



DEPARTMENT OF BIOTECHNOLOGY

Scheme and syllabus for III and VIII semesters under 160 credits

For the Academic Year 2021-22 onwards

INSTITUTE VISION & MISSION

VISION

Promoting Prosperity of mankind by augmenting human resource capital through quality Technical Education & Training

MISSION

Accomplish excellence in the field of Technical Education through Education, Research and Service needs of society

DEPARTMENT VISION & MISSION

VISION

To be a Centre of excellence in the field of Biotechnology equipped to create graduates who endeavor for the welfare of mankind.

MISSION

- To impart quality education for lifelong professional growth and opportunity in a wide range of Careers.
- To create awareness towards socio-ethical implications of potentials of Biotechnology.

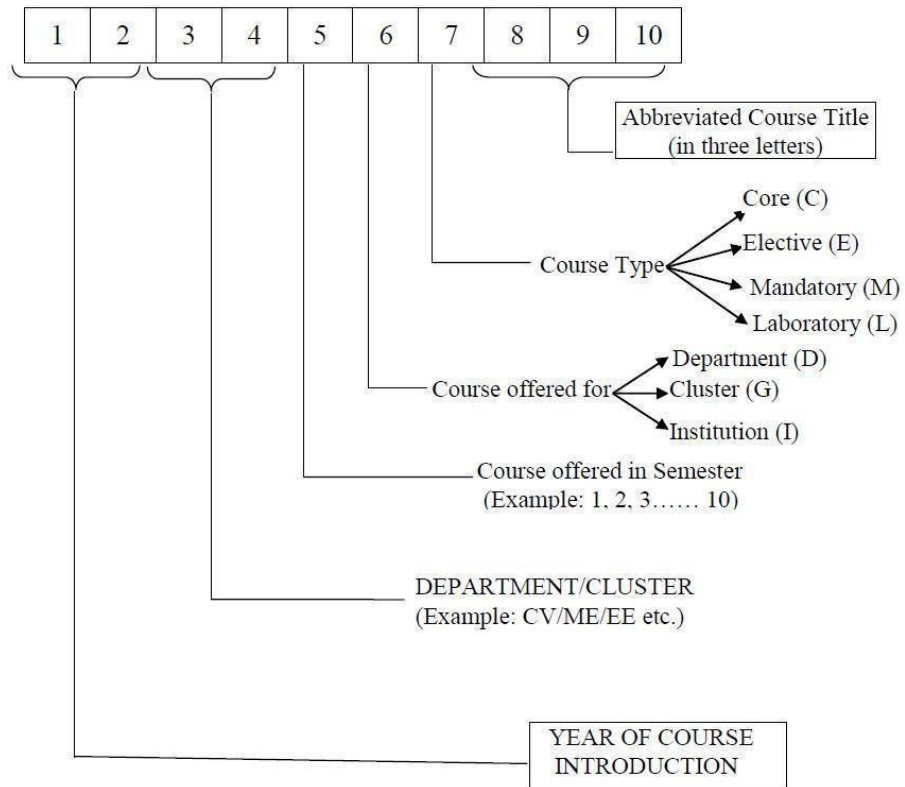
PROGRAMME OUTCOMES (POs)

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OBJECTIVES

PSO1	Apply knowledge of basic sciences and biotechnological techniques to manipulate living organisms.
PSO2	Design, optimize, analyse and scale up a bioprocess to develop value added products
PSO3	Generate, analyse and interpret Biological data using Insilico approaches.

NOMENCLATURE FOR THE COURSE CODE



III Semester

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
BS-7	22MA3BSTFN	Transform Calculus, Fourier Series and Numerical Techniques	2	1	0	3	4
PC-1	22BT3PCFME	Fluid Mechanics	3	0	1	4	5
PC-2	22BT3PCPPC	Process Principles and Calculations	3	0	0	3	3
PC-3	22BT3PCMBG	Microbiology	3	0	1	4	5
PC-4	22BT3PCBBM	Basics of Biomolecules	3	1	0	4	5
AE-3	22BT3AEMCP	Mathematical concepts using Python	0	0	1	1	2
AE-4	22MA3AEUHV	Universal Human Values	0	1	0	1	2
HS-3	22CV3HSEVS	Environmental Studies	1	0	0	1	1
HS-4	22MA3HSCPH	Constitution of India, Professional Ethics and Human Rights	1	0	0	1	1
NCMC-1	22BT3NCPYA	Physical Activity (<i>or any other</i>)				PP/NP	-
Total: -			16	3	3	22	28

Humanities and Social Sciences including Management Courses (HS); Basic Science Courses (BS); Engineering Science Courses (ES); Professional Core Courses (PC); Professional Elective Courses (PE); Open Electives (OE); Project Work (PW); Technical Seminar (SR); Internship in industry or Institution (IN); Non-Credit Mandatory Courses (NC).

IV Semester Scheme

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
BS-8	22BT4BSEM4	Biostatistics and Design of Experiments	2	1	0	3	4
ES-1	22BT4ESPET	Process Engineering Thermodynamics	2	1	0	3	4
PC-5	22BT4PCBAB	Biochemistry and Bioenergetics	3	0	1	4	5
PC-6	22BT4PCCMB	Cell and Molecular Biology	3	0	0	3	3
PC-7	22BT4PCBCA	Basics of Computer Applications	3	0	1	4	5
PC-8	22BT4PCHMT	Heat and Mass Transfer	3	0	0	3	3
INT-1	22BT4SRIN1	Seminar- Internship involving Social Activity	0	0	1	1	2
HS-5	22MA4HSKN/ 22MA4HBKN	Samskrutika Kannada / Balake Kannada	1	0	0	1	1
NCMC-2	22BT4NCCLA	Cultural Activity (<i>or any other</i>)				PP/NP	-
TOTAL: -			17	2	3	22	27

Humanities and Social Sciences including Management Courses (HS); Basic Science Courses (BS); Engineering Science Courses (ES); Professional Core Courses (PC); Professional Elective Courses (PE); Open Electives (OE); Project Work (PW); Technical Seminar (SR); Internship in industry or Institution (IN); Non-Credit Mandatory Courses (NC).

III Semester

Course Title	TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES	Course Code	22MA3BSTFN
Credits	03	L – T – P	2-1-0
Contact Hours	40		

COURSE OBJECTIVES: The purpose of the course is to facilitate the learners to:

- Appreciate the importance of Series, Transforms and Numerical Techniques in Engineering Problems.
- Acquire the knowledge of Series, Transforms and Numerical Techniques to apply them in their core domain.
- Improve their Mathematical thinking and acquire skills required for sustained lifelong learning.

TEACHING-LEARNING PROCESS (General Instructions):

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted
2. so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
3. State the need for Mathematics with Engineering Studies and Provide real-life examples.
4. Encourage the students for group learning to improve their creative and analytical skills.

UNIT-1

LAPLACE TRANSFORMS:

[08 hours]

Definition and Laplace transforms of elementary functions (statements only). Problems on Laplace transform of Laplace transforms of derivatives and integrals. Laplace Transform of periodic functions (statement only) and unit-step function – Problems. Inverse Laplace transforms: definition and problems. solution of differential equations.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation
---------------------------	--

UNIT-2

FOURIER SERIES:

[08 hours]

Introduction to infinite series, convergence and divergence. Periodic functions, Dirichlet's conditions. Fourier series of periodic functions with period 2π and arbitrary period. Complex Fourier series. Practical harmonic analysis.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation
---------------------------	--

UNIT-3

FOURIER TRANSFORMS:

[08 hours]

Definition and problems on Fourier Transform. Fourier sine and cosine transforms – Problems.

Inverse Fourier transform, Inverse Fourier cosine and sine transforms - Problems. Convolution theorem (only statement) – problems.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation
---------------------------	--

UNIT-4

NUMERICAL SOLUTION OF PDE:

[08 hours]

Classification of second-order partial differential equations, finite difference approximation of derivatives. Solution of one-dimensional heat equation by Schmidt explicit formula and Crank- Nicholson method. Solution of one-dimensional wave equation using explicit three level formula and implicit scheme.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation
---------------------------	--

UNIT-5

CALCULUS OF VARIATIONS:

[08 hours]

Definition, Variation of a functional, Euler's equation, variational problems.

Applications: Hanging cable problem, Brachistochrone problem.

Z-TRANSFORMS:

Definition, Standard Z-transforms, Damping rule, Shifting rule, Initial value and final value theorems-problems. Inverse Z-transform and applications to solve difference equations.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation
---------------------------	--

SUGGESTED LEARNING RESOURCES:

TEXT BOOKS:

1. B. S. Grewal: "Higher Engineering Mathematics", Khanna publishers, 44th Ed.2018
2. E. Kreyszig: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed. (Reprint), 2016.

REFERENCE BOOKS:

1. B.V. Ramana: "Higher Engineering Mathematics", McGraw-Hill Education, 11th Ed.
2. Srimanta Pal & Subodh C. Bhunia: "Engineering Mathematics "Oxford University Press, 3rd Reprint, 2016.
3. N. P Bali and Manish Goyal: "A textbook of Engineering Mathematics", Laxmi Publications.
4. C. Ray Wylie, Louis C. Barrett: "Advanced Engineering Mathematics", McGraw-Hill Book Co. New York, 6th Edition.
5. Gupta C.B, Sing S. R. and Mukesh Kumar: "Engineering Mathematic for Semester I and II", Mc- Graw Hill Education (India) Pvt. Ltd 2015.
6. H. K. Dass and Er. Rajnish Verma: "Higher Engineering Mathematics", S. Chand Publication (2014).
7. James Stewart: "Calculus" Cengage publications, 7th edition, 4th Reprint 2019.

WEB LINKS AND VIDEO LECTURES (E-RESOURCES):

1. [http://www.class-central.com/subject/math\(MOOCs\)](http://www.class-central.com/subject/math(MOOCs)) 2. <http://academicearth.org/> 3. <http://www.bookstreet.in>.
4. VTU e-Shikshana Program
5. VTU EDUSAT Program

ASSESSMENT (BOTH CIE AND SEE)

Component	Type of assessment	Max. Marks	Total	50 % Weightage	Total
CIE – Theory	Quiz	10	100	5	50
	AAT	10		5	
	Test 1	40		20	
	Test 2	40		20	
	Test 3	40		20	
SEE	End Exam	100		50	

Two best scores out of the three tests will be considered for CIE.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

SEMESTER END EXAMINATION:

- Each unit consists of one full question.
- Five full questions to be answered.
- To set one question each from Units 2, 3 & 4 and two questions each from Unit .

Course outcomes (Course Skills Set)

After successfully completing the course, the student will be able to understand the topics:

Course Code	CO	COURSE OUTCOME (CO)	PO	Strength
22MA3BSTFN	CO 1	Apply the concepts of Transform Techniques, optimization and Finite Difference Methods to solve engineering problems.	1	3
	CO 2	Analyze Engineering Application Problems using the concepts of Transform Techniques, optimization and Finite Difference Methods.	1	1
	CO 3	Demonstrate the importance of Transform Techniques, optimization and Finite Difference Methods in engineering using programming tools.	1 & 5	1

Course Title	FLUID MECHANICS														
Course Code	2	2	B	T	3	P	C	F	M	E	Credits	04	L – T – P	3 – 0 – 1	
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PRE-REQUISITES: Knowledge of Engineering Physics and Mathematics.

COURSE DESCRIPTION: This course provides students with the fundamental knowledge of momentum transfer and solid-liquid separation operations. This course gives the basic knowledge of fluid-flow phenomena, kinematics of flow, and various aspects of transportation of fluids and metering of fluids. Basic concepts of dimensional analysis also included in this course.

COURSE OBJECTIVES: The course objective is to make students capable of identifying the various types of fluids, their flow characteristics and their applications. This course will also enable students to understand the principle behind various solid-liquid separation processes like filtration, sedimentation and mixing in upstream and downstream processes. This course will train students to formulate, analyse and solve engineering problems involving fluid mechanics.

PART A: THEORY UNIT 1 FLUID FLOW PHENOMENA [9L]

Significance of Dimensionless groups and constants, Dimensional analysis – Rayleigh’s method, Buckingham’s π method; Fluid definition and Classification (Newtonian and Non-Newtonian), Newton’s law of viscosity, Pressure measurement using manometers, Hydrostatic equilibrium, Types of flow-laminar & turbulent, Flow in Boundary Layers, Reynolds experiment, Conceptual problems.

UNIT 2 FLOW OF INCOMPRESSIBLE FLUIDS [10L]

Fluid flow – Continuity and Bernoulli equations, Flow through circular and non-circular conduits- Hagen Poiseuille equation, Pressure drop through packed bed - Ergun’s equations, Flow through fluidized bed Conceptual problems.

UNIT 3 FLOW MEASUREMENTS [8L]

Flow measurements - Orifice meter, Venturimeter, Rota meter, Performance & Characteristics of Pumps - Centrifugal & Reciprocating pumps, Energy calculations, Fans, Compressors and Blowers, Conceptual problems.

UNIT 4 SOLID-LIQUID SEPARATIONS [7L]

Sedimentation & Settling - Batch & Continuous Sedimentation, Stokes law, Terminal settling velocity. Kynch theory and Thickener design. Filtration - constant rate and constant pressure filtration, Filtration equipment, Fluidization -Characteristics of fluidized systems, flow through packed beds.

UNIT 5 MIXING [5L]

Mixing – Principle of mixing (solid-solid, solid-liquid, Liquid-Liquid), mixing index, Agitators (propeller, paddle, turbine), flow patterns (radial and axial flow pattern), Concept of swirling and vortexing, methods to prevent vortexing, Types of mixers - Sigma Mixer, Ribbon blender, Muller mixer, Tumbler mixer, Banbury mixer: Principle, construction, working. Power number, power consumption in mixing operation.

