promoter tagging, activation tagging, herbicide resistance, insect resistance, disease resistance, terminator seed technology; Products of genetic transformation: Case studies for golden rice, Bt cotton and FlavrSavr tomato.

UNIT:4 **[12 Hours]**

Primary and secondary metabolities in plant. Alkaloids and its importance. Prducction of secondary metabolities through tissue culture, bioreactor based production and optimization of biotransformation.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1Introduction to Plant Biotechnology by H S Chawal, Science Publisher Inc. 2. Plant Biotechnology by Adrian Slater, Oxford press
Ref. Books 1Introduction to Plant Biotechnology by M.K.Razdan, Science Publisher Inc. 2 Plant Biotechnology by Agnes Ricroch ,S.Chopra, S.J.Fleisher, Springer

Title of the subject						
Subject Code		L	T	P	C	QP
	Bioinformatics	**3**	**1**	**0**	**4**	A

Course Educational Objective

CEO1: Providing fundamental knowledge of different computational tools to find sequential analysis using various software.

CEO2: To familiar with different Bio-informatics algorithms for prediction of structure of protein and DNA..

CEO3: Providing knowledge on use of different biological database.

CEO4: Creating the computational programming for data analysis.

Course outcomes: At the end of the course, the student will be able to

CO1	Understand and analyze the concept of use of various biological databases.
CO2	Analysis ofvarious algorithms for structural study of DNA & protein.
CO3	Design different molecular modeling using software.
CO4	Develop of different computational program for drug design.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	2	-	3	-	-	-	-	-	-	-			
CO2	2	2	-	3	-	-	-	-	-	-	-	1			
CO3	-	-	2	2	1	-	-	-	-	-	-	-			
CO4	-	2	2	1	3	-	-	-	-	-	-	-			
Avg.															

UNIT:1 **[12 Hours]**

Sequence data banks- Introduction to sequence data banks- protein sequence data bank. NBFR-PIR, SWISSPORT, Signal peptide data bank, Nucleic acid sequence data bank –Gen bank, EMBL nucleotide sequence data bank, AIDS Virus sequence data bank. RRNA data bank, structural data banks- protein Data bank (PDB), The Cambridge Structural Database (CSD) : Genome data bank – Metabolic pathway data : Microbial and Cellular Data Banks.

UNIT:2 **[12 Hours]**

systems of microbes, Hybridoma data Bank Structure, Virus Information System, Cell line Information system; other important Data Banks in the area of Biotechnology/life sciences/biodiversity.

Sequence Analysis : Analysis Tools for Sequence Data Banks: Pair wise alignment-NEEDLEMAN AND Wunsch algorithm, Smith Waterman, BLAST, FASTA algorithms to analyze sequence data: Sequence patterns motifs and profiles

UNIT:3 **[13 Hours]**

Secondary Structure Predictions prediction algorithms, Chao-Fasman algorithm, Hidden-Markov model, Neural Networking.

Tertiary Structure predictions: prediction algorithms, Chao-Fasman algorithm, Hidden-Markov model, Neural Networking.

UNIT:4 **[10 Hours]**

Protein classifications, Fold libraries, Protein structure prediction; Fold recognition (threading), Protein structure predictions: Comparative Modeling (Homology, Advanced topics: Protein folding, Protein-ligand interactions, Molecular Modeling & Dynamics, Drug Designing.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Bryan Bergeron, Bioinformatics computing, Prentice Hall Inc.

2. Baxevanis AS and Ouellette BF, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Wiley International Science.

Ref. Books

1. Tao Jiang, Ying Xu, Michael Q. Zhang, Current Topics in Computational Molecular Biology, MIT press.
2. Thomas lengauer,Bioinformatics from genome to drug .WILLEY-VCH press.
3. Mount DW, Bioinformatics: Sequence and Genome Analysis, Spring Harbor Press.

Subject Code	Title of the subject	L	T	P	C	QP
	Downstream processing	3	-	-	3	A

Pre -Requisite:

Course Educational Objective

CEO1:. Learn the fundaments of downstream processing

CEO2: Understand the principle, working and application of major unit operations in Bioprocessing of industrially important products.

Course outcomes: At the end of the course, the student will be able to

CO1	understand the principles of major downstream operations used in a bioprocess industry such as filtration, centrifugation, extraction and chromatography.
CO2	design and optimize the cost effective biosepation techniques.
CO3	understand techniques such as precipitation, coagulation and flocculation in downstream processing.
CO4	learn product recovery and product polishing methods.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	1	1	1	-	-	-	-	-	-	-			
CO2	-	1	2	3	2	-	-	-	-	-	-	-			
CO3	-	-	2	2	3	-	-	-	1	-	-	-			
CO4	-	-	2	3	-	2	-	-	-	-	-	1			
Avg.															

UNIT:1 **[12 Hours]**

Introduction; An overview of bioseparation. Role and importance of Bioseparation process in biotechnological processes. Problems and requirements of bioproduct purification. Cost- cuttingstrategies Characteristics of biological mixtures – Process of Classification of Bioproducts -Biological activity Analysis of purity-Process economics-Capital and operating cost analysis

UNIT:2 **[14 Hours]**

Separation of cells and other insolubles from fermented broth. Foam separation, Precipitation, Filtration and microfiltration, centrifugation (batch, continuous, basket).Chromatography in bioseparation.

UNIT:3 **[10 Hours]**

Cell disruption: Physical methods (osmotic shock, grinding with abrasives, solid shear, liquid shear), Chemical methods (alkali, detergents), Enzymatic methods, RO, Ultra-filtration: Semipermeablemembranes, membrane geometry and ultrafiltration module configuration.