TEXT BOOKS

1. Unit operations in Chemical Engineering by McCabe W.L. and Smith J.C. McGraw Hill.
2. Introduction to chemical Engineering by Badger and Banchero. McGraw Hill.

REFERENCE BOOKS

1. Chemical Engineering-Vols I&II by Coulson and Richardson, Butterworth-heinemann (5th Ed.).
2. Principles of Unit Operations by Foust A.S. Et al, John Wiley & Sons Inc (2nd Ed.).
3. Transfer Processes & Unit Operations by Geankoplis C.J., PHI Publishers (3rd Ed.) **e-b ooks**

1. Unit operations in Chemical Engineering by McCabe W.L. and Smith J.C. McGraw Hill.
(<http://www.ualberta.ca/~seyedsha/Ebooks/Unit%20Operations%20Of%20Chemical%20Engineering,%205th%20Ed,%20McCabe%20And%20Smith.pdf>)

2. Chemical Engineering-Vols I&II by Coulson and Richardson, Butterworth-heinemann
([http://traininghrd.nigc.ir/files/files/chemist%20book%20cd2/chemical%20eng/RICHARDSON,%20J.%20F.%20\(2002\)2/Coulson_Richardsons_Chemical_Engineering_Volume_2.pdf](http://traininghrd.nigc.ir/files/files/chemist%20book%20cd2/chemical%20eng/RICHARDSON,%20J.%20F.%20(2002)2/Coulson_Richardsons_Chemical_Engineering_Volume_2.pdf))

MOOCs

1. <https://www.edx.org/course/basics-transport-phenomena-delftx-tp101x#!>
2. <http://www.nptel.ac.in/syllabus/102106027/> **PART B: LAB (2hrs/week)**

1. Friction in circular pipes
2. Flow rate measurement using venturi meter
3. Flow rate measurement using orifice meter
4. Characteristics of centrifugal Pumps
5. Flow through packed bed
6. Flow through fluidized bed
7. Batch sedimentation
8. Filtration in leaf filter
9. Rotary evaporator
10. Double pipe heat exchanger

REFERENCE BOOKS

1. Lab manual by Faculty

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes mid-term tests, weekly/fortnightly class tests, homework, assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): Includes written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

COURSE OUTCOMES (COs)

CO1	Comprehend the concepts of fluid dynamics, solid-liquid separation operations and mixing in upstream and downstream processes.
CO2	Apply physical principles governing fluid flow types, characteristics, transport systems and solidliquid separation operations in chemical and bioprocess industries.
CO3	Identify, interpret and analyze and solve problems based on fluid flow and solid-liquid separation operations.
CO4	Conduct experiments on momentum transfer, and solid-liquid separation processes and interpret the data
CO5	Work individually in exploring applications of fluid mechanics and solid-liquid separation operations in biotechnology or bioprocess and communicate the findings of the literature as oral presentations and report submission.

CO-PO-PSO mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1														1	
CO2	3													2	
CO3		3												2	
CO4				3										2	
CO5									2	2		1		1	

Course Title	PROCESS PRINCIPLES AND CALCULATIONS														
Course Code	2	2	B	T	3	P	C	P	P	C	Credits	03	L – T – P	3 – 0 – 0	
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PREREQUISITES: Engineering chemistry and mathematics.

COURSE DESCRIPTION: The fundamental engineering principles of bioprocess are highlighted in this course. Additionally, it emphasizes how biotechnological processes are used nowadays as well as the function of bioprocess engineers in the biotechnological sector.

COURSE OBJECTIVES: To enable the students to formulate and solve problems related to material balances in steady state unit operations and energy balances of chemical reactions, stoichiometry of microbial growth & product formation

UNIT 1 INTRODUCTION TO BIOPROCESS CALCULATIONS

[7L]

Concept of mole, Mole fraction. Compositions of mixtures of solids, liquids and gases, concentration of solutions, Calculating dilutions: Concentrations by a factor of x, Preparing percent solutions, Diluting percent solutions, pH and pka calculations.

UNIT 2 IDEAL GAS LAW AND VAPOUR-PRESSURE

[7L]

Dalton's law and Amagat's Law, Relationship between partial pressure and mole fraction, Average molecular weight of gas mixture. Vapour-Pressure concept, effect of temperature on vapour pressure, T-X-Y diagram, Raoult's law and Henry's law. humidity concepts. Humidity chart

UNIT 3 MATERIALS BALANCE WITHOUT REACTION

[8L]

General material balance equation for steady and unsteady state. Typical steady state material balances in distillation, absorption, extraction, crystallization, drying, mixing, evaporation, Humidification & dehumidification. Elementary treatment of material balances involving bypass, Recycle and purge.

UNIT 4 STEADY STATE MATERIAL BALANCE WITH REACTION

[9L]

Principles of Stoichiometry, Concept of limiting, excess reactants and inerts, fractional and percentage conversion, fractional yield and percentage yield, selectivity, Fuels: Proximate and Ultimate analysis of coal, Combustion Calculations.

UNIT 5 ENERGY BALANCE

[8L]

General steady state energy balance equation, Heat capacity. Enthalpy, Std. Heat of formation, Std. Heat of reaction and Std. Heat of combustion, Heat of solution. Heat of mixing, ΔH_c calculations, elevated temperatures. Stoichiometric equations for microbial growth & product formation.

NOTE: Emphasis should be given on Biotechnological/Biochemical examples in all the units.

TEXT BOOKS:

1. Basic Principles and Calculations in Chemical Engineering by Himmelblau D. M. Ed 6. PHI Publishers (6th Ed.), 1997.
2. BioProcess Engineering, Basic concepts by Shuler & Kargi, PHI Publishers (2nd Ed.) 2002

REFERENCE BOOKS:

- 1 Chemical Process Principles Part – I by Hougen O. A., Waston K. M. and Ragatz R. A., Wiley, New York
- 2 Stoichiometry (SI Units) by Bhatt B. L. and Vora S. M. . Tata McGraw Hill (3rd Ed.), 1996.

e- books:

1. Chemical process and principles by Olaf a. Hougen and Kenneth M. Watson

MOOCs:

- 1) <https://nptel.ac.in/courses/103103165> " .

ASSESSMENT:

Continuous Internal Evaluation (CIE): includes mid-term tests, weekly/fortnightly class tests, homework assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

COURSE OUTCOMES (COs):

COs	Description
CO 1	Apply the concepts of material and energy balances in process calculations to steady-state unit operations including reactions and without reactions.
CO 2	Analyze the stoichiometric equations for microbial growth & product formation for material balance calculations.
CO 3	Design the solutions to the problems related to humidification and dehumidification operations using psychrometric chart
CO 4	Deliver a seminar on the topic related to the course.

	P O 1	P O 2	P O 3	P O4	P O 5	P O 6	P O 7	P O 8	P O 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2												1	
CO2		2												2	
CO3			2											1	
CO4									2	2				1	

Course Title	MICROBIOLOGY														
Course Code	2	2	B	T	3	P	C	M	B	G	Credits	04	L – T – P	3-0-1	
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PRE-REQUISITES: Basics of biology, Biology for Engineers.

COURSE DESCRIPTION: The tiny microbes play essential role in each and everyone's life. This course will enable students to understand the diverse nature of microbial world. Also focusses on morphological and functional properties of Bacteria, Fungi, and Viruses. Uses laboratory experiments that stress aseptic techniques and that develop skills necessary to handle microbes, including the characterization of unknown microbes.

COURSE OBJECTIVES: The course emphasizes on historical perspective, types and distinctive features of tiny microbes. It deals with microscopic observations, invitro culturing, determination of growth and study of physico-chemical properties of various microorganisms. The course also provides knowledge of distinctive metabolic activities of microbes and their control.

PART A: THEORY UNIT 1 DISTINCTIVE FEATURES AND OBSERVATION OF MICROORGANISMS [8L]

History of Microbiology, the Scope of Microbiology, Microbial diversity And Taxonomy (Numerical, Phylogenetic and Molecular approaches), Types of Microorganisms.

MICROSCOPY: Basic principle, microscopic parameters (resolving power, NA, magnification), Types: Bright-Field Microscopy, Dark-Field Microscopy, Phase-Contrast Microscopy, Fluorescence Microscopy, Electron Microscopy (principle, ray diagram, procedure and applications). Numerical questions on resolving power.

UNIT 2 MICROBIAL NUTRITION AND GROWTH [10L]

The morphology and ultra-structure of Bacteria: Gram +ve, Gram –ve and Archaeobacteria, Nutritional requirements: Basic nutrients, classification, culture media and types. Culturing of Bacteria: Types (pure culture techniques), Bacterial Growth: Growth curve, calculation of generation time, factors affecting growth, Measurement of growth: Direct and indirect methods, numerical questions in SPC, DMC and DCW.

UNIT – 3 MICROBIAL REPRODUCTION AND METABOLISM [9L]

Bacterial reproduction: Binary fission and Genetic recombination in bacteria, Fungi: Salient features, morphology, classification and reproduction. Viruses: general characteristics, classification and nomenclature, morphology and replication (of bacterial, plant and animal viruses in general).

Microbial Metabolism-overview of Metabolic pathways (Glycolysis, HMP, ED pathway, alcohol and acid fermentation-homo & heterolactic, mixed acid), Primary and secondary Metabolites-brief mention with examples and applications.

UNIT - 4 CONTROL OF MICROORGANISMS

[7L]

Physical methods: Terminology, Microbial death curve, Physical methods: Heat, filtration, radiation, osmotic pressure, low temperature (instruments involved), Chemical methods: (Phenol & Phenolic compounds, Alcohols, Halogens, Dyes, Detergents, Aldehydes, Heavy metals, etc), Antibiotics and their mechanism of action.

UNIT – 5

APPLICATIONS OF MICROORGANISMS

[5L]

Microbes in Agriculture: Recycling of Nutrients, Biofertilizers, Biopesticides, Aquatic Microbiology: microbial fauna of fresh and marine water, Microbes in Food industry: As food contaminants, Food processing, Microbes as food (Yeast and SCP).

PART B: PRACTICAL (2 Hr/week)

1. Laboratory rules, General instruments (Microscope, Autoclave, Hot air oven, Incubator, LAF) and other requirements in Microbiology laboratory.
2. Media preparation, plugging and sterilization. (NA/NB, PDA/PDB, MRBA, EMB agar, Blood agar, Mac Conkey agar).
3. Pure culture techniques (serial dilution, pour plate, spread plate and streak plate methods).
4. Isolation and characterization of Microbes from soil, Water and Air.
5. Examination of microorganisms from hand, nail, tooth scrapings and rotten fruits and vegetables.
6. Enumeration of microbes (Bacteria and Fungi) by DMC, SPC and Turbidometry.
7. Examination of living microbes by TWM technique, Hanging drop technique (Bacteria and Protozoa).
8. Staining techniques: Simple staining, Gram staining and endospore staining for Bacteria and Lacto phenol cotton blue staining for fungi.
9. Biochemical Tests (Starch hydrolysis, Gelatin liquefaction, MPN, Catalase and IMViC tests).
10. Measurement of growth and factors influencing growth of microbes (Determination by dry weight, effect of TDT and TDP, size determination by Micrometry).
11. Antibiotic susceptibility testing of bacteria.
12. Alcoholic and mixed acid fermentation.

TEXT BOOKS:

1. General Microbiology, Michael j Pelczar, Chan and Krieg, Tata McGraw Hill Pub
2. Industrial Microbiology, Prescott and Dunn, CBSPub. (4th Ed.)

REFERENCE BOOKS:

1. General Microbiology, Stanier, John Ingraham and Mark Wheelis, Mac- Millan Pub.
2. Microbiology an Introduction, Tortora, Funke and Case. Pearson education.
3. Experiments in Microbiology, Plant pathology and Biotechnology,, K.R.Aneja(4th ed.)

1. <http://www.austincc.edu/rohde/noteref.htm>
2. http://www.freebookcentre.net/medical_books_download/Medical-Microbiology.html
3. <http://books.pakchem.net/microbiology-books.html> MOOCs:
4. <https://www.mooc-list.com>
5. <https://www.mysliderule.com/topic/microbiology> Online courses:
6. <http://www.onlinecollegecourses.com>

Continuous Internal Evaluation (CIE): includes mid-term tests, weekly/fortnightly class tests, homework assignments, problem solving, group discussions, quiz, seminar, mini-project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

COURSE OUTCOMES (COs):

COURSE OUTCOMES	Descriptor
CO 1	Understand the working principle of microscopes, classification systems and metabolic diversity of microorganisms.
CO 2	Analyse and determine the growth, invitro culturing techniques, physicochemical properties and controlling of microorganisms.
CO 3	Select and apply appropriate microorganisms and their value-added products in various applications
CO 4	Conduct experiments, analyse and interpret the data pertain to biochemical and metabolic potential of microorganisms.
CO5	Design a project, collect data, interpret results, make a report and communicate effectively.

[illegible]

CO2		3										
CO3		3										
CO4				3								
CO5					3		2		3	2		2

Course Title	BASICS OF BIOMOLECULES													
Course Code	2	2	B	T	3	P	C	B	B	M	Credits	04	L – T – P	3 – 1 – 0
CIE	100 marks (50% weightage)											SEE	100 marks (50% weightage)	

COURSE PRE-REQUISITES: Knowledge of chemistry, Mathematics and Basics of Biology.

COURSE DESCRIPTION: This course describes the structures of important biological molecules along with the basic concepts of organic and solution chemistry.

COURSE OBJECTIVES: This course is a foundation course needed to understand the concepts of Biochemistry & Bioenergetics, Bio analytical Techniques, Enzyme Technology, Molecular Biology, Genetic Engineering and Bioinformatics & Metabolic Engineering.

UNIT 1 BASIC CONCEPTS & STRUCTURE OF CARBOHYDRATES [9L+1T]

Structure and properties of water, pH and buffers. Derivation and numerical on Henderson Hasselbach equation. Non-covalent interactions- hydrogen bonds, van der Waals forces, electrostatic and hydrophobic interactions.

Carbohydrates: Introduction, sources, classification into mono, oligo and polysaccharides, Classification of monosaccharides based on number of carbon atoms and functional groups. Isomerism: D & L and R and S system of nomenclature, Isomerism of carbohydrates. Fischer and Haworth formula, pyranose and furanose structures, anomers and epimers, chair and boat conformations. Structure and function of simple sugars: mono and disaccharides, homo and hetero polysaccharides, glycoconjugates (Proteoglycans, glycoproteins, glycolipids)

UNIT 2 STRUCTURE OF LIPIDS [4L+1T]

Lipids: Introduction, sources, nomenclature, classification, properties and functions. Derived lipids: phospholipids, glycolipids, and waxes. Steroids: structure and biological role.

UNIT 3 STRUCTURE OF AMINO ACIDS AND PROTEINS [8L+2T]

Introduction, classification, optical isomerism, chemical properties, acid-base properties, polyionic nature, zwitterions, pKa and pI, peptide bond formation and properties, biologically important peptides (oxytocin, vasopressin, bradykinin and glutathione), classification of proteins, levels of protein structure, determination of primary structure (sequencing strategies),

UNIT 4 STRUCTURE AND CONFORMATION ANALYSIS OF PROTEINS

[10L+2T]

Conformational analysis and forces that determine proteins structures, geometries, potential energy calculations, phi, psi and omega angles, Ramachandran or steric contour diagram, potential energy calculations, allowed chi angles of side chains in proteins, hydrogen bonding, disulphide bonds, salt bridges, hydrophobic interactions, alpha helices, beta sheets, helix to coil transition, general features and thermodynamic aspects of protein folding and folding kinetics, protein-ligand interactions, Scatchard plot, co-operative interactions, allosteric effects, Hill constant, Relationship between the primary, secondary

and tertiary structure of proteins, fibrous proteins (structure of collagen and keratin), Quaternary structures with Hemoglobin as an example.

UNIT 5 STRUCTURE OF NUCLEIC ACIDS [5L+1T]

General characteristics of nucleic acid structure, geometries, glycosidic bond, rotational isomers, ribose puckering, A, B and Z forms of DNA, base pairing, base stacking, tertiary structure of nucleic acids, intramolecular interactions in the double helix, thermodynamics of melting of DNA, interaction with small ions, tertiary structure of nucleic acids, Supercoiling, linking number, protein–DNA/RNA interactions.

TEXT BOOKS:

1. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox, W.H. Freeman and company (5th Ed.)
2. Biochemistry by Voet and Voet, Wiley New York

- REFERENCE BOOKS:**
1. Principles of Biochemistry by Lubert Stryer Freeman (Int. Ed.)
 2. Principles of Nucleic Acid Structure by Sanger, Springer Verlag
 3. Principles of Protein Structure by G Schulz and R H Schirmer, Springer Verlag

e-books:

1. <https://archive.org/details/LehningersPrinciplesofBiochemistry5e>
2. <http://www.tok.ro/toksite/downloads/Bioinformatika/Konyvek/biokemia,%20sejtbiologia%20%20konyvek/Stryer%20Biochemistry.pdf>

MOOCs:

1. <https://www.mooc-list.com/course/principles-biochemistry-edx?static=true>

ASSESSMENT: Continuous Internal Evaluation (CIE): Includes mid-term tests, weekly/fortnightly class tests, homework, assignments, problem solving, group discussions, quiz, seminar and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE

COURSE OUTCOMES (COs):

At the end of the course the students will be able to:

COURSE OUTCOMES	Descriptor
CO 1	Understand and explain the physiochemical properties and structural conformations of biomolecules
CO 2	Apply the concept of solution chemistry to compute the numerical related to preparation of solutions and buffers
CO3	Analyse the functional aspects of biomolecules based on the given data
CO4	Co-relate and demonstrate the structural and functional aspects of biomolecules (AAT) by models/charts etc.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	-	-	-	-	-	-	3		
CO2	3												3		
CO3		3											3		
CO4	3								3	3		2	3		

Course Title	MATHEMATICAL CONCEPTS USING PYTHON	Course Code	22BT3AEMCP
Credits	01	L–T–P	0-0-1

Part-A

Unit-1 :

Getting Started With Python

4hrs (2 Labs)

General Information, Core Python, Variables, Expressions, Statements and Functions, Logical Operators and Controls statements, Data Types, Strings, Lists Dictionaries, Files and Regular Expressions.

Unit-2:

Python Libraries and Scripts

4hrs (2 Labs)

Mathematics Modules, numpy Module, sympy Module, Scipy Module Plotting with matplotlib.pyplot, Scoping of Variables, Writing and Running Programs.

Calculus: Differentiation, Integration, Taylor Series, Fourier Series and Integral Transforms

Part-B

Unit-3:

Linear Algebra

4hrs (2 Labs)

Matrix Operations and Finding inverse of given matrix

Solving linear System of equations - Gauss Elimination Method (With and without pivoting), LU Decomposition Methods, Solving linear System of equations -Gauss Seidel, Gauss Jacobi method
Finding eigen values and eigen vectors, Finding dominant and least eigen value and eigen vectors

Unit-4:

Numerical Methods

4hrs (2 Labs)

Root finding –Bisection method and Newton-Raphson method

Numerical differentiation-

Numerical Inegration-Simpsons $1/3^{\text{rd}}$ and $3/8^{\text{th}}$ rule, Wedles Rule

Interpolation –Lagrange's and Newton forward and backward

Euler's Method, Runge-Kutta Methods, Predictor and corrector methods

Unit-5:

Data analysis and Visualization

4hrs (2 Labs)

Data analysis: Importing Datasets, Data Cleansing, data processing [CSV and XLS], data frames. Data visualization: Scatter plots, line charts, bar charts, histogram, pair plots, Pie chart, area charts, Box plots, heat maps and 3D charts.

Prescribed Text Books:

1. Python for Everybody: Exploring Data Using Python 3, Charles R. Severance, 1st edition, University of Michigan, 2016.
2. Numerical Methods in Engineering with Python 3, Jaan Kiusalaas, Cambridge University Press, 2013.

Reference Text Books:

1. Programming Python, Mark Lutz, 4th edition, O'Reilly Media, 2010
2. Learning to Program using Python, Cody Jackson, 2nd edition, Packt Publishing, 2018.

Assessment

Both CIE and SEE are given equal (50:50) weightage

Component	Type of assessment	Max. Marks	Total	50 Weightage	%	Total
CIE – LAB	CIE-1	50	50	50		50
SEE-LAB	End Exam	50		50		

Course outcomes (Course Skills Set):

After successfully completing the course, the student will be able to understand the topics

Course Code	CO	COURSE OUTCOME (CO)	PO	Strength
22MA3AEMCP	CO 1	Comprehend the concepts of Python basics and mathematical concepts linear algebra, numerical methods and Probability and statistics.		
	CO 2	Conduct experiments to apply mathematical concepts and analyze the datasets using Python	1,2, 4	3

Course Title	UNIVERSAL HUMAN VALUES										CREDITS	1		
Course Code	2	2	M	A	4	A	E	U	H	V	L T P	0	1	0
Total Number of hours											15			

Course Objectives:

To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.

UNIT 1

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; ‘Natural Acceptance’and Experiential Validation- as the process for self-exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

UNIT 2

Understanding Harmony in the Human Being - Harmony in Myself!

7. Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’
8. Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility
9. Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer)
10. Understanding the characteristics and activities of ‘I’ and harmony in ‘I’
11. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
12. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one’s own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

UNIT 3

Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship

13. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
14. Understanding the meaning of Trust; Difference between intention and competence
15. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
16. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
17. Visualizing a universal harmonious order in society- Undivided Society, Universal Order from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

UNIT 4

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

18. Understanding the harmony in the Nature
19. Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT 5

Implications of the above Holistic Understanding of Harmony on Professional Ethics

20. Natural acceptance of human values
21. Definitiveness of Ethical Human Conduct

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

TEXT BOOKS:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE MATERIAL:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal

9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes one CIE (MCQ)and 3 AAT's and attendance evaluation.

Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes. Semester

End Examination (SEE): Both CIE and SEE are given equal (50:50) weightage. The

Student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

At the end of the course, the student will have the ability to

- CO1** Conduct self-exploration and distinguish between values and skills, happiness and accumulation of physical facilities, the self and the body, Intension and Competence of an individual
- CO2** Analyse the value of harmonious relationship based on trust and respect in personal and professional life
- CO3** Examine the role of a human being in ensuring harmony in society and nature
- CO4** Apply the understanding of ethics in life and profession

COURSE TITLE	ENVIRONMENTAL STUDIES										CREDITS	1		
COURSE CODE	2	2	C	V	3	H	S	E	V	S	L T P	1	0	0
CIE	50 marks (50% weightage)										SEE	50 marks		

COURSE OBJECTIVE: The students will be able to develop a sense of responsibility about the environment, natural resources, their conservation and understand the concept, structure and function of different ecosystems and the ill effects of environmental pollution and other environmental issues like population growth, Acid rain, global warming etc.,

COURSE OUTCOME: Student can an ability to

CO1: Discuss the components and impacts of human activities on environment.

CO2: Apply the environmental concepts for conservation and protection of natural resources.

CO3: Identify and establish relationship between social, economic and ethical values from environmental perspectives

Unit 1 Introduction to Environment 03Hrs

Definition, about the Earth, Earth's Structure i.e. Atmosphere and its parts, Hydrosphere, Lithosphere and Biosphere.

- Ecology & Ecosystem, Balanced ecosystem, types of Ecosystem.

Unit 2

Human Activities on Environment

03Hrs

Human activities - Food, Shelter, Economic and Social Security. ▪

Effects of Human activities on Environment:

Agriculture,

- Housing,
- Industries,
- Mining and
- Transportation activities

Environmental Impact Assessment (E I A)

- Sustainable development

Unit 3 Natural Resources

03Hrs

Definition, Renewable and Non-Renewable sources. ▪

Major Natural Resources are -

- Water resources, its availability, quality, water borne & water induced diseases, ➤ Mineral resources, classification, uses in various Industries as byproducts.
- Forest resources – causes & consequences of deforestation, various afforestation programs.
- Conventional and Non-conventional energy resources -

➤ Hydroelectric, Wind power, Solar, Biogas, geothermal energy. ➤ Fossil fuel based energy resources – Coal, Oil & Gas, Nuclear power ➤ Hydrogen as an alternate future sources of energy.

Unit 4

Environmental pollution

03Hrs

Introduction, following are few types of pollutions to study -

- Water pollution - definition, types, sources, effects and control of water pollution.
- Land pollution - definition, types, sources, effects, Solid waste management.
- Noise pollution - definition, sources, effects & control of noise pollution.
- Air pollution - definition, sources, effects & control of air pollution

Unit 5 Current Environmental Issues & Importance 03Hrs

- Population growth, effects & Control, Climatic changes,
- Global warming, Acid rain, Ozone layer depletion and its effects.
- Environmental protection – initiatives by Government and non–Govt. Organizations (NGO's), Role of Legal aspects.
- Environmental Education, Women education

Total contact hours = 15 (Weekly 1 Hr.)

ASSESSMENT

C I E Marks: Conduct 3 Tests, considering best of 2. The pattern of Test paper consists of two parts. Part- A consists of 20 MCQs for 1 mark each; Part-B consists of 3 descriptive questions, 10 marks each. Student should answer 2 full questions from part-B. Two quizzes, each quiz is for 5 marks covering full syllabus. TOTAL C I E MARKS: 20+20+10=50 MARKS

SEE QUESTION PAPER PATTERN PART-A

- 20 Multiple Choice Questions Covering full syllabus
- 1 Mark each, students have to attend all questions

PART-B

- Consist of 4 main questions. It may be subdivisions of 3 or 4. • Each question consists of 10 marks, covering full syllabus
 - Student should Answer only 3 full questions.
- 30 marks

SEE TOTAL MARKS: 20+30=50 MARKS

1. Environmental studies by - Dr. Geetha Balakrishna (Revised Edition-Sun star publication)
2. Ecology by – Subramanyam (Tata McGraw Hill Publication)
3. Environmental studies by – Dr. J.P. Sharma (Fourth edition)
4. Environmental studies by – Smriti Srivastav (Published by Kataria & Sons)

1. Environmental studies by – Benny Joseph
2. Environmental studies by – Dr. D.L. Manjunath

1. NPTEL (Open Sources / power point and visuals)
2. Ecological studies / IITR / Open Sources
3. Ministry of Environment and forest & wildlife.

[illegible]

Course Code	22IC3HSCPH / 22IC4HSCPH	Course Name	CONSTITUTION PROFESSIONAL HUMAN RIGHTS OF INDIA, ETHICS AND
Credits	01	L-T-P	1-0-0

Total Hours: 15 Course

Objectives:

1. To educate students about the country's highest law.
2. To respect human dignity and protect people's rights from discrimination.
3. To discuss about risk management, workplace safety, and increase understanding of concerns pertaining to the profession.

UNIT-1

Introduction to Indian Constitution

[03 hours]

Framing of the Indian constitution: Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India, Fundamental Rights and its limitations. Fundamental Duties and their significance. Directive Principles of State Policy: Importance and its relevance. Case Studies

UNIT -2

[03 hours] Union Executive and State Executive

The Union Executive – The President and the Vice President, the Prime Minister and The Council of Ministers. The Union Parliament – Lok Sabha & Rajya Sabha.

The Supreme Court of India.

State Executive – The Governors, the Chief Ministers and the Council of Ministers. The State Legislature – Legislative Assembly and Legislative Council. State High Courts.

UNIT -3

[03 hours]

Election Commission of India, Amendments and Emergency Provisions Election Commission of India – Powers & Functions – Electoral Process in India.
Methods of Constitutional Amendments and their Limitations.
Important Constitutional Amendments – 42nd, 44th, 61st, 74th, 76th, 77th, 86th and 91st.
Emergency Provisions. Case Studies.