UNIT:4 **[14 Hours]**

Separation of soluble bio-products: Liquid-liquid extraction, Distillation, Absorption, Adsorptionprecipitation,.Other bioseparation techniques like Dialysis, electro-dialysis, LiquidElectrophoresis. Products polishing : Crystallization and drying.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books 1. Roger G. Harrison, Paul W. Todd, Scott R. Rudge, and DemetriPetrides, Bioseparations Science and Engineering, Oxford University Press, USA (October 31, 2002) 2. *Heinemann, Product Recovery in Bioprocess Technology, Butterworth Publication.*
Ref. Books 1. Wankat P.C, " Rate controlled separations ", Elsevier, 1990 2. *Asenjo J.M., " Separation processes in Biotechnology " Marcel Dekker Inc. 1993.* 3. *Belter PA and Cussler E, " Bioseparations ", Wiley 1985*

Title of the subject						
Subject Code		L	T	P	C	QP
	Environment Biotechnology	3	-	-	3	A

Pre -Requisite:

Course Educational Objective

CEO1: To introduce the environmental biotechnology and its importance

CEO2: To have knowledge on biodegradation processes

Course outcomes: At the end of the course, the student will be able to

CO1	acquire the basic knowledge in environmental pollution and source of pollution.
CO2	learn on biological treatment of waste water.
CO3	understand the types of Xenobiotic compounds and their adverse effect on environment.
CO4	learn about the pollution control mechanisms by the application of Biotechnology.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	1	-	1	2	-	-	-	-	-			
CO2	-	2	1	-	-	2	-	-	-	-	-	-			
CO3	-	-	2	2	-	1	3	-	-	-	-	-			
CO4	-	-	2	1	-	2	2	-	-	-	-	-			
Avg.															

UNIT:1 **[10 Hours]**

Introduction to environmental biotechnology, Environmental monitoring bioreporter, biomarker.Bioprospecting, Biomicroelectronics and biosensor technology; Introduction to environmental pollutants: Water, Soil and Air: their sources and effects. Removal of Specific Pollutants: Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal accumulation, Biosorption & detoxification mechanisms.

UNIT:2 **[12 Hours]**

Microbiology and biochemistry of wastewater treatment: Biological Treatment of anaerobic and aerobic; methanogenesis, methanogenic,acetogenic, and fermentative bacteria- technical process and conditions; Use of Genetically Engineered Organisms. Emerging biotechnological processes in waste - water treatment; Applications include treatment of municipal and industrial waste waters and model/ reaction.

UNIT:3 **[14 Hours]**

Bioremedation of xenobiotic compounds: Xenobiotic compounds: Aliphatic, Aromatics, Polyaromatic Hydrocarbons, Polycyclic aromatic compounds, Pesticides, Surfactants and microbialtreatment of oil pollution. Biotransformation and biocatalysts. Phytoremedation

UNIT:4 **[12 Hours]**

Bio-oxidation& microbial leaching: Biooxidation – Direct and Indirect Mechanisms, Recovery of metals from solutions; Microbes in petroleum extraction; Microbial desulfurization of coal. Clean technologies: Composting Technology and Organic farming, biofertilizers, bio pesticides, microbial polymer production and bio plastic technology. Biotechnology of fossil fuels: Desulfurization of coal, oil shales, microbial

enhanced oil recovery (MEOR). Biofuels: Biogas technology, biohydrogen, bioethahnol production. Biotechnology of mineral processing. Ethicalissues in environmental biotechnology and regulatory framework.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books *1 Text book of Environmental Biotechnology by P.K.Mohapatra, I.K.International* *2. Environmental Biotechnology: concept and application by Hans Joachim, Jordening, J.winter, Wiley- Vch*
Ref. Books *1 Advanced Environmental Biotechnology by S.K. Agarwal, A P H Publishing corporation* *2 Environmental Biotechnology by D.K.Markandey and. Rajvaidya A P H Publishing Corporation*

Title of the subject						
Subject Code		L	T	P	C	QP
	Bioprocess Engineering	**3**	**0**	**0**	**3**	A

Course Educational Objective

CEO1: To understand the importance of bioprocess engineering and the role of bioprocess engineer and the importance of regulatory constraints.

CEO2: To understand the mechanism of enzyme action, their kinetics and about stoichiometry of microbial growth.

Course outcomes: At the end of the course, the student will be able to

CO1	learn the screening, culture, preservation and applications of microorganismin bioprocess engineering.
CO2	understand the design and principle of different bioreactors used in biotechnology industries.
CO3	acquire knowledge in optimization of growth parameters of microorganisms.
CO4	understand techniques such as precipitation, coagulation, flocculation and crystallization used inproduct purification.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	1	1	-	1	-	-	-	-	-	-			
CO2	2	1	2	1	-	-	-	-	-	-	-	-			
CO3	-	2	3	2	2	-	-	-	-	-	-	-			
CO4	-	-	1	2	2	-	-	-	-	-	-	-			
Avg.															

UNIT:1 **[14 Hours]**

Introduction to bioprocess technology: Screening preservation and improvement of industrially important micro organisms, raw material and media formulation for formentation process, air and media sterilization, primary and secondary metabolites. Influence of environmental facts on growth and product formation.

UNIT:2 **[13 Hours]**

Concept of bioprocess, bioreactor designing, mixing and residence time distribution in bioreactor,,Anlysis of batch , fed-batch and continuous bio reactions, pulse bioreactors, fluidized bioreactors and photo bioreactors, pneumatic and hydro dynamic fermentations, solid substrate, surface, submerged fermentations, fermentations economics. Bioreactor design for animal cell culture and for waste treatment, growth models.

UNIT:3 **[10 Hours]**

Growth kinetics: Microbial growth cycle, measurement of growth, control of process parameters: measurement of process parameters likes' pH, temperature, dissolved oxygen, foam. Scale up and scale down process.

UNIT:4 **[12 Hours]** Downstream processing: cell separation, cell disintegration, foam separation, precipitation, centrifugation, drying, crystallization and product purification, effluent treatment. Bioprocess economics. Use of microorganism in mineral beneficiation and oil recovery, microbial leaching of minerals.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books *1Bailey and Ollis, "Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.). 1986. Press.* *2. Scragg.A.H "Bioreactors in Biotechnology"- A Practical approach*
Ref. Books *1. Bailey &Olis, Biochemical Engg. Fudamentals, MGH.,1990* *2Levenspiel, O., Chemical Reaction Engineering, Wiley Eastern Ltd.*

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Title of the subject						
Subject Code		L	T	P	C	QP
	Proteomics and Genomics	**3**	**0**	**0**	**3**	A

Course Educational Objective	
CEO1: To understand the protein interaction, tools and application of Proteomics	
CEO2: To know about the tools and techniques of genomics	
Course outcomes: At the end of the course, the student will be able to	
CO1	learn protein interaction and various tools used inproteomics
CO2	understand the 2-D electrophoresisand Peptide fingerprinting
CO3	acquire knowledge in application of proteomics
CO4	Understand techniques such as Genome sequencing , accessing and retrieving genome and functional genomics and comparative genomics .