UNIT-4

[03 hours]

Human Rights

Human Rights – Meaning and significance, Types Human Rights, Powers and Functions of National and State Human Rights Commission of India. Human rights in constitution of India.

UNIT-5

[03 hours]

Professional Ethics

Scope and Aims of Engineering Ethics, Responsibilities of Engineers and impediments to Responsibilities. Honesty, Integrity and Reliability; Risks – Safety and Liability in Engineering. Case Studies.

Course Outcomes:

Students will:

- Recognize the significance of the Indian Constitution as the supreme legal authority.
- Analyse human rights theories and concepts.
- apply the principles of moral obligations and duties to safeguard the public's welfare and safety.

At the end of the course, the student will have the ability to

CO1	Recognize the significance of the Indian Constitution as the supreme legal authority.	Remember	PO6, PO12
CO2	Analyse human rights theories and concepts.	Analyse	PO6, PO12
CO3	Apply the principles of moral obligations and duties to safeguard the public's welfare and safety.	Application	PO8, PO12

Text Books:

1. “An Introduction to Constitution of India and Professional Ethics” by Merunandan K.B. and B.R. Venkatesh, Meragu Publications, 3rd edition, 2011.
2. “Constitution of India & Professional Ethics & Human Rights” by Phaneesh K. R., Sudha Publications, 10th edition, 2016.

Reference Books:

1. “V.N. Shukla's Constitution of India” by Prof (Dr.) Mahendra Pal Singh (Revised), Eastern Book Company, Edition: 13th Edition, 2017, Reprint 2019.
2. “Ethics in Engineering” by Martin, W. Mike., Schinzinger, Roland., McGraw-Hill Education; 4th edition (February 6, 2004) .

E-Book:

1. https://books.google.co.in/books/about/Constitution_of_India_and_Professional_E.html?id=VcvuVtd88QC
Constitution of India and Professional Ethics, by G.B. Reddy and Mohd Suhaib, I.K. International Publishing House Pvt. Ltd., 2006.
2. <http://www.scribd.com/doc/82372282/Indian-Constitution-M-Raja-Ram-2009#scribd> Indian Constitution, by M. Raja Ram, New Age International Pvt. Limited, 2009.

Course Outcomes and Programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						<input type="checkbox"/>						<input type="checkbox"/>
CO2						<input type="checkbox"/>						<input type="checkbox"/>
CO3								<input type="checkbox"/>				<input type="checkbox"/>

Correlation between programme outcome and course outcome:

Programme Outcome	Course Outcome	Blooms Taxonomy
<p>PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.</p> <p>PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and Life-long learning in the broadest context of technological change.</p> <p>PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.</p> <p>PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and Life-long learning in the broadest context of technological change.</p>	<p>O1</p> <p>Recognize the significance of the Indian Constitution as the supreme legal authority.</p> <p>CO2</p> <p>Analyse human rights theories and concepts.</p> <p>CO3</p> <p>Apply the principles of moral obligations and duties to safeguard the public's welfare and safety.</p>	<p>Remember</p> <p>Analyse</p> <p>Application</p>

Course Assessment and Evaluation:

Type of Assessment	Marks	Course outcome attained
Average of the two internal tests will be taken.		
Test 1,2 & 3 (Online Test) Multiple Choice Questions	Test 1 (20 Marks) Test 2 (20 Marks) Test 3 (20 Marks)	CO1 CO1 CO1
AAT-1 (Assessment) AAT-2 (Assessment)	AAT-1 (5 Marks) AAT-2 (5 Marks)	CO2 CO3

SEE Exam Question paper format

CO1,CO2 , CO3, CO4 & CO5			
SEE	Online Examination		
Pattern	50 Multiple Choice Questions	Total Marks	50X2=100

IV Semester

Course Title	Biostatistics and Design of Experiments	Course Code	22BT4BSEM4
Credits	4	L – T – P	3-1-0
Contact hours	40		

Pre requisites:

- Basic concepts of Statistics
- Basic concepts of Probability- addition theorem, conditional probability, Bayes' theorem, discrete random variable - Binomial distribution.

Course Objectives:

- Student will get acquainted with the procedure of collecting, designing, analyzing and drawing inference about the data.
- To understand the fundamentals of design and the methods of optimization.

Teaching-Learning Process (General Instructions)

The sample strategies, which the teacher can use to accelerate the attainment of the various course outcomes are listed in the following:

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

UNIT-1

Statistics & Probability Distributions [8 hours]

Curve fitting: $y = a + bx$, $y = a + bx^2$, $y = ab^x$; Correlation and regression; Introduction to Probability; Discrete distribution - Poisson; Continuous distributions - Normal.

UNIT-2

Statistical Inference – I [8 hours]

Introduction - Sampling, Estimation – point, interval; Construction of confidence interval; Procedure for testing of hypothesis- level of significance. Test of significance for single proportion [Large sample] , difference between two proportions [Large sample], ratio of variances (F- distribution), Chi -Square distribution-goodness of fit, independence of attributes.

UNIT-3
Statistical Inference – II [Comparison Of Means] [8 hours] Parametric test - Test of significance for single mean & difference of two means [Small & large sample], paired t- test, Analysis of variance (one-way and two-way classifications). Non parametric test - Kruskal Wallis One Way Analysis of Variance by Ranks, Wilcoxon Signed Rank Test, Wilcoxon Mann-Whitney Test.
UNIT-4
Descriptive Statistics: [8 hours] Types of variables, measure of spread, logarithmic transformations, multivariate data. Basics of study design, cohort studies, model fitting, principles of experimental design.
UNIT-5
Design and Analysis of Experiments [8 hours] Randomised block design, Completely Randomised block design, Latin Square Design, Factorial Experiments, Response surface methodology, Optimization strategies with case studies.

On completion of the course, student will have the ability to:

O#	COURSE OUTCOME(CO)
CO1	Demonstrate an understanding of principles of experimental design.
CO2	Analyze and interpret the data.
CO3	Appreciate the use of Statistical methods in real world examples of bioscience and bioengineering.

PO#	PROGRAM OUTCOME (PO)
PO1	Engineering Knowledge: Apply the knowledge of Mathematics, Science, Engineering fundamentals and engineering specialization to the solution of complex engineering problems.
PO2	Problem Analysis: Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.
PO10	Communication: Communicate effectively with the engineering community and with society at the large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

TextBooks: • Biostatistics, Alvin E. Lewis, McGraw-Hill Professional Publishing 2013.

- Statistics and Numerical Methods in BASIC for Biologists J.D. Lee and T.D. Lee Van Nostr and Reinhold Company, 1982.
- Statistical Analysis of Gene Expression Microarray Data T.P. Chapman CRC 2003.
- SAS Essentials: Mastering SAS for Data Analytics Alan C. Elliott, Wayne A. Woodward, John Wiley & Sons 2nd Edition, 2015.
- Numerical Method of Statistics (Cambridge Series in Statistical and Probabilistic Mathematics)

John F. Monahan, Cambridge University Press, 2011.

- Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology and Health) Warren J. Ewens Gregory Grant, Springer. 2010.

Ebooks and online course materials:

- VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource
- https://www.youtube.com/watch?v=1Q6_LRZwZrc
- <https://www.youtube.com/watch?v=gPt2DubVJQM>
- <https://www.coursera.org/courses?query=biostatistics>
- <https://www.edx.org/learn/biostatistics>
- <https://www.classcentral.com/subject/biostatistics>

Assessment:

- Each unit consists of one full question.
- Each full question consists of three or four subdivisions.
- Five full questions to be answered. • To set one question from Units 2, 3, 4 and two questions from Unit 1 and Unit 3
- Questions for CIE and SEE will be designed to evaluate the various educational components
- (Blooms taxonomy) such as:
- Remembering and understanding the course contents (weightage: 40%)
- Applying the knowledge acquired from the course (weightage: 35%)
- Analyzing various engineering problems (weightage: 15%)
- Understanding of various system models (weightage: 5%)

Continuous Internal Assessment (CIE) 50 marks (Weightage 50%)

- Three Tests (Average of two best Tests) 40 marks
- Quiz 05 marks
- Project 05 marks
- **Semester End Examination (SEE) 100 marks**

COURSE TITLE	PROCESS ENGINEERING THERMODYNAMICS												
COURSE CODE	2	2	B	T	4	E	S	P	E	T	Credits	03	L-T- P
													2-1-0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)	

COURSE PRE-REQUISITES: Knowledge of Engineering Physics, Chemistry and Mathematics.

COURSE DESCRIPTION: Basic thermodynamic concepts and associated conceptual engineering problems are covered in this course. The fundamental definition and evolution of thermodynamic laws are covered in this course. The course also emphasizes fluid properties and PVT behavior of pure fluids. Additionally, it will describe the fundamental concepts of chemical equilibrium, phase equilibria, bioenergetics, and heterogeneous reaction equilibria.

COURSE OBJECTIVES: The objective of the course is to prepare the students to understand and apply the various concepts in thermodynamics in biochemical engineering processes.

UNIT 1 BASIC CONCEPTS AND LAWS OF THERMODYNAMICS [6L+3T]

System, Surroundings & Processes, Open & Closed systems, State properties, Intensive & Extensive Properties, State & Path functions, Equilibrium state & Phase Rule, Zeroth Law of Thermodynamics, Reversible & Irreversible processes, First Law of Thermodynamics, Heat Capacity, Heat reservoirs & Heat Engines, Second Law of thermodynamics, Concept of entropy, Carnot Principle, Calculation of entropy changes, Clausius inequality, Entropy & irreversibility, Third law of Thermodynamics.

UNIT 2 PVT BEHAVIOUR AND COMPRESSIBILITY CHARTS [4L+2T]

PVT Behavior of pure fluids, Equations of state & Ideal gas law, Processes involving ideal gas law: Constant volume, Constant pressure, Constant temperature, Adiabatic & Polytrophic processes, Equations of state for real gases: Vander Waals equation, Redlich-Kwong equation, Peng-Robinson equation, Virial equation, Principles of corresponding states, Generalized compressibility charts

UNIT 3 PROPERTIES OF PURE FLUIDS AND PROPERTIES OF SOLUTIONS [7L+3T]

Work function, Gibbs free energy, Relationships among thermodynamic properties: Exact differential equations, Fundamental property relations, Maxwell's equations, Clapeyron equations, relationships between C_p and C_v , Gibbs-Helmholtz equation, Fugacity, fugacity coefficient, effect of temperature & pressure on fugacity, Determination of fugacity of pure gas, Fugacities of solids and liquids, Activity: Effect of temperature and pressure on activity, Partial molar properties, chemical potential, fugacity in solutions, Henry's law and dilute solutions, Activity in solutions, activity coefficients, Gibbs- Duhem equation

UNIT 4 PHASE EQUILIBRIA

[4L+3T]

Criteria of phase equilibria, Criterion of stability, Duhem's theorem, Vapour-Liquid Equilibria (VLE) in ideal solutions, Non-Ideal solutions, Liquid-Liquid equilibrium, Calculation of activity coefficients, consistency check for VLE data

UNIT 5 BIOCHEMICAL ENERGETICS

[5L+2T]

Reaction stoichiometry, Criteria of biochemical reaction equilibrium, Equilibrium constant & standard free energy change, Effect of temperature, Pressure on equilibrium constants & Other factors affecting equilibrium conversion, Heterogeneous bioreaction equilibria, Phase rule for reacting systems. Stoichiometry and energetic analysis of cell growth and product formation-elemental balances, degree of reduction concepts-available –electron balance, yield coefficients, oxygen consumption and heat evolution in aerobic cultures

Bibliography

TEXT BOOKS:

1. Introduction to Chemical Engineering Thermodynamics by Smith J. M., Van Ness H. C. McGraw Hill (6th Ed.), 2003.
2. A Textbook of Chemical Engineering Thermodynamics by Narayanan K. V., Ed 1. PHI publishers (1st Ed.), 2001.

REFERENCE BOOKS:

1. Biochemical Calculations by Segel I. H., John Wiley & Sons Inc. (2nd Ed.), 1976.
2. Chemical Engineering Thermodynamics by Rao Y. V. C., New Age International.
3. Engineering Thermodynamics by Jones J. B., Hawkins. , John Wiley & Sons Inc.

e-books:

1. Engineering thermodynamics by P K Nag.
2. Engineering thermodynamics by Tarik Al Shemmeri.

MOOCs:

1. www.nptel.ac.in -biotechnology-thermodynamics
2. www.ocw.mit.edu-thermodynamics and kinetics.

ASSESSMENT:

Continuous Internal Evaluation (CIE): includes mid-term tests, weekly/fortnightly class tests, homework assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

COURSE OUTCOMES (COs):

COs	Description
CO-1	Apply the thermodynamic principles in physical, chemical and biological systems
CO-2	Analyze the problems related to phase and biochemical reaction equilibria.
CO-3	Design solution for issues related to thermodynamics for given chemical or bio-processes.
CO-4	Review literature related to biochemical thermodynamics and analyze the problems individually.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2	PS O 3
CO1	3													1	
CO2		2												2	
CO3			1											1	
CO4									2	2		1		1	

Course Title	BIOCHEMISTRY & BIOENERGETICS													
Course Code	2	2	B	T	4	P	C	B	A	B	Credits	04	L – T – P	3 – 0– 1
CIE	100 marks (50% weightage)											SEE	100 marks (50% weightage)	

COURSE PRE-REQUISITES: Knowledge of organic chemistry and Basics of Biomolecules

COURSE DESCRIPTION: This course describes the major metabolic pathways and their bioenergetics.

COURSE OBJECTIVES: This course is a foundation course needed to understand the concepts of Metabolic Engineering, Enzyme Technology, Structural Biology, Molecular Biology and Bioinformatics.

PART A: THEORY

UNIT – 1 PRINCIPLES OF BIOENERGETICS [7L]

Thermodynamic concepts, Free energy change and equilibrium constant, Coupling reactions High energy compounds, Structure and properties of ATP, Biological oxidation–reduction reactions, Free energy and reduction potential, Bio-energetic interconversions and associated thermodynamic constraints, Simple numerical.

UNIT – 2 CARBOHYDRATE METABOLISM [8L]

Introduction, Glycolysis: pathway, regulation and bioenergetics, Gluconeogenesis: pathway regulation and bioenergetics, Glycogen metabolism: degradation, synthesis, regulation and bioenergetics, TCA cycle: pathway, regulation and bioenergetics, Substrate-level phosphorylation, Amphibolic and Anaplerotic reactions, HMP pathway, Glyoxylate pathway, Electron transport chain: Structure and functions of electron carriers of ETC, Oxidative phosphorylation, Energetics of Electron transport chain, electrochemical potential energy calculation, Malate-Aspartate shuttle system.

UNIT – 3 PHOTOSYNTHESIS [7L]

Introduction, Structure of photopigments, Bacterial photosynthesis, Structure of Chloroplast, Photosynthetic apparatus, Photosynthetic reaction centre, Hill reaction, Light reaction, Cyclic and non-cyclic photophosphorylation, CO₂ assimilation reaction, C₄ and CAM pathways, Photorespiration.

UNIT – 4 LIPID METABOLISM [8L]

Digestion, mobilization and transport of fats, Oxidation of saturated fatty acid & its Energetics, Formation of ketone bodies and their oxidation, Biosynthesis of fatty acid: fatty acid synthase complex, biosynthesis of palmitate and its energetics, Biosynthesis of phospholipids and their Energetics, Biosynthesis of cholesterol and its regulation.

UNIT – 5

NITROGEN METABOLISM

[9L]

Overview of amino acid catabolism in mammals: transamination (mechanism of transamination involving PLP to be included), oxidative deamination, Nitrogen excretion, Urea cycle and its energetics, Overview of amino acid biosynthesis: amino acid biosynthetic families.

Biosynthesis of nucleotides: de novo purine nucleotide synthesis (AMP and GMP), de novo pyrimidine nucleotide synthesis (UTP and CTP), biosynthesis of deoxyribose nucleotides (dADP, dGDP, dCDP and dTTP), Regulation of biosynthesis of purine and pyrimidine nucleotides, Recycling of purine and pyrimidine nucleotides by salvage pathway, Catabolism of purine and pyrimidine nucleotides.

TEXT BOOKS:

1. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox, W.H. Freeman and company (5th Ed.)
2. Principles of Biochemistry by Lubert Stryer (Freeman Int. Edition)

REFERENCE BOOKS:

1. Biochemistry by Voet and Voet, Wiley New York
2. Biochemistry by Garrett and Grisham, Thompson Learning
3. Bioenergetics by David.G.Nicolls and Styart J. Ferguson, Academic Press, Elsevier **e-b ooks**
1. https://books.google.co.in/books/about/Bioenergetics.html?id=0_9EWX1fg8wC&redir_esc=y
2. <https://archive.org/details/LehningersPrinciplesOfBiochemistry5e>

MOOCs

1. <https://www.mooc-list.com/course/principles-biochemistry-edx?static=true>
2. <http://nptel.ac.in/syllabus/syllabus.php?subjectId=102101002>

PART B: BIOCHEMISTRY LAB (2hrs/week)

1. Preparation of buffers
2. Colorimetry and Spectrophotometry
3. Estimation of blood sugar by O-toluidine method
4. Estimation of blood sugar by Hegde and Johnson method
5. Estimation of inorganic phosphate by Fiske-Subbarow method
6. Estimation of amino acid by ninhydrin method
7. Estimation of urea by diacetyl monooxime method
8. Estimation of protein by Bradford method
9. Estimation of cholesterol by Zak and Henly's method
10. Estimation of serum creatinine
11. Estimation of serum alkaline phosphatases
12. Estimation of serum transaminases

REFERENCE BOOKS:

1. Lab manual by Faculty
2. An introduction to Practical Biochemistry by David T. Plummer, Tata Mc Graw Hill (3rd Ed.)
3. Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande, I.K. International Pvt. Ltd.

ASSESSMENT:

Continuous Internal Evaluation (CIE): Includes mid-term tests, weekly/fortnightly class tests, homework, assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

CO-PO MAPPING

COs	Description
CO 1	Apply the principles of thermodynamics compute the bioenergetics of metabolic pathways in living systems
CO 2	Analyze the role of key metabolic reactions and intermediary metabolites in the metabolic pathways and their mode of regulation.
CO 3	Design alternative reactions in a pathway to effectively overcome a blockade in a metabolic pathway
CO 4	Design, conduct experiments related to qualitative and quantitative analysis of biomolecules and interpret data
CO 5	to engage in independent learning and work effectively as an individual to carry out literature search effectively ,design , conduct experiments & interpret data and write a technical report (OPE)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2		3											3		
CO3			2										3		
CO4				3									3		
CO5				3					2	2			3		

COURSE TITLE	CELL AND MOLECULAR BIOLOGY												
COURSE CODE	2	2	B	T	4	P	C	C	M	B	Credits	03	3-0-0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)	

COURSE PRE-REQUISITES: Knowledge of basics of cell biology and genetics

COURSE DESCRIPTION: The Molecular biology course focuses on the molecular aspects of the cell and its molecular components especially DNA, RNA and protein. The course deals with the application of the cell structure and its function to the molecular processes. The course relate to all cellular processes involving the genetic material and its output, viz., replication, transcription, translation, DNA repair and Recombination as well as their regulation.

COURSE OBJECTIVES: The graduates having basic knowledge of cell structure, functions and genetics can understand the concepts of molecular process and its regulation and gene and global level. The course thus would provide a background appropriate for applying the knowledge in applied biotechnology such as genetic engineering, genomics, Bioinformatics, Pharmaceutical Biotechnology, diagnostics, and therapeutics.

PART A: THEORY

UNIT - 1 INTRODUCTION TO CELL & REPLICATION OF DNA [12 L]

Structural differences between pro and eukaryotic cell, Nucleus, Chromosome, genome and their packaging in Prokaryotic and eukaryotic cell, Nucleolus and transcription, Chromatin and its relation with transcription regulation, Role of ER in translation and protein maturation, Golgi and its role in PTM, Plasma membrane and signal transduction, cytoskeletal elements and their role in molecular processes . Information flow in biological systems: central dogma and updated central dogma (Retroviral & HIV replication involving reverse transcriptase as a case study). DNA as the genetic material, cell cycle and linking cell cycle with DNA replication and regulation. Experiments related to DNA replication, Replication of DNA in pro and eukaryotes: Basic mechanism including initiation, elongation and termination in Bacteria and Yeast, Inhibitors of replication.

UNIT 2 DNA DAMAGE, REPAIR & RECOMBINATION [6 L]

DNA Damage and its role in carcinogenesis, Mutations, types, mutagens. DNA Repair, various types. Genetic recombination in eukaryotes and prokaryotes, Homologous recombination, Holliday junctions, Site-specific & illegitimate recombination. DNA transposons, retrotransposons, retroviral integration.

UNIT 3 PRO & EUKARYOTIC TRANSCRIPTION [9 L]

Genes structure and their function, RNA polymerases (prokaryotes & eukaryotes), mechanism of transcription in prokaryotes and eukaryotes, general and basal transcription factors, promoters, enhancers, RNA Processing: exons & introns, splicing, spliceosomes, snRNPs, self-splicing introns, capping, polyadenylation, RNA editing, transcription inhibitors.

UNIT 4 PRO & EUKARYOTIC TRANSLATION

[7 L]

Ribosome structure & function, genetic code, Mechanism of translation, activation of amino acid initiation, elongation and termination of protein synthesis. Post and Co-translational modifications, folding and maturation, translocation, Protein Misfolding disorders, inhibitors of translation.

UNIT 5 GENE EXPRESSION AND REGULATION

[5 L]

Gene regulation in mono and polycistronic genes, Operon models: gal, lac, trp; positive versus negative regulation, Chromatin structure & regulation, histone modifiers, coactivators & corepressors, transcriptional control.

PRIMARY REFERENCES

1. Molecular Biology of the Cell, Bruce Alberts Garland Science Pub.
2. Cell and Molecular Biology by Gerald Karp, John Wiley & Sons.
3. Genes VIII/IX/X/XII by Lewin

SECONDARY REFERENCES

1. Cell and Molecular Biology by Lodish, Freeman pub.
2. Molecular Cell Biology by Darnell and Baltimore.

e- books

1. Molecular Biology of the Cell, Bruce Alberts Garland SciencePub

<http://bit.ly/MolBioCell5thPDFFree>

Biology by David Freifelder https://openlibrary.org/authors/OL773152A/David_Freifelder

MOOCs

1. <http://www.nptel.ac.in/courses/102103012/>
2. <https://www.mooc-list.com/tags/biotechnology>
- 3 <http://ocw.mit.edu/courses/biology>

ASSESSMENT: Continuous Internal Evaluation (CIE): Includes mid-term tests, weekly/fortnightly class tests, homework, assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE

Course Outcomes

COs	Description
CO1	Understand the structure and function of bio molecules and their interactions
CO2	Compare & contrast basic molecular processes in prokaryotes & eukaryotes.
CO3	Interpret the outcomes of the knowledge of mutations and genetic recombination.
CO4	Apply the knowledge of molecular mechanisms to disease states and their treatment .
CO5	Demonstrate cellular procedures using research based knowledge and communicate effectively.

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1															
CO2	3												2		
CO3	2														
CO4						2								1	
CO5				2					2	2					

AAT: CO5: Demonstrate cellular procedures using research based knowledge and communicate effectively.

1. Study of mitosis from onion root tips (DNA replication).
2. Study of meiosis from onion flower buds (DNA recombination).
3. Differential staining of blood cells (Distinguishing normal and diseased state of cells)
4. Banding of Polytene chromosomes in Drosophila .(Transcription)

Course Title	BASICS OF COMPUTER APPLICATIONS														
Course Code	2	2	B	T	4	P	C	B	C	A	Credits	04	LTP	3–0– 1	
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PREREQUISITES: Basics of computer concepts.

COURSE DESCRIPTION: This course imparts the knowledge about languages like SQL, PERL, Python, and MATLAB tools and their scope in biotechnology field. Students will be able to write Perl, Python scripts and MATLAB codes which are important in Bioinformatics and other biological science applications.

COURSE OBJECTIVES: The objective of the course is to make graduates comprehend the languages like SQL, PERL, Python, and MATLAB tools and prepare them to work individually and as a team in a multidisciplinary environment.

PART A: THEORY

UNIT – 1 Operating System concepts

[7 L]

Introduction to O.S., types of O.S., O.S services, system calls, system components, system structures, virtual machines. Process Management - Process concept, process scheduling, co-operating processes, inter process communication, concept of threads and multithreading.

UNIX/Linux: Introduction to Linux, basic commands, working with the files, file attributes, pipes, wildcards, working with processes, working with basic editors (vi, emacs). Shell programming, basic decision making statements, basic regular expressions, string search applications using regular expressions.

UNIT – 2 BASICS OF DATABASES

[9 L]

DBMS: Database system-concepts and architecture. RDBMS: concepts, constraints, languages and design, Entity- Relationship model, Microsoft SQL server, introduction to SQL, basic commands, using SQL in MS Access, creating and modifying tables, joining tables, simple queries using SQL, inner join, outer joins, data sorting and filters.

UNIT – 3 PERL

[9 L]

An overview of Perl: Escape sequences, Numerical data types, strings in Perl, Operators, Perl statements: Introduction to statements, Types - Input/output statements, conditional statements, looping, and jumping statements. Lists: Introduction to lists and accessing list values. Arrays:

Initializing array, adding elements to an array, accessing single and multiple elements from an array. Array manipulation functions (pop, push, shift, unshift, splice, sort). Hashes: Introduction to Hashes, creating a hash, working with hashes, adding, changing and accessing

hash values. Regular expressions: Introduction to regular expressions, patterns, metacharacters, modifiers, grouping and alteration. Matching, substitution, translation and binding operators.

Representing Sequence Data, Store a DNA Sequence, Concatenating DNA Fragments, Transcription, Translation, Perl Documentation, Calculating the Reverse Complement in Perl, Reading Proteins in Files, Searching for motifs.

UNIT – 4 PYTHON

[7 L]

Python - Machine learning: Statistics, data distribution, regression, clustering train/test model and prediction.

Modeling and simulation in python: The Modeling Framework, Pharmacokinetics-The minimal model, Glucose and Insulin-model implementation and simulation, solving differential equations, case study.

UNIT – 5 MATLAB

[7 L]

Introduction, Syntax overview, Data types, variables, operators, decision making, loops, arrays, matrix, functions, data I/O exceptions, plotting, graphics.

Introduction to Bioinformatics Toolbox and Simbiology: Construction and simulation of model, Model creation for Kinetics of Receptor-Ligand, Simulation of the Glucose-Insulin Response, Estimate the Bioavailability of a Drug, Data Analysis, Statistics

PART B: Practicals (2 hrs/week)

1. A Program to implement Data Definition language
2. A Program to implementation on Data manipulation language
3. A Program to implement Nested Queries & Join Queries
4. Perl programs for Bioinformatics applications.
5. Python programs on fundamentals.
6. Python programs on machine learning.
7. Python programs on Modeling and simulation
8. MATLAB programming on fundamentals.
9. MATLAB programming on Bioinformatics Toolbox and Simbiology.