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	1	2	-	-	-	-	-	-	-	-			
CO2	1	-	1	3	-	-	-	-	-		-	2			
CO3	-	2	3	2	1	-	-	-		-	-	-			
CO4	-	-	2	1	2	1	-	-	-	-	-	-			
Avg.															

UNIT:1 **[14 Hours]**

Mapping protein interaction and applications: Global expression profiling, comprehensive mutant libraries, mapping protein interactions, applications of genome analysis and genomes. Introduction and tools of proteomics: Proteomics and Proteomes, Various tools used in proteomics (N-terminal sequencing of proteins, 2-D electrophoresis Differential display proteomics, Yeast two hybrid and three hybrid system, phage display, isoelectrofocusing, Peptide fingerprinting. LC/MS-MS for identification of proteins and modified proteins, SAGE, Protein micro array).

UNIT:2 **[12 Hours]**

Applications of proteomics: Mining proteomes, protein expression profiling, identifying protein – protein Interactions and protein complexes, mapping- protein identification, new directions in proteomics, structural proteomics; Proteomics and Drug delivery. Transcriptomics.

UNIT:3 **[10 Hours]**

Introduction to genomics: Orientation and structure of genomes, subdividing the genome, assembling a physical map of a genome. Sequencing methods and strategies, genome annotationand information from web, bioinformatics.

UNIT:4 **[10 Hours]**

Genome sequencing projects- Microbes, plants and animals; Accessing and retrieving genomeproject Reverse genetics, Structural genomics, Functional genomics and Comparative genomics;High throughput screening in genome for drug discovery identification of gene targets,Pharmaco-genomics

and drug development.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books : *1.Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley* *2.Introduction to Genomics by Lesk AM, Oxford University Press (2008)* *3. Proteomics: from protein sequence to function by Pennington, S.R. and Dunn, M. J., Viva Books (2001)*
Ref. Books : *1. Brown TA, Genomes, 3rd Edition. Garland Science* *2. Campbell AM &Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings*

Title of the subject

Subject Code		L	T	P	C	QP
	Nanobiotechnology	**3**	**0**	**0**	**3**	A

Pre -Requisite:

Course Educational Objective

CEO1: To provide the knowledge on importance on nano biotechnology and its application.

CEO2: To have an idea about the application of nano biotechnology in industry and allied sciences at the end of course, student will be able.

Course Outcome

CO1	Learn the concept of "nanotechnology" and its interdisciplinary aspects.
CO2	Students will learn various approaches to synthesize characterized their advantages and limitations.
CO3	To understand the importance of engineered nonmaterial's for biomedical, therapeutic and environmental applications.
CO4	To evaluate the potential toxic effects of nanotechnology on living organisms and the environment.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	-	1	-	2	-	-	-	-	-			
CO2	-	-	1	2	1	2	-	-	-	-	-	-			
CO3	-	2	2	1	1	-	-	-	-	-	-	1			
CO4	-	-	2	2	3	2	-	-	-	-	-	-			
Avg.															

UNIT:1 **[10 Hours]**

Basic Concepts of Nanoscience: Importance of "Nano" dimension, size matters: bulk vs nanomaterials, nanotechnology exists in nature, brief history of nanotechnology, applications of nanotechnology, challenges and future prospects, effect of 'nano' scale on material properties (electrical, thermal, mechanical, optical, chemical), quantum structures, quantum confinement, classification of nanostructured materials, surface effects of nanomaterials

UNIT:2 **[10 Hours]**

Synthesis and Characterization of Nanomaterials: Bottom-up and bottom-down approaches: milling, arc discharge, laser ablation, spray pyrolysis, chemical vapor deposition, physical vapor deposition, wet chemical synthesis of nanoparticles, self-assembled monolayer, Characterization of nanostructures, Spectroscopy: UV-Vis, FTIR; Electron microscopy: Scanning electron microscopy, EDX, Transmission electron microscopy, Atomic force microscopy.

UNIT:3 **[10 Hours]**

Engineered Nanomaterials for Biological Applications: Current status of nanobiotechnology, biogenic synthesis of nanoparticles: microbial and plant mediated, surface functionalization of nanomaterials, biological applications of functionalized nanomaterials, Biological nanomachines: ribosomes, photosynthesis systems, Bionanomotors, Nano-antimicrobials, Immobilized nanoparticles for water disinfection and biopesticides delivery applications.

UNIT:4 **[12 Hours]**

Biomedical Applications and Nanotoxicity: Biopolymers, Polymeric biomaterials, lipid nanoparticles for drug delivery applications, magnetic nanoparticles based hyperthermia treatment of cancer, DNA nanotechnology, Nano-biosensors: fabrication, functionalization, applications, Cytotoxic and genotoxic effects of nanomaterials, toxic effects on environment, impact of nanotechnology on society and industry.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Gabor L. Hornyak., H.F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2008.

2."Nanostructures and Nanomaterials: Synthesis, Properties and Applications", G. Cao, Imperial College Press (2004)

3.Nanobiotechnology; Concepts, Applications and Perspectives", C. M. Niemeyer, C. A. Mirkin, Wiley-VCH (2004)

Ref. Books

1. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.

2. Poole C., and Owens F., Introduction to Nanotechnology, John Wiley, New Jersey, 2003.

3. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.

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Title of the subject						
Subject Code		L	T	P	C	QP
	Structural Biology	**3**	**0**	**0**	**3**	A

Pre -Requisite:

Course Educational Objective2

CEO1: Evaluate appropriate physical scale (length, force, time, energy, etc.) that is applicable

In living systems.