TEXT BOOKS:

1. Operating system concept by Silberschatz, Peterhalvin and Greg Gauge, VI edition, John Wiley, 2003.
2. Linux: The complete reference by Richard Peterson, McGraw Hill, 1998.
3. Microsoft SQL Server 2008 For Dummies, Mike Chapple, 2009, John Wiley & Sons Publisher
4. Sandeep Nagar, Introduction to Python for Engineers and Scientists. Open Source Solutions for Numerical Computation-Apress (2018)
5. Rudra Pratap, Getting Started with MatLab A quick introduction for scientists and engineers, Oxford University Press
6. Beginning Perl for Bioinformatics, James Tisdall, Publisher: O'Reilly, First Edition October 2001
7. Perl cook book by O'Reilly & Associates, second edition, 2003.

REFERENCE BOOKS:

1. Learning Perl (III edition) by Tom Christiansen, Jon Orwant, Larry Wall, 2001.
2. SAMS teach SQL yourself in 10 minutes by Ben Forta, 3rd Edition
3. SQL Queries for more mortals: A hands on guide to data manipulation in SQL by Michael J. Hernandez and John L. Viescas (2000).
4. A First course in database systems by Jeffrey D. Ullman and Jennifer D. Widon. (2nd Ed.)

e-books:

1. Fangoh, Introduction to Python for Computational Science and Engineering, Open Source, available on github.
2. www.onlineprogrammingbooks.com/sql/
3. <http://www.freebookcentre.net>
4. <http://www.getfreebooks.com> **MOOCs:**

1. www.edx.org
2. www.w3schools.com
3. www.mooc-list.com

ASSESSMENT:

Continuous Internal Evaluation (CIE): includes mid-term tests, weekly/fortnightly class tests, homework assignments, problem solving, group discussions, quiz, seminar, mini-project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): a written examination for theory courses and practical/design examination with built-in oral part (Viva-Voce). Both CIE and SEE have equal (50:50) weightages. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

COURSE OUTCOMES (COS):

COs	Description
CO1	Comprehend the concept of operating system, DBMS and computer languages.
CO2	Apply the concept of SQL to create and constitute the PERL scripts for various applications.
CO3	Analyze the data using Python and MATLAB and deduce ER diagrams.
CO4	Conduct experiments to create and access the databases, execute the Perl scripts for various biological and allied applications and analyze the datasets using Python and MATLAB.

[illegible]

Course Title	HEAT AND MASS TRANSFER														
Course Code	2	2	B	T	4	P	C	H	M	T	Credits	03	L – T – P	3 – 0 – 0	
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PRE-REQUISITES: Knowledge of Engineering Physics and Mathematics.

COURSE DESCRIPTION: This course provides students with the fundamental knowledge of heat and mass transfer. The course also includes heat and mass transfer problems and description of phase diagrams and experimental equipment.

COURSE OBJECTIVES: The course objective is to provide students with the fundamental knowledge needed to successfully practice the profession of biological engineering using the knowledge of heat and mass transfer. It trains students to design, test, and analyze systems and processes that involve transport phenomena. The course also enables students to formulate and solve heat and mass transfer problems and to use experimental equipment. Students will learn to identify, formulate and solve engineering problems.

PART A: THEORY UNIT – 1 CONDUCTIVE & CONVECTIVE HEAT TRANSFER [9L]

Modes of heat transfer, Conduction - Steady state heat conduction through unilayer and multilayer walls, critical thickness of insulation, Overall & Individual heat transfer co-efficient, LMTD, Forced & natural convection, Basic concepts in unsteady state heat conduction, Heat Transfer equipment - Double pipe heat exchanger, Shell and Tube heat exchanger, Conceptual problems.

UNIT – 2 CONDENSATION AND EVAPORATION [7L]

Condensation - Film wise & drop wise condensation, Evaporation principle, Evaporators - Horizontal tube evaporator, long tube vertical evaporator, Forced circulation evaporators, Single and multiple effect evaporator, Enthalpy balances and Economy of evaporator, Conceptual problems.

UNIT – 3 BASICS OF MASS TRANSFER [8L]

Mass transfer Operations, Diffusion – Types, Steady state diffusion:- Fick's I law, equimolar counter current diffusion, Measurement of diffusivity, Mass transfer coefficients, Conceptual problems, Basic concepts in unsteady state diffusion, Fick's II law, Theories of mass transfer across phase boundaries – two film theory and penetration theory, Analogy between heat and mass transfer using dimensionless numbers.

UNIT – 4 MASS TRANSFER OPERATIONS – I

[10L]

Distillation - Methods of distillation, Distillation of binary mixtures – Raoult's law, McCabe Thiele method, Conceptual problems; Basic concepts in Extraction, Liquid-Liquid extraction - Principle, ternary equilibrium diagram, equilibrium calculations, Aqueous two phase extraction.

UNIT – 5 MASS TRANSFER OPERATIONS – II

[5L]

Absorption- principle; Basic concepts in Adsorption - Nature of adsorbents, Adsorption Isotherms; Drying - Principle of drying, drying rate curve; Crystallization – Principle, stages in crystallization and methods of super saturation; Leaching-principle.

TEXT BOOKS

1. Unit operations in Chemical Engineering by McCabe W.L. and Smith J.C. McGraw Hill.
2. Introduction to chemical Engineering by Badger and Banchero. McGraw Hill.

REFERENCE BOOKS

1. Chemical Engineering-Vols I&II by Coulson and Richardson, Butterworth-heinemann (5th Ed.).
2. Principles of Unit Operations by Foust A.S. Et al, John Wiley & Sons Inc (2nd Ed.).
3. Transfer Processes & Unit Operations by Geankoplis C.J., PHI Publishers (3rd Ed.)
4. Biological and Bioenvironmental Systems Heat and Mass Transfer by Dutta A.K., Technology & Engineering (2002).

e-b ooks

1. Unit operations in Chemical Engineering by McCabe W.L. and Smith J.C. McGraw Hill.
(<http://www.ualberta.ca/~seyedsha/Ebooks/Unit%20Operations%20Of%20Chemical%20Engineering,%205th%20Ed,%20McCabe%20And%20Smith.pdf>)
2. Chemical Engineering-Vols I&II by Coulson and Richardson, Butterworth-heinemann
([http://traininghrd.nigc.ir/files/files/chemist%20book%20cd2/chemical%20eng/RICHARDSON,%20J.%20F.%20\(2002\)2/Coulson_Richardsons_Chemical_Engineering_Volume_2.pdf](http://traininghrd.nigc.ir/files/files/chemist%20book%20cd2/chemical%20eng/RICHARDSON,%20J.%20F.%20(2002)2/Coulson_Richardsons_Chemical_Engineering_Volume_2.pdf))

MOOCs

1. <https://www.edx.org/course/basics-transport-phenomena-delftx-tp101x#!>
2. <http://ocw.mit.edu/courses/chemical-engineering/10-302-transport-processes-fall-2004/index.htm2>.
3. <http://www.nptel.ac.in/syllabus/102106027/>

ASSESSMENT

Continuous Internal Evaluation (CI): Includes mid-term tests, weekly/fortnightly class tests, homework, assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): Includes written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE

COURSE OUTCOMES (COs)

COs	Description
CO1	Comprehend the concepts of modes of heat transfer, heat exchangers, evaporators, insulation, diffusion and separation processes.
CO2	Apply physical laws governing heat transfer and mass transfer in bioprocess operations.
CO3	Identify, interpret and analyse and solve problems based on steady state heat and mass transfer phenomena.
CO4	Work individually to Identify real life problems associated with unit operations in biotechnology or bioprocess, search for solutions, and communicate the findings of the literature study and solution proposed, as oral presentations and report submission.

CO-PO-PSO mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1														1	
CO 2	3													2	
CO 3		3												2	
CO 4									2	2		1		1	

ಬಳಕೆಕನ್ನಡ			
ವಿಷಯ ಸಂಕೇತ (Course Code)	22HS4IC BAK	ನಿರಂತರ ಮೌಲ್ಯ ಆಂತರಿಕ ಮಾಪನ್ ಅಂಕಗಳು	50
ಒಂದು ವಾರಕ್ಕೆ ಬೆ ರೇಧನಾವಧಿ (Teaching Hours / week (L:T:P:S)	1-0-0	ಸೆಮಿಸ್ಟರ್ ಅಂತಯ ಪರೀಕ್ಷೆಗೆ ದ ಯಅಂಕಗಳು	50
ಒಟ್ಟು ಟೈಂ ರೇಧನಾವಧಿ Total Hours of Pedagogy	15 ಗಂಟೆಗಳು	ಒಟ್ಟು ಟಾ ಅಂಕಗಳು	100
ಕೆರೆ ಡಿಟಾ (Credits)	01		
<p style="text-align: center;">:</p> <p>ಬಳಕೆಕನ್ನಡ ಪಠ್ಯ ದಕಲಿಕೆಯುಉದದೇ ರೀ ಶಗಳು</p> <ul style="list-style-type: none"> To create the awareness regarding the necessity of learning local language for comfortable and healthy life. To enable learners to Listen and understand the Kannada language properly. To speak, read and write Kannada language as per requirement and train the learners for correct and polite conservation. 			

ಭೇರಿ ಧನ ಮತ್ತು ಕಲೇ ಕಾ ವೇ ಯ ವೇ ಸ್ಥ ರೀ (Teaching – Learning Process – General Instructions):

These are sample Strategies, which teacher can use to accelerate the attainment of the course outcomes.

1. ಬಳಕೆ ಕನ್ನ ಡವನ್ನ ನ್ ತರಗತಿಯಲ್ಲಿ ಶೆ ಕ್ಷಕರು ಬೆ ರಿ ರೀಧಿಸುಲ್ ವಿಟಿಯು ಸ ಚಿಸಿರುವ ಪಠ್ಯ ಪುಸ್ತಕ ಕವನ್ನ ನ್ ಉಪಯೋಗಿಸಬೇಕೆಂ.

2. ಪೆರಿ ಮುಖ ಅಂಶಗಳ ಚಾಟಿಟ ಗಳನ್ನ ನ್ ತಯಾರಿಸುಲ್ ವಿದಯಯ ಟಟಗಗಳನ್ನ ನ್ ಉತ್ತ

ರಿ ರಿ ರೀಜಿಸುಮೆದು ಮ ತತತರಗತಿಯಲ್ಲಿ ಅವುಗಳನ್ನ ನ್ ಚಚಿಗಸಲ್ಲ ಅವಕಾಶ ಮಾಡಿ ಕೆರಿ ಡುಮೆದು

3. ಪೆರಿ ತಿ ವಿದಯಯ ಟಟಗ ಪುಸ್ತಕ ಕವನ್ನ ನ್ ತರಗತಿಯಲ್ಲಿ ಬಳಸೆಂವಂತೆ ನೆ ರಿ ರೀಡಿಕ್ಕೆ ಳುರಿ ರೀಂ

ಮೆದುಮತತ ಪೆರಿ ತಿಪಾರ್ತತತಪೆರಿ ವಚನ್ನಳ ಮಲ್ ಅಂಶಗಳಿಗೆ ಸಂಬಂಧ ಪಟಟಟ್ ಪೆರಕ ಚಟಟ ವಟಿಕೆಗಳಿಗೆ ತೆ ಡರಸತಕೆ ದುರಿ ರೀಂ .

4. ಡಿಜಿ ಟಟ ಲ್ ತಂತೆ ಜಿಇಸಾ ನ್ ದ ಮುಖಂತರ ಇತಿತ ರಿ ರಿ ರೀಚೆಗೆ ಡಿಜಿ ಟಟ ಲ್ ಲೇಕರಣ ಗಂಡಿರುವ

ಭಾಷೆಕಲ್ ಕೆಯವಿಧಾನ್ನಗಳನ್ನ ನ್ನಿಪಿಟಿದ್ಯಶಯಮಾಧಯಮದಮುಖಂತರಚುಚೆ ಗಸಲ್ಲ ಕೆರಿ ಮ ಕೆರಿ ಗಳುರಿ ರೀಂ ಮೆದು ಇದರಿಂದ ವಿದಯಯ ಟಟಗಗಳನ್ನ ನ್ ತರಗತಿಯಲ್ಲಿ ಹೆರಿ ಚುರಿ ರೀಂ

ಏಕಾಗೆ ತಯಂದ ಪಾರ್ ಕೆ ರೀಳಲ್ರಿಂ ಮತ ತಅಧಯ ಯನ್ನ ಲ್ಲಿ ತೆ ಡಗಲ್ರಿಂ ಅನ್ನ ಕ ಲಇಗೇಂತತ ದೆ

5. ಭಾಷಾಕಲ್ ಕೆಯ ಪೆ ಯೇಗಾಲ್ಯ ದ ಮುಖಂತರ ಬಹುಬೆ ರೀಗ ಕನ್ನ ಡ ಭಾಷೆಯನ್ನ ನ್ ಕಲ್ ಯಲ್ರಿಂ

ಅನ್ನ ಕ ಲಇಗೇಂವಂತೆ ಕಾಯಗಚಟಟ ವಟಿಕೆಗಳನ್ನ ನ್ನತತ ರಿ ರಿ ಕರ ಯಾಯೇಜನೆಗಳನ್ನ ನ್ನ ಪಿಸುವುದು

UNIT – 1

2 Hours

1. Introduction, Necessity of learning a local language. Methods to learn the Kannada language.
2. Easy learning of a Kannada Language: A few tips. Hints for correct and polite conversation, Listening and Speaking Activities.
3. Key to Transcription.