CEO2: To study the bimolecular assemblies and its confirmations

Course outcomes: At the end of the course, the student will be able to

CO1	Student can evaluate the appropriate physical scale (length, force, time, energy, etc.) that is applicable in living systems.
CO2	The undergraduate will study the bimolecular assemblies and its confirmations
CO3	Student will know the biophysical techniques used in structural and functional analysis
CO4	Student will get the knowledge of experimental physical techniques and their mechanisms in biological systems.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	1	1	-	-	-	-		-	-			
CO2	-	1	2	2	1	-	-	-	-	-	-	-			
CO3	2	2	1	-	3	-	-	-	-	-	-	-			
CO4	1	1	-	2	-	-	-	-	-	-	-	1			
Avg.	2.4	2.4													

UNIT:1 **[10 Hours]**

Life and its physical basis, length force and time scales in living systems, chemicalbonding and stability of molecules, forces and energies at nanometer scale: Intermolecular interactions,electrostatic screening, chemical composition ofliving systems

UNIT:2 **[10 Hours]** Macromolecules and supramolcular assemblies: types of macromolecules and biological systems, molecular assemblies, membrane, ribosome, extracellular matrix, Chromatin. Chromosomal analysis.
UNIT:3 **[12 Hours]** Macromolecular structural determination: Physical technique in proteins, nucleic acids and polysaccharides structure analysis- UV, IR, Fluorescence spectrophotmetry, NMR,ESR, Raman Spectroscopy and their application in Biomedical field. Structure determination by Crystallography and X-Ray Diffraction.
UNIT:4 **[10 Hours]** Physical Techniques: Diffusion, Sedimentation, Osmosis, Viscosity, their definition, factors Influencing them and their application in biology.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books 1 Crothers and Eisenberg: Physical chemistry application to life sciences , *Benjamin Cummings, USA.* *2.Biophysical techniques by Upadhyay and Upadhyay* *3 The Cell by Cooper*

Title of the subject						
Subject Code		L	T	P	C	QP
	Biosensor and Diagnostics	**3**	**0**	**0**	**3**	A

Pre -Requisite:

Course Educational Objective

CEO1: To Provide knowledge about different biosensors and their principles

CEO2: To utilize the bioreactor to produce different products

knowledge about different biosensors and their principles

CO1	Student will gain the knowledge about different biosensors and their principles
CO2	Student will know the construction and mechanism of biosensor with their components
CO3	Student will get the relationship of biosensors with biological systems
CO4	Students will know the application of biosensor for different diagnosis process

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	1	2	1	-	-	-	-		-	-			
CO2	-	2	2	-	2	1	-	-	-	-	-	-			
CO3	-	2	2	1	3	-	-	-	-	-	-	-			
CO4	-	-	-	2	2	1	-	-	-	-	-	1			
Avg.															

UNIT:1 **[15 Hours]**

Introduction to biosensors- principles and applications; Components of Biosensor- Biological, Biochemical, Electrochemical, Electronic; Immobilization as key to biosensor construction,
Bioaffinity principle and biosensor.

UNIT:2 **[15 Hours]**

Biosensor diversification, Principle, construction and applications of Redox mediated (Amperometric& Potentiometric) biosensor, Field Effect transitor systems (FETs) based biosensor, Thermistor based biosensor, Piezoelectric biosensors, Conductimetric biosensor, Calorimetric biosensor & Optoelectric biosensors; Whole cell biosensor, Immuno sensors & In-vivo Biosensors.

UNIT:3 **[6 Hours]**

Variations on the biological /biochemical component, Bioaffinity principles, whole cell biosensors

UNIT:4 **[9 Hours]**

Applications of Biosensors: Clinical Chemistry & diagnostics, Medicine and health care,
Veterinary, Agriculture and food production, Food preservation & contamination, Environment and pollution monitoring.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1Turner APF et al., Biosensors fundamentals & Applications, Oxford University Press.

2 Blum LJ &Coulet PR, Biosensor Principles & Applications, , Marcel & Decker

3 Ramsay G, Commercial Biosensor, John Willey & Son

4 Walker JM &Rapley R, Molecular Biology and Biotechnology, Panima publishers

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Subject Code	**Course Title**	L	T	P	C	QP
	Plant Biotechnology Lab	**0**	**0**	**2**	**2**	**A**

Course Educational Objective

In this laboratory, students will have the opportunity to understand the techniques of plant tissue culture and establishment of plantlet.

The establishment of plant tissue culture laboratory for micropropagation and generation of transgenic plants.

Course outcomes: At the end of the course, the student will be able to:	
CO1	learn about the preparation of various plant tissue culture media and their sterilization.
CO2	know about the establishment of callus culture.
CO3	learn about agrobacterium mediated gene transfer technique.
CO4	acquire the skill for protoplast isolation and somatic hybridization.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1												
CO2	3	3	1												
CO3	3	1	1												
CO4	2	3	2												
Avg.															

LIST OF EXPERIMENTS

1. Media preparation, sterilization technique explant preparation 2 establishment of meristem culture
2. Study of organogenesis
3. multiple shoot generation
4. Somatic embryogenesis in carrot and encapsulation somatic embryo
5. Anther culture of Datura
6. Establishment of suspension culture
7. Agrobacterium mediated transformation (Demonstration)
8. Embryo/Endosperm Culture
9. Isolation of protoplasts

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Subject Code	**Course Title**	L	T	P	C	QP
	Bioinformatics Lab	**0**	**0**	**2**	**2**	**A**

Pre –Requisite: mathematics, computer, biology

Course Educational Objective

In this laboratory, students will have the opportunity to understand the biological database used in Bioinformatics for biotechnological analysis.

Study of various bioinformatics tools to designing of genome, protein for biological applications.

Course outcomes: At the end of the course, the student will be able to:

CO1	understand about the various genome and protein database and its applications in biotechnology.
CO2	learn to design the phylogenetic tree for genome analysis.
CO3	familiar with various bioinformatics software.
CO4	learn the technique of molecular docking, receptor analysis and Molecular Dynamics simulation.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3	-											
CO2	2	1	3												
CO3	3	3	3												
CO4	3	2	3												
Avg.															

LIST OF EXPERIMENT

1. Retrieving Human genome data, OMIM, SNP databases to understand genetic and metabolic disorders. (At least 2 each)
2. Mining genomic data to identify genomic features: codon usage, repeats, Homologous sequences etc.
3. Making Phylogenetic tree of given sequences by using ClustalW and PHYLIP.
4. Gene and promoter prediction for Prokaryotes and eukaryotes (comparative analysis by using different tools: at least 3)
5. Learning about molecule visualisation software like Rasmol, Pymol etc.
6. Primary Structural databases: pdb, ndb, csd and Derived databases of structures: DSSP, FSSP, CATH & SCOP.
7. Prediction of secondary structures of proteins: at least 3 methods
8. Prediction of Tertiary structure of proteins and Validation of model protein structure: Energy minimization, Procheck, verify 3D, Prosa II, ERRAT etc.
9. Molecule drawing. Conversion of 2D structure to 3D structure.
10. Molecular docking and analysis of receptor with ligand
11. Molecular Dynamics simulation

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Subject Code	**Course Title**	L	T	P	C	QP
BBTPC6130	**Down Stream Processing Lab**	**0**	**0**	**2**	**1**	**A**

Pre –Requisite: mathematics, computer, biology
Course Educational Objective
In this laboratory, students will have the opportunity to understand the isolation and separation of various biomolecules
Application of molecules for generation of products

Course outcomes: At the end of the practical, the student will be able to:	
CO1	understand about the various macromolecules present in the cell/microorganisms
CO2	learn to isolation of molecules from cell/tissue
CO3	Separation of molecules using techniques
CO4	Use of enzymes for production of different products

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1												
CO2	3	3	1												
CO3	3	1	1												
CO4	2	3	2												
Avg.															