4. ವಯ ಯತಕರ ಕ, ಸಾರಿ ರಿಜಾ ಮಯ ಸ ಚಕ / ಸಂಬಂಧಿತ ಸಾಗನಾವಮಳು ಗ ಮತ ತ ಪೆ ಶನ್ನ್
ಗಟಕ ಪದಗಳು - **Personal Pronouns, Possessive Forms,**

Interrogative words

ಭೆ ರಿ ರೀದನೆ ಮತತ ಕಲ್ ಕಾವಿಧಾನ್	ಪುಸತ ಕ ಆಧಾರಿತ ಬಲ್ಲ ಕ್ಕೆ ರಿ ರೀಡಟಗ ವಿಧಾನ್ ಪೆ ಮುಖಾಂಶಗಳ ಚಾಟ್ ಸಗಗಳನ್ನ ನ್ನಳಸೆಮೆದು, ಪಿಪಿಟಿ ಮತತ ದೃಶಯ ಮಾಧಯ ಮದ ವಿ ರಿ ರೀಡಿಯೇಗಳನ್ನ ನ್ ಬಳಸೆಮೆದು, ವಿದಯಯ ಟಟಗಗಳಂಗೆ ಚಟಟ ವಟಿಕೆಗಳಮುಕಾಂತರಚಚಿಸುವುದು
---------------------------------	--

UNIT – 2

3 Hours

1. ಗುಣ, ಪರಿಮಾಣ ಮತ ತ ವಣಗ ಬಣಣ ವಿಶೆ ರೀಷಣಗಳು, ಸೆಂಖಯ ವಾಚಕಗಳು
Qualitative,
quantitative and colour
adjectives, numerals.
2. ಕಾರಕ ರ ಪಗಳು ಮತತ ವಿಭತಕರ ಪೆ ತಯ ಯಗಳು - ಸಪ ತ ಮಿ ವಿಭತಕರ ಪೆ ತಯ ಯಗಳು
(ಅ, ಅದೆ, ಅವೆ, ಅಲ್ ರೆಲ್) prediticite forms, locative case.

ಭೆ ರಿ ರೀದನೆ ಮತತ ಕಲ್ ಕೆಜಾ ವಿಧಾನ್	ಪುಸತ ಕ ಆಧಾರಿತ ಬಲ್ಲ ಕ್ ಬೆ ರಿ ರೀಡಟಗ ವಿಧಾನ್ , ಪೆ ಮುಖ ಅಂಶಗಳಚಾಟ್ ಗಗಳನ್ನ ನ್ ಬಳಸುವುದು ಪಿಟಿ ಮತ ತದೃಶಯ ಮಾಧಯ ಮದ ವಿ ರಿ ರೀಡಿಯೇಗಳನ್ನ ನ್ ಬಳಸುವುದು ವಿದಯಯಟಟಗಗಳಂಗೆ ಚಟಟ ವಟಿಕೆಗಳ
------------------------------------	---

	ಮುಕಾರಿ ರಿಂತರಚಚಿಗಸುವುದು
UNIT – 3	3 Hours
1. ಚತತ ಟಟಗ ವಿಭತಕರ ಪೆ ತಯ ಯದ ಬಳಕೆ ಮತತ ಸೆಂಖಯ ವಾಚಕಗಳು – Dative cases, and numerals. 2. ಸೆಂಖಯ ವಾಚಕಗಳು ಮತ ತ ಬಹುವಚನ್ ನಾಮರ ಪಗಳು – Ordinal numerals and Plural markers.	
ಭೆ ರಿ ರೀದನೆಮತತ ಕಲರಿ ಕೆಇವಿಧಾನ	ಪುಸತ ಕ ಆಧಾರಿತ ಬಲ್ಲ ಕ್ ಬೆ ರಿ ರೀಡಟಗ ವಿಧಾನ , ಪೆ ಮುಖ ಅಂಶಗಳ ಚಾಟರಿ ಗಗಳನ್ನ ನ ಬಳಸುವುದು ಪಿಟಿ ಮತತದ್ಯಶಯ ಮಾಧಯ ಮದ ವಿ ರಿ ರೀಡಿಯೇಗಳನ್ನ ನ ಬಳಸುವುದು ಠ ವಿದಯಯಟಟಗಗಳಂ ಗೆ ಚಟಟ ವಟಿಕೆಗಳ ಮುಕಾರಿ ರಿಂತರಚಚಿಗಸುವುದು

UNIT – 4	3 Hours
-----------------	----------------

1. ಅಪಪ ಣೆ / ಒಪಿಪ ಗೆ, ನರಿ ದಟಗಶನರಿ , ಪಾರಿ ರಿ ರಿ ರೀತರಿ ಹ ಮತ ತ ಒತತ ಯ ಅರ ಗರ ಪ ಪದಗಳು ಮತತ ವಾಕಯ ಗಳು.Permission, Commands, encouraging and Urging words (Imperative words and sentences)	
2. "ಇರು ಮತತ ಇರಲರಿ " ಸಾಇಾಯಕ ರಿ ರಿ ಕರ ಯಾಪದಗಳು, ಸೆಂಭಾವಯ ಸ ಚಕ ಮತತ ನರಿ ಪೆ ರೀಧಾನಗಟಕ ಕೆರ ಯಾ ಪದಗಳು. – Helping verbs “iru and iralla”, corresponding Future and negation verbs.	

<p>ಭೆರಿರೆದನೆಮತತ ಕಲ್ರಿ ಕೆಇ</p> <p>ವಿಧಇನಾ</p>	<p>ಪುಸತ ಕ ಆಧಇರಿತ ಬಲ್ಲ ಕ ಬೆರಿರೆಡಟಗ ವಿಧಇನಾ , ಪೆರಿ ಮುಖ</p> <p>ಅಂಶಗಲ ಚಾಟ್ರಿ ಗ ಗಲನ್ನ ನಾ ಬಲಸೆಂಮೆದು</p> <p>ಪಿಪಿಟಿಮತತ ದೃಶಯಮಾಧಯಮದವಿರಿ</p> <p>ರಿರೆಡಿಯೆಗಲನ್ನ ನಾ ಬಲಸುವುದು ವಿದಯಯ ಲಿ</p> <p>ಟಟಗಗಲಂ ಗೆ ಚಟಟ ವಟಿಕೆಗಲ</p> <p>. ಮುಕಾರಿ ಂಂತರಚಚಿಗಸುವುದು</p>
---	--

UNIT – 5	4 Hours
-----------------	----------------

<p>1. ಕನಾಗಟಟ ಕ ರಇಜಯ ಮತ ತ ರಇಜಯ ದ ಬಗೆರಿ ಕುರ ತದ ಇತರ ಮಾಹಿತಿಗಲ.</p> <p>Karnataka State and General Information about the State.</p>
<p>2. ಕನ್ನ ಡ ಭಾಷೆ ಮತತ ಸಾಹಿತಯ . Kannada Language and History.</p>
<p>3. Kannada Language Script Part – 1</p>

<p>ಭೆರಿರೆದನೆಮತತ ಕಲ್ರಿ ಕೆಇ</p> <p>ವಿಧಇನಾ</p>	<p>ಪುಸತ ಕ ಆಧಇರಿತ ಬಲ್ಲ ಕ ಬೆರಿರೆಡಟಗ ವಿಧಇನಾ ಪೆರಿ ಮುಖ ಅಂಶಗಲ ಚಾಟ್ರಿ ಗ ಗಲನ್ನ ನಾ ಬಲಸೆಂಮೆದು</p> <p>ಪಿಪಿಟಿ ಮತತ ದೃಶಯ ಮಾಧಯ ಮದ ವಿರಿ</p> <p>ರಿರೆಡಿಯೆಗಲನ್ನ ನಾ ಬಲಸುವುದು ವಿದಯಯ ಲಿ</p> <p>ಟಟಗಗಲಂ ಗೆ ಚಟಟ ವಟಿಕೆಗಲ</p> <p>. ಮುಕಾರಿ ಂಂತರಚಚಿಗಸುವುದು</p>
---	---

<p>ಬಲಕೇರಿ ಕನ್ನನ ಡಕಲೇ ಕೇರಿ ಯಿಂದವೇ ದಯಯ ಧಿಗಲಿಗೇರಿ ಆಗ ವಾ ಅನ್ನೇ ಕೇ ಲಗಲ</p> <p>: ಮತ್ತ ಫಲಿತ ರೀ ರೀಂಶಗಲ course Outcomes (Course Skill Set)</p> <p>At the end of the Course, The Students will be able:</p> <ol style="list-style-type: none"> 1. To understand the necessity of learning of local language for comfortable life. 2. To Listen and understand the Kannada language properly. 3. To speak, read and write Kannada language as per requirement. 4. To communicate (converse) in Kannada language in their daily life with kannada speakers. 5. To speak in polite conversation.
--

Assessment Details – (both CIE and SEE) :

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together Continuous Internal Evaluation:

Three Tests each of 20 Marks (duration 01 hour)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of 10 Marks : 1. First assignment at the end of 4th week of the semester

7. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks (duration 01 hours)

8. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course. The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks **CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per**

the outcome defined for the course.

ಸ್ತಮಿಸ್ವ ರಾ ಅ ರೀ ರೀಂತ ಯ ದ ಪರಾ ಕೆರಿಯು ಈ ಕೆಳಗಿನಂತ ರುತರೀರಿದಾ - - Semester End Exam (SEE):

SEE Pattern will be in MCQ Model for 25 marks and 25 marks for descriptive model. Duration of the exam is 02 Hours.

ಪರಾಯ ಪುಸ್ತಕೀ ಕ : ಬಳಕೆ ಕನ್ನಡ

Course outcomes (Course Skills Set)

After successfully completing the course, the student will be able to understand the topics:

Course Code	CO	COURSE OUTCOME (CO)	PO
22HS3ICBAK 22HS44CBA K	CO 1	To create an awareness regarding the necessity of learning local language for a comfortable living and to know more about Kannada culture and literature.	PO10
	CO 2	To develop proper speaking, reading and writing skills in kannada.	PO10
	CO 3	To engage as a member of a team and enhance the skill in group communication and presentation.	PO9

ಸಾಂಸ್ಕೃತಿಕ
ತಿಕಕನ್ನಡ

ವಿಷಯ ಸಂಕೇತ (Course Code)	22HS3ICSAK 22HS4ICSAK	ನಿರಂತರಆಂತರಿಕ ಮೌಲ್ಯ ಮಾಪನ್. ಅಂಕಗಳು	50
ಒಂದುವಾರಕ್ಕೆ ರೀತಿ ರೀತಿ ಅವಧಿ (Teaching Hours / week (L:T:P:S)	1-0-0	ಸೆಮಿಸ್ಟರ್ ಅಂತರ ಪರಿಶೀಲನೆ ಅಂಕಗಳು	50
ಒಟ್ಟು ಟೀಚಿಂಗ್ ಅವಧಿ Total Hours of Pedagogy	12 ಗಂಟೆಗಳು	ಒಟ್ಟು ಟೀಚಿಂಗ್ ಅಂಕಗಳು	100
ಕೆರೆಡಿಟ್ (Credits)	01		

ಸಾಂಸ್ಕೃತಿಕ ತಿಕಕನ್ನಡ ಪಠ್ಯಕ್ರಮದ ಕೆಳಕಂಡಂತಿವೆ

1. ವ್ಯಕ್ತಿತ್ವ ಪರ ಪದವಿ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಸಾಹಿತ್ಯ ಮತ್ತು ತಿಕಕನ್ನಡದ ಸಂಸ್ಕೃತಿಕ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
2. ಕನ್ನಡ ಸಾಹಿತ್ಯದ ಪರಿಚಯ ಭಾಗವಾದ ಆಧುನಿಕ ಪದ್ಯ ಮತ್ತು ಆಧುನಿಕ ಕವಿತೆಯ ಸಾಂಸ್ಕೃತಿಕವಾಗಿ ಪರಿಚಯಿಸಿ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಸಾಹಿತ್ಯ ಮತ್ತು ತಿಕಕನ್ನಡದ ಸಂಸ್ಕೃತಿಕ ಬಗೆಯನ್ನು ಅರಿವುಹಾಗೂ ಆಸಕ್ತಿ ಹೆಚ್ಚಿಸುವುದು.
3. ತಿಕಕನ್ನಡದ ಕವಯಿತ್ರಿಗಳ ಪರಿಚಯವನ್ನು ಹಾಗೂ ಅವುಗಳ ಸಾಂಸ್ಕೃತಿಕ ವಿಷಯಗಳನ್ನು ಪರಿಚಯಿಸುವುದು ಕನ್ನಡಶಾಸ್ತ್ರದ ಸಂಪತ್ತನ್ನು ಪರಿಚಯಿಸುವುದು.

ಘಟಕ - 2	4 Hours
<p>ಆಧ್ಯ ಕಪೂರ್ವಾಃ : ದಕಾವಯಭಾಗ</p> <p>3. ವಚನಗಳು : ಬಸಾ ಣ, ಅಕೆ ಮಹಾದಟವಿ, ಅಲ್ ರೆ ಮಪೆ ಭು, ಜೆ ರೆಡರದಯಸಿಮಯಯ, ಆಯು ಕೆರ ಲ್ಲೆ ಓಮ .</p> <p>4. ಕೆ ರೇತಗನಾಂ ರಿ ಗಳ ಪುರಂದರದಯ ಸುರತಲ್ ರಿ ಅದರಿಂದಟನ್ನ ಫಲ್ ಇದರಿಂದಟನ್ನ ಫಲ್</p> <p>ಠ - ತ್ತು ಮನೆಇ</p> <p>ಣಿಸ್ ರುಕಂಡಯ ರಿ ಕನಾಂ ದಯಸುರ</p>	
<p>ಭೆ ರಿ ರೇದನೆ ಮತತ ಕಲ್ ರಿ ಕಾ ವಿಧಾನ್</p>	<p>ಪುಸತ ಕ ಆಧ್ಯಾರಿತ ಬಲ್ಲ ಕ್ ಬೆ ರಿ ರೇಡಟಗ ವಿಧ್ಯಾನ್ , ಪೆರಿ ಮುಖ ಅಂಶಗಳ ಚಾಟ್ ರಿ ಗಳನ್ನ ನ್</p> <p>ಬಳಸೆಂಮೆದು ಪಿಪಟಟ್ ಮತ ತ ದೃಶಯ ಮಜಾಧಯ ಮದ ವಿರಿ ರಿ ರೇಡಿಯೇಗಳನ್ನ ನ್</p> <p>ಠ</p> <p>ಬಳಸೆಂಮೆದು ವಿದಯಯ ಟಟಗಗಳಂ ಗೆಚಟಟ ವಟಿಕೆಗಳಮುಕಾಂತರಚಚಿಗಸುವುದು .</p>
ಘಟಕ - 3	3 Hours
<p>ಆಧ್ಯ ನಿಕಕಾವಯ ಭಾಗ</p> <p>3. ಕುರುಡು ಕಾಂಚಾ ಣ : ದಯ. ರಾ. ಬೆ ರೆಂಂದೆ ರಿ .</p> <p>4. ಹೆರಿ ಸಬಲ್ಮಿನ್ R ರಿ ರಿ ರಿ ರೇತ್ ಕೆಂವಂಪು</p>	
<p>ಭೆ ರಿ ರೇದನೆ ಮತತ ಕಲ್ ರಿ ಕಾ ವಿಧಾನ್</p>	<p>ಪುಸತ ಕ ಆಧ್ಯಾರಿತ ಬಲ್ಲ ಕ್ ಬೆ ರಿ ರೇಡಟಗ ವಿಧ್ಯಾನ್ , ಪೆರಿ ಮುಖ ಅಂಶಗಳ ಚಾಟ್ ರಿ ಗಳನ್ನ ನ್</p> <p>ಬಳಸೆಂಮೆದು ಪಿಪಟಟ್ ಮತ ತ ದೃಶಯ ಮಜಾಧಯ ಮದ ವಿರಿ ರಿ ರೇಡಿಯೇಗಳನ್ನ ನ್</p> <p>ಠ</p> <p>ಬಳಸೆಂಮೆದು ವಿದಯಯ ಟಟಗಗಳಂ ಗೆಚಟಟ ವಟಿಕೆಗಳಮುಕಾಂತರಚಚಿಗಸುವುದು .</p>
ಘಟಕ - 4	3 Hours
<p>ತ ರೀ ರೀಂಂತ ಕವೇ</p> <p>ಡಾ. ಸೆ. ಎಂಂ. ವಿಶ್ವಾಂ</p> <p>ಎ ಎನ್ ಮ ತಿಗ</p> <p>ರಿ ರೇರಲ್ ರಿ ಂಗಯಯ</p> <p>ರು ಕತೇ ಗಳಪರಚಯ ಕಥೇರೇ ಮತ್ತ ಪೇ ವಾಸಾಃ ಕಥನ್ನ</p> <p>ಇಂ ರಿ ರಿ ರೇಶೆ ಇ ರಯಯ : ವಯ ತಕರ ಮತತ ಐತಿಹಯ -</p> <p>ರಿ ವ್ ಮಾಗನಾಂ ರಿ ಎಂಬ R ರಿ ಜನ್ ಪವಗತ : ಹಿ. ಚಿ. ಬೆ</p>	

ಭೇದಿಸಿದನೆ ಮತತ ಕಲೆ ಕಾ ವಿಧಾನ	ಪುಸತ ಕ ಆಧಾರಿತ ಬಲ್ಲ ಕ ಬೇರೇಡಟಗ ವಿಧಾನ , ಪೆ ಮುಖ ಅಂಶಗಳ ಚಾಟೆ ಗ ಗಳನ್ನ ನ ಬಳಸೆಂಮೆದು ಪಿಪಟಟ್ ಮತ ತ ದೃಶಯ ಮೂಧಯ ಮದ ವಿ ರೇಡಿಯೇಗಳನ್ನ ನ ಬಳಸೆಂಮೆದು ವಿದಯಯ ಟಟಗಗಳಂ ಗೆಚಟಟ ವಟಿಕೆಗಳಮುಕಾಂತರಚಚಿಗಸುವುದು
ಘಟಕ - 5	2 Hours

ವೇ ಜ್ಞ ನ್ನ ಮತ್ತ ತೇ ರೀಂತ್
: - ಜ್ಞ ನ್ನೇ
ಕನ್ನ ಡ ಕಂಪೂಯ
ಟಟ ಶಬೇಂಕೆ ರೇ ರೇಶ

ಭೇದಿಸಿದನೆ ಮತತ ಕಲೆ ಕಾ ವಿಧಾನ	ಪುಸತ ಕ ಆಧಾರಿತ ಬಲ್ಲ ಕ ಬೇರೇಡಟಗ ವಿಧಾನ , ಪೆ ಮುಖ ಅಂಶಗಳ ಚಾಟೆ ಗ ಗಳನ್ನ ನ ಬಳಸೆಂಮೆದು ಪಿಪಟಟ್ ಮತ ತ ದೃಶಯ ಮೂಧಯ ಮದ ವಿ ರೇಡಿಯೇಗಳನ್ನ ನ ಬಳಸೆಂಮೆದು ವಿದಯಯ ಟಟಗಗಳಂ ಗೆಚಟಟ ವಟಿಕೆಗಳಮುಕಾಂತರಚಚಿಗಸುವುದು
----------------------------------	---

- ಸೇರಿಕೆ ರೀತಿಕೇ ರೀಂಸ್ಕ ರೀತ ತ ಕ ಕನ್ನ ಡ ಕಲ್ ಕೆಯ ರೀತಿಕೇ ರೀಂಂದ ವಾ ದಯಯ ಧಿಗಳಿಗ
ಆಗುವ ಪರಣಾಮಗಳು (course Outcomes):**
1. ಕನ್ನ ಡ ಭಾಷೆ , ಸವಹಿತಯ ಮತತ ತ ಕನ್ನ ಡ ಸೇ ಸೇ ರೀ ತಿಯ ಪರಿಚಯವಾಗ್ ತ್ತ ದೇ .
 2. ಕನ್ನ ಡ ಸವಹಿತಯ ದ ಆಧುನ್ ಕ ಪೂರ್ ಮತತ ತ ಆಧುನ್ ಕ ಕಾವಯ ಗಳು ಮತತ ತ ಸೇ ಸೇ ರೀ ತಿಯ ಬಗ್ಗೆ ಆಸಕ ರತ್ ಮೂಡುತ್ತ ದೇ .
 3. ತೇ ತಿ ಕ ವಯ ಕರತ್ ಗಳ ಪರಿಚಯವಾಗ್ ತ್ತ ದೇ .
 4. ಕನ್ನ ಡ ಭಾಷಾಭಾಯ ಸೇ , ಸವಮಾನ್ ಯ ಕನ್ನ ಡ ಹಾಗು ಆಡಳಿತ ಕನ್ನ ಡದ ಪದಗಳ ಪರಿಚಯವಾಗ್ ತ್ತ ದೇ .

ಮೌಲಯ ಮಾಪನ್ನ ವಿಧಾನ್ನ (Assessment Details – both CIE and SEE) :

(methods of CIE - MCQ, Quizzes, Open book test, Seminar or micro project)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The student has to obtain a minimum of 40% marks individually both in CIE and 35% marks in SEE to pass. Theory Semester End Exam (SEE) is conducted for 50 marks (01 hour duration). Based on this grading will be awarded.

Continuous Internal Evaluation:

Three Tests each of 20 Marks (duration 01 hour)

a) First test at the end of 5th week of the semester

b) Second test at the end of the 10th week of the semester

c) Third test at the end of the 15th week of the semester Two assignments each of 10 Marks :

1 First assignment at the end of 4th week of the semester

2 Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

3 At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to **50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

ಸ್ವ ಮಿಸ್ವ ರಾ ಅ ರೀ ರೀತಿಂತ್ ರೀ ಯ ದ ಪರೇ ರೀ ಕೆ ರೀ ಯ ಈ ಕೆಳಗಿನ್ನೇ ರೀತಿಂತ್ ರೀ ರ ತ ರೀ ದಾ -
- Semester End Exam (SEE):

SEE Pattern will be in MCQ Model for 25 marks and 25 marks for descriptive model. Duration of the exam is 02 Hours.

ಪರಾ ರೀ ಯ ಪುಸಾ ರೀ ಕ

: ಸಾಂಸಾ ರೀ ರೀ ರೀ ತಿಕ ಕನ್ನ

ಡ

ಡಾ ಹೆ ಚಿ ಬೆ ರೀ ರೀ ರಲ್ ರೀ ಂಗಯಯಮತತ ಡಾ ಎಲ್ ತಿಮ ಮೆ ರೀ ರೀ ರೀ ಶ

ರೀ ರೀ ಶೆ ಇ ರಯಯ ತಾ ರೀ ರೀ ರೀ ರೀ ಕವಿಶೆ ಇ ವ ದಯಯಲ್ಯ ಬೆಳಗಾವ

Course outcomes (Course Skills Set)

After successfully completing the course, the student will be able to understand the topics:

Course Code	CO	COURSE OUTCOME (CO)	PO
	CO 1	To create an awareness regarding the necessity of learning local language for a comfortable living and to know more about Kannada culture and literature.	PO10

22HS3ICBAK 22HS44CBAK	CO 2	To develop proper speaking, reading and writing skills in kannada.	PO10
	CO 3	To engage as a member of a team and enhance the skill in group communication and presentation.	PO9



Scheme & Syllabus for
V & VI Semester
Under 160 credits
A.Y. 2021-22 onwards



DEPARTMENT OF BIOTECHNOLOGY

V Semester

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PC-9	22BT5PCREN	Reaction Engineering	2	1	0	3	4
PC-10	22BT5PCGEN	Genetic Engineering	3	0	1	4	5
PC-11	22BT5PCBIN	Bioinformatics	2	1	1	4	6
PC-12	22BT5PCBAT	Bioanalytical Techniques	2	1	1	4	6
PC-13	22BT5PCIMM	Immunotechnology	3	0	0	3	3
PE-1	22BT5PEPE-1	Professional Elective -1	3	0	0	3	3
PW-1	22BT5PCPW-1	Project -1	0	0	1	1	2
NCMC-3	22XX5NCINL	<i>Indian Literature (or any other)</i>				PP/NP	
		<i>Details of 40 AICTE Activity Points</i>					
TOTAL:-			15	3	4	22	29

Professional Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-1	22BT5PEMTE	Metabolic Engineering	3	0	0	3	3
PE-1	22BT5PESTN	Signal Transduction	3	0	0	3	3
PE-1	22BT5PEMBT	<i>Microbial BT</i>	3	0	0	3	3
PE-1	22BT5PEFMB	Food Microbiology	3	0	0	3	3
PE-1	22BT5PEVCI	Vaccines and cancer immunotherapy	3	0	0	3	3



DEPARTMENT OF BIOTECHNOLOGY

Course Title	REACTION ENGINEERING														
Course Code	2	2	B	T	5	P	C	R	E	N	Credits	03	L – T – P	2 – 1 – 0	
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PRE-REQUISITES: Microbiology, Process Engineering Thermodynamics and Process Principles and Calculations.

COURSE DESCRIPTION: This course deals with the study of ideal and non-ideal bioreactors. The course also gives an insight into the concepts behind ideal chemically reacting systems represented by batch, continuous stirred tank reactors and plug-flow reactor and elementary steps involved to yield a reaction rate expression. It emphasizes on models for dealing with non-ideal flow reactors and the use of residence time distributions to predict the performance of reactions. It also describes the methods to predict yield coefficients using stoichiometric principles and energetics of microbial growth.

COURSE OBJECTIVES: The course objective is to enable students to differentiate between various reactors. Students will be able to understand the performance of ideal and non-ideal reactors by making use of design equations and various models. Students will also know about the criteria for scale-up of bioreactors and factors on which selection of bioreactors depends. On completion of the course, students will be able to determine yield coefficients using microbial growth kinetics.

PART A: THEORY UNIT 1

REACTION KINETICS

[5L+3L]

Law of mass action and rate equation, definitions and examples of elementary and non-elementary reactions, theories of reaction rate and temperature dependency, analysis of experimental reactor data: evaluation of rate equation, half-life method, integral and differential analysis for constant volume system. Conceptual numericals.

UNIT 2

IDEAL BIOREACTORS

[6L+3L]

Design equations for homogeneous system: batch, stirred tank and tubular flow reactor, size comparison of reactor systems, combination reactor systems, recycle reactors. Conceptual numericals.]

UNIT 3

NON-IDEAL BIOREACTORS

[6L+2T]

Non-ideal reactors: residence time distribution studies, pulse and step input response of reactors, RTD's for CSTR and PFR, calculations of conversions for First order reactions, One parameter models - tanks in series and dispersion models. Zero Parameter Models, Conceptual numericals



DEPARTMENT OF BIOTECHNOLOGY

UNIT 4

KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION

[3L+2T]

Phases of cell growth in batch cultures; simple unstructured kinetic models for microbial growth - Monod model; Growth associated and non-growth associated product formation kinetics; Leudeking-Piret models; substrate and product inhibition on cell growth and product formation; Continuous culture; Conceptual numericals.

UNIT 5

DESIGN AND ANALYSIS OF BIOREACTORS

[7L+2T]

Stability and analysis of bioreactors, biomass production and effect of dilution rate. Design and operation of various bioreactors, eg. CSTF, fedbatch systems, airlift bioreactors, fluidized bed reactors, scale up of bioreactors - Scale-up and Scale-down of bioreactors - strategies and methods for scale-up, similarity criteria, Hubbard method, method of Wang et al., Ettler's method, dimensionless numbers and scale up, scale up based on aeration and power requirement (Aeration and Power number), regime analysis and the scale-down bioreactor, criteria for selection of bioreactors.

TEXT BOOKS

1. Chemical Reaction Engineering by Levenspiel O., John Wiley, Third Edition, 2006.
2. Elements of Chemical Reaction Engineering by Fogler, H.S., Prentice Hall, 1986.
3. Bioprocess Engineering by Shuler and Kargi, Prentice Hall, Second Edition, 2005.

REFERENCE BOOKS

1. Bioprocess Engineering by Aiba, Humphrey & Millis, Academic Press, Second Edition, 1973
2. Biochemical Engineering by James Lee, Prentice