LIST OF EXPERIMENT

Downstream Processing:

1. Harvesting cells using filtration or centrifugation techniques.
2. Isolation of enzyme from cell/microorganisms
3. Identification of extracellular products (enzyme / polysaccharide / some other traceable element) from fermentation broth or shake-flask culture broth.
4. Cell disruption by homogenizers, osmotic shock, sonication and French press.
5. Protein fractionation using precipitation/solvent extraction techniques.
6. Protein fractionation using chromatography (gel filtration and ion-exchange)
7. Separation of proteins and DNA using affinity chromatography
8. Effect of inhibitors on enzyme kinetics
9. Immobilization of cells and enzymes using different matrices (PVA, alginate, etc.)
10. Application of immobilized cells and enzymes in batch and continuous stirred tank reactors.
11. Biotransformation reaction using whole cell and/or enzyme(s).

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Title of the subject						
Subject Code		L	T	P	C	QP
	Food Biotechnology	**3**	**0**	**0**	**3**	A

Pre -Requisite:

Course Educational Objective

CEO1:To provide knowledge on food production technology

CEO2: To have idea on food preservative technologies

Course outcomes: At the end of the course, the student will be able to

CO1	understand the composition of major food products ,analysis of food quality and food production technology.
CO2	understand the role of beneficial enzymes in food processing and preservation.
CO3	understand the causes of food spoilage and technology used to control or destroy micro organism commonly found in food.
CO4	understand the role of beneficial micro organisms in food processing and preservation.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	-	2	1	1	-	-	-	-	-	-			
CO2	-	2	1	-	2	2	-	-	-	-	-	-			
CO3	-	-	-	1	3	2	-	-	-	-	-	1			
CO4	-	1	-	2	-	1	2	-	-	-	-	-			
Avg.															

UNIT:1 **[10 Hours]**

Food quality and Production technology Analysis of food, major ingredients present in different product, Food additives colour, flavour, vitamins, Single cell protein, mushroom, Fermentative production of food, Pickling and alcoholic beverages, Genetically manipulated crop based food, oriental foods, probotics/ prebiotics in food products.

UNIT:2 **[10 Hours]**

Technology for improved process Enzyme in bakery, fermented cereal products, Enzymes in fat/oil industries, Protease in cheese making, enzymes in beverage production, Utilization of food waste for production of value added products, enzymes in sugar syrup, genetically modified food.

UNIT:3 **[14 Hours]**

Food spoilage and control Spoilage of food, Microbiology of water, meat, milk, vegetables, Microbial safety of food products, Chemical safety of food products, heavy metal, fungal toxins, pesticide and herbicide contamination, Food preservatives and additives, Post-harvest technology for food preservation. Technology – canning, dehydration, ultrafiltration, sterilization, irradiation etc.

UNIT:4 **[15 Hours]** Microbiology of fruits & vegetable and products like jam, jelly, sauce, juice; Microbiology of cereal and cereal products like bread, biscuits, confectionary. Microbiology of milk & milk products like cheese, butter, ice-cream, milk powder; Microbiology of meat, fish, poultry & egg and their products.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books 1. *Food Biotechnology by V K. Joshi and R.S. Singh, I K International Publishing House.* 2. *Food Biotechnology by Rita Singh , Global vision publishing house*
Ref. Books 1. *Fundamental of food biotechnology by Byong H. Lee, Wiley-BCH.* 2. *Food biotechnology by S.C. Bhatia, WPI Publishing*

Title of the subject

Subject Code		L	T	P	C	QP
	Animal Biotechnology	**3**	**0**	**0**	**3**	A

Course Educational Objective

CEO1: To provide a basic knowledge on animal cell culture.

CEO2: To provide the knowledge on application of cell culture for pharmaceutical purposes.

Course outcomes: At the end of the course, the student will be able to

CO1	understand the basics of animal cell culture and culture conditions.
CO2	acquire knowledge in optimization of media, scaling up animal cell culture, characterization and maintenance of cell lines.
CO3	Students will understand the stem cell culture and its applications in tissue engineering and animal cloning.
CO4	Students will learn molecular biology techniques like PCR, hybridization and RFLP.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	1	1	-	2	-	-	-	-	-	-			
CO2	3	-	2	2	1	-	-	-	-	-	-	-			
CO3	-	-	2	3	2	-	-	-	-	-	-	2			
CO4	-	-	-	1	2	-	2	1	-	-	-	-			
Avg.															

UNIT:1 **[12 Hours]**

Animal Biotechnology Equipments and materials for animal cell, culture technology, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, Development of primary culture. Development of cell line by enzymatic disaggregation, Biology and characterization of the cultured cells, measuring parameters of growth

UNIT:2 **[15 Hours]**

Different type of cell culture media, growth supplements, serum free media, balanced salt solution, other cell culture reagents, culture of different tissues and its application.Behavior of cells in culture, division, their growth pattern, metabolism of estimation of cell number. Measurement of viability and cytotoxicity; Scaling up the cell culture to large scale/industrial level production.Development of cell lines, characterization and maintenance of cell lines, cryopreservation, common cell culture contaminants. Culture of cells for production of various biologicals.

UNIT:3 **[10 Hours]**

Application of animal cell culture, stem cell cultures, embryonic stem cells and their applications. Hybridoma technology, Organ culture technology, Transfection of animal cells, Future tissue engineering, animal cloning.

UNIT:4 **[10 Hours]** Bacterial and viral diseases in animals; monoclonal antibodies and their use in diagnosis; molecular diagnostic techniques like PCR, insitu hybridization; northern and southern blotting; RFLP.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books ***1.*** *Animal cell culture by R.I. Freshney* *2. Animal Biotechnology by P.Ramadas*
Ref. Books *1. In vitro cultivation of Animal cells by Dr.C.K.Leach,Butterworth and Heinnmamm Ltd.1994.* *2. Hand book of Animal Husbandry by Gopalakrishnan .* *3. A Text Book of Biotechnology R C Dubey, S Chand publication*

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Title of the subject						
Subject Code		L	T	P	C	QP
	Bio system Engineering	**3**	**0**	**0**	**3**	A

Course Educational Objective

CEO1: student will know a range of advanced design methods and be able to apply a structural design method to a typical biosystems engineering design problem;

CEO2: student will have some skill in recognizing and describing biosystems design problems;

Course outcomes: At the end of the course, the student will be able to

CO1	familiar with the theory on technology development and systems innovation and be able to apply this to a typical biosystems engineering design case
CO2	have developed skill in redefining and redesigning a biosystem
CO3	be able to evaluate and reflect on a design from a technical, biological and sustainability point of view
CO4	have developed competence in functioning in and contributing to design teams

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	1	2	-	-	-	-	-	-	-	-			
CO2	1	-	2	2	-	1	-	-	-	-	-	-			
CO3	-	2	2	2	1	-	-	-	-	-	-	-			
CO4	-	-	-	1	2	2	-	-	-	-	-	1			
Avg.															

UNIT:1 **[14 Hours]**

Introduction to Biosystems Engineering : An introductory series of lectures will introduce students to various elements of the degree programme in Biosystems Engineering. The course will also include topics of current developments and case studies in the area. Essays in selected topics will be required.

UNIT:2 **[15 Hours]**

Introduction to Biosystems : Definitive properties and levels of organization of living systems. Chemical composition of living systems. Cell metabolism. Origin of life-metabolic evolution. Diversity of life forms. Animal and plant tissues and organs. Physiological systems. Protists. Nutrient requirements of organisms. Populations, communities and ecosystems. Biogeochemical cycles. Emergence of man. Impact of man on the biosphere.Social implications of recent advances in biology.

UNIT:3 **[14 Hours]**

Biosystems Modelling : Numerical and computer modeling of biological engineering processes including the drying of solid and liquid biomaterials.Numerical modeling systems using finite element and finite difference methods including practical examples as well as analytical solutions.

UNIT:4 **[13 Hours]**

Biosystems Engineering : Modes of heat transfer in biological materials. Heat exchangers. Mass balances, mass transfer. Separation processes including: distillation, filtration, membrane processes, centrifugation, chromatography. Reactor design, Psychrometrics in biological systems. Process laboratory.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books Biosystems Engineering I: Creating Superior Biocatalysts (Advances in Biochemical Engineering/Biotechnology Book 120) 10th Edition, Kindle Edition

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Title of the subject						
Subject Code		L	T	P	C	QP
	Medical and Pharmaceutical Biotechnology	**3**	**0**	**0**	**3**	A

Course Educational Objective

CEO1: To provide knowledge on drug development and new generation antibiotics.

CEO2:To provide theory and practical knowledge on diagnosis technique.

Course outcomes: At the end of the course, the student will be able to

CO1	understand the drug development in pharmaceutical process
CO2	understand the recent disease and diagnosis and their therapy
CO3	learn about the role of proteomics assay in drug development
CO4	know about the control of different pharmaceutical products.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	2	1	-	-	-	-	-	-	-	-			
CO2	-	-	2	3	1	1	-	-	-	-	-	-			
CO3	-	3	2	-	2	-	-	-	-	-	-	2			
CO4	-	-	-	2	-	3	2	1	-	-	-	-			
Avg.															

UNIT:1 **[13 Hours]**

Production of pharmaceuticals by genetically engineered cells (hormones, interferons), Microbial transformation for production of important pharmaceuticals (steroids and semi-synthetic antibiotics), Techniques for development of new generation antibiotics. Protein engineering, drug design, drug targeting.

UNIT:2 **[13 Hours]**

ELISA and hybridoma technology, Use of enzymes in clinical diagnosis, Use of biosensors for rapid clinical analysis, Diagnostic kit development for microanalysis, Genetic diseases and DNA based diagnoses, DNA vaccine, Gene Therapy, Toxicogenomics

UNIT:3 **[11 Hours]**

Role of Proteomics in Drug Development, Diagnosis of disease by Proteomics. Development of antibody based protein assay for diagnosis. Separation and identification techniques for protein analysis, Development of antibody based protein array for diagnosis

UNIT:4 **[8 Hours]**

Pharmaceutical products and their control, Therapeutical categories such as laxatives, vitamins, analgesics, non-steroid contraceptives, antibodies and Biologicals Hormones.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. *Stanbury.P.F, Whitaker.A and Hall.S.J, "Principles of Fermentation Technology", 2nd Edition, Aditya Books (P) Ltd, 1995.*

2. *Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine) by Jochen Decker, U. Reischl*
3. *Gary Walsh, "Pharmaceutical Biotechnology-Concepts and Applications," Wiley, 2007*

Ref. Books

1. *EpenetosA.A.(ed), Monoclonal antibodies: applications in clinical oncology, Chapman and Hall Medical, London*
2. *Text book of industrial pharmacy by S R Hiremath, Orient Black Swan publication.*
3. *Leon and Lachman et al- Theory and Practice of Industrial pharmacy.*

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Title of the subject						
Subject Code		L	T	P	C	QP
	Biomaterial	**3**	**0**	**0**	**3**	A

Pre -Requisite:

Course Educational Objective

CEO1: To provide Knowledge on biomaterial and biomedical engineering.

CEO2: To provide knowledge on different types of composite materials.

Course outcomes: At the end of the course, the student will be able to

CO1	Students will able to Classify and understand the properties of biomaterials
CO2	Student will also acquire knowledge on various types of biomaterials and use of novel biomaterials in biomedical engineering.
CO3	Students will understand the concepts for developing new materials for tissue engineering and bio-implant applications.
CO4	Students will be able to know biocompatibility of materials using in vivo and in vitro techniques.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	1	1	-	1	-	-	-	-	-	-			
CO2	2	-	2	1	2	-	-	-	-	-	-	-			
CO3	-	2	1	3	2	-	-	-	-	-	-	-			
CO4	-	-	2	1	2	-	-	-	-	-	-	1			
Avg.															

UNIT:1 **[10 Hours]**

Introduction to biomaterials, Types and properties (mechanical, structural, thermal, optical, electrical and surface) of biomaterials, Synthetic polymer, Natural polymer.

UNIT:2 **[12 Hours]**

Novel Biomaterials and uses in Biomedical engineering: Hydrogels, self-assembling peptides. Implants materials: metallic implant materials, stainless steels, Co-based alloys, Ti- based alloys; ceramic implant materials, aluminum oxides, hydroxyapatite glass ceramics carbons. Polymeric implant

UNIT:3 **[14 Hours]**

Polymers for drug delivery: types of polymer, pharmaceutical polymers, physicochemical properties of polymers and relationship with structure, properties, kinetics, mechanisms and applications. , Biomaterials for ophthalmology, orthopaedic and dental implants, Biologically functional biomaterials

UNIT:4 **[14 Hours]**

Biocompatibility and blood compatibility, Biomaterials: its foreign body response in a body. Biological interface, interaction with biomaterials and adhesion, Biological response to implants, 2D and 3D matrices (scaffolds) of biomaterials for tissue engineering, Soft tissue and hard tissue replacement, cardiovascular implants. Characterization techniques of biomaterials.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books 1. *Buddy D. Ratner Allan S. Hoffman Frederick J. Schoen Jack E. Lemons. Biomaterials Science, Second Edition: Wiley Science 2004.* 2. *Bhatt SV, Biomaterial, Narosa publishing house*
Ref. Books 1. *Park J and R. S. Lakes R S, Biomaterials: An Introduction, Springer 2009*

Title of the subject						
Subject Code		L	T	P	C	QP
	Protein Engineering	**3**	**0**	**0**	**3**	A

Course Educational Objective

CEO1:To provide importance and application of protein engineering.

CEO2: To have an idea about industrial important enzymes.

Course outcomes: At the end of the course, the student will be able to

CO1	Gain the knowledge about different forces acting on protein structure interactions and proein enginnering applications.
CO2	Know thermodynamic and chemical principle of proteins
CO3	Have the knowledge in the features, design principles and approaches of protein engineering with stabilization.
CO4	Be understand the biophysical techniques used in protein characterization.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	1	2	-	-	-	-		-	-			
CO2	2	1	2	2	-	-	-	-	-	-	-	-			
CO3	-	2	1	3	2	-	-	-	-	-	-	-			
CO4	-	-	2	1	3	-	-	-	-	-	-	1			
Avg.															

UNIT:1 **[12 Hours]**

Overview of protein structure and its hierarchical architecture; Protein engineering – definition, applications; Forces stabilizing proteins – Van der waals, electrostatic, hydrogen bonding and weakly polar interactions, hydrophobic effects. Structural features of protein, Ramachandran map, Protein-protein, Protein-DNA, protein-ligand interactions. Protein structure-function relationship.

UNIT:2 **[10 Hours]**

Stability of Protein Structure: Laws of thermodynamics, heat, energy and work, chemical equilibrium flexibility, reversible folding and unfolding, pH titration, chemical denaturation, Thermal denaturation, solvent perturbation and chemical modification.

UNIT:3 **[11 Hours]**

Features or characteristics of proteins that can be engineered- affinity and specificity; Experimental methods of protein engineering: Rational designing, Directed evolution like site directed mutagenesis, Module shuffling, Guided protein recombination, etc.; Computational Approaches to protein engineering. Mechanism of stabilization of proteins from psychrophilesand thermophiles vis-à-vis those from mesophiles; Protein and enzyme engineering case studies For its stability, specifity and affinity- Protease, Lipase and Lysozyme. Role of solvent.

UNIT:4 **[10 Hours]**

Characterization of proteins: NMR spectroscopy, crystallography, spectroscopic (UV-Vis, CD, IR,Florescence), calorimetric methods, Viscometry, Molecular sieve chromatography,

Electrophoresis, EPR in protein structure and function analysis with example.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books 1. Edited by T E Creighton, Protein function. A practical approach, 2nd Edition, Oxford university press. *2. Cleland and Craik, Protein Engineering, Principles and Practice, Vol 7, Springer Netherlands.* *2. Mueller and Arndt., Protein engineering protocols, 1st Edition, Humana Press.* *3. L. Alberghina, Protein Engineering for industrial biotechnology, Harwood Academic Publisher*

Title of the subject						
Subject Code		L	T	P	C	QP
	Engineering Economics & Costing	**2**	**0**	**0**	**2**	**A**

Course Educational Objective

CEO1: to understand the significance of the economic aspects of engineering and to become proficient in the evaluation of engineering proposals in terms of worth and cost

CEO2: to help students to grasp various economics concepts and theories towards making economic decision.

Course outcomes: At the end of the course, the student will be able to:

CO1	Understanding the fundamentals of economic theory in general- concept of demand & supply, theories of production-Laws of returns
CO2	Overview of cost and revenueconcepts: Understood the nature and behavior of cost, cost sheet, Break-even analysis- linear approach and understanding of depreciation with its measurement.
CO3	Acquainted with evaluation of engineering proposals(Private and public) by learning the concept of Time-value of Money, Determination of economic life of an asset, Replacement of existing asset with a new asset etc.
CO4	Familiar with Indianfinancial system and banking structure, idea about concept of national income – its measurement and inflation.
CO5	Ultimately learners of the subject get the benefits of understanding the diverse situation happening in the economy and able to make rational decision in the field of engineering.

CO-PO & PSO Mapping:

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	4	5	6	7	8	9	10	11		1		
CO2											2		1		
CO3											2		2		
CO4											2		1		
Avg.											1		1		

UNIT:1 **[10 Hours]**

Engineering Economics –Meaning,Nature, Scope, Basic problems of an economy, Micro economics and Macro Economics.Demand and Supply Analysis -Meaning of demand, Demand function, Law of Demand and its exceptions, Determinants of demand, Elasticity of demand &its measurement (Simple numerical problems to be solved) Meaning of supply, Law of supply and its exception, Determinants of supply, Elasticity of supply, Determination of market equilibrium (Simple numerical problems to be solved).Theory of Production - Production function, Laws of returns: Law of variable proportion, Law of returns to scale

UNIT:2 **[10 Hours]**

Cost and revenue concepts, Elements of costs, Preparation of cost sheet, Segregation of costs into Fixed and variable costs. Basic understanding of different market structures, Price and output Determination under perfect competition (Simple numerical problems to be solved), Break Even Analysis - Linear approach (Simple numerical problems to be solved). Depreciation- Causes of depreciation, Methods of calculating depreciation

(Straight line method, Declining balance method)

UNIT: 3 **[12 Hours]**

Time value of money -Interest Analysis - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence.Evaluation of engineering projects-
Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects. Replacement Analysis- Determination of economic life of an asset, Replacement of existing asset with a new asset.

UNIT:4 **[8 Hours]**

Overview of Indian financial system. Commercial bank, Functions of commercial bank, Central bank, Functions of Central Bank. Inflation- Meaning of inflation, types, causes, measures to control inflation. National Income - Definition, Concepts of national income, Method of measuring national income.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Riggs, Bedworth and Randhwa, “Engineering Economics”, McGraw Hill Education India

Principles of Economics, DevigaVengedasalam; KarunagaranMadhavan , Oxford University Press.

Ref. Books 1. Engineering Economy by William G.Sullivan, ElinM.Wicks, C. PatricKoelling, Pearson R.PaneerSeelvan, “ Engineering Economics”, PHI

Ahuja,H.L., “Principles of Micro Economics” , S.Chand& Company Ltd

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Title of the subject						
Subject Code		L	T	P	C	QP
	IPR, Bioethics and Bio safety	**3**	**0**	**0**	**3**	A

Pre -Requisite:

Course Educational Objective

CEO1: To provide the knowledge on importance on IPR in Biotechnology.

CEO2:To introduce biosafety regulations and its application in biotechnology

Course outcomes: At the end of the course, the student will be able to

CO1	Student will understand the basics of intellectual property rights and its importance
CO2	Students will obtain knowledge in patent requirements; patent writing and patenting procedure.
CO3	Students will understand the professional responsibilities for biosafety, biosafety levels, international agreements and protocols for Biosafety.
CO4	Students will understand the social and ethical issues related to plant, animal and modern biotechnology.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	2	1	2	-	-	-	-		-	-			
CO2	1	2	2	3	-	-	-	-	-	-	-	-			
CO3	-	1	2	1	2	-	-	-	-	-	-	-			
CO4	-	-	2	2	-	-	-	3	-	-	-	2			
Avg.															

UNIT:1 **[12 Hours]**

Concept of property, rights, duties and their correlation; Intellectual property rights and its types- Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of new GMOs; Process patent vs product patent; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS.

UNIT:2 **[14 Hours]**

Basic requirement of a patentable invention- novelty, inventive step, Prior art and Stae of art; Patent databases; Searching International Databases; Analysis and report formation; Indian Patent Act 1970 and Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a patent, International patenting-requirement, Patent infringement- meaning, scope, litigation, remedies; Case studies and examples-Rice, Neem etc.

UNIT:3 **[12 Hours]**

Introduction to Biosafety regulations; Primary Containment for Biohazards and Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India. Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture;

Environmental release of GMOs.
UNIT:4 **[10 Hours]** Overview of National Regulations and relevant International Agreements including Cartagena Protocol. Concept of Bioethics, Public concerns on Human genome research and transgenics- Genetic testing and screening, Ethics in clinical trials and GCP, ELSI & Human genome projects; Ethics in human cloning- a case study.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books 1. Stanley SA, Bioethics, Wisdom educational services 2. Sateesh MK, Bioethics and Biosafety, IK International Pvt. Ltd.

Title of the subject						
Subject Code		L	T	P	C	QP
	Bioprocess optimization	**3**	**0**	**0**	**3**	A

Pre -Requisite:

Course Educational Objective

CEO1: To introduce the basic knowledge of biochemical process and its application

CEO2: To understand the solving of material balances problems involving chemical reactions

Course outcomes: At the end of the course, the student will be able to

CO1	familiar with different types of biochemical process variables and their measurements
CO2	know about biochemical kinetic models
CO3	know about the calculation of bioprocess optimization
CO4	have an idea about different types biopharmaceutical production process

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	1	2	-	-	-	-	-	-	-	-			
CO2	2	-	1	1	-	-	-	-	-	-	-	-			
CO3	2	-	-	2	-	-	2	1	-	-	-	-			
CO4	1	-	2	2	-	-	1	-	-	-	-	1			
Avg.	2.4	2.4													

UNIT:1 **[10 Hours]**

Biochemical process variables and their measurements; Control principles and their application in bioreactors; Theory of electrode processes and their applications; Measurement and control of pH, temperature, dissolved oxygen, aeration and agitation, redox potential, foam, etc.; On-line analysis of process parameters; Use of computer in control and optimization of microbiological processes.

UNIT:2 **[10 Hours]**

Types of kinetic model; Data smoothing and analysis; Mathematical representation of bioprocess; Parameter estimation; Numerical integration techniques; Parameter sensitivity analysis; Statistical validity; Discrimination between two models; Physiological state markers
and its use in the formulation of a structured model; Dynamic simulation of batch, fed-batch steady and transient culture metabolism; Numerical optimization of bioprocess using mathematical models.

UNIT:3 **[15 Hours]**

Calculations of Bioprocess Optimization: Units and dimensions, mole concept, the chemical equations and stoichiometry, limiting and excess reactant, conversion and yield. Mass and energy balances in bioprocesses, flow sheet and process calculations, metabolic stoichiometry of growth and product formation, Ideal gas law calculations, real gas relationships, vapor pressure and liquids, saturation, partial saturation and humidity. Microbial Stoichiometry

UNIT:4 **[10 Hours]** Supervision of bio pharmaceutical production process: Supervise bio pharmaceutical production activities: Biopharmaceutical production schedule and guidelines to production operators to handle production activities, Directions for junior biologists production operators -proper ingredients.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books *1.Optimization and Applicability of Bioprocesses : Purohit, H.J., Kalia, V.C., Vaidya, A.N., Khardenavis, A.A. (Eds.)* ***2.** Fundamentals of Modern Bioprocessing: Sarfaraz K. Niazi, Justin L. Brown*
Ref. Books *1.Bioprocess Engineering Principles by Pauline M Doren* *2. Bioprocess Engineering: Basic Concepts by Michael L Shuler and F. Kargi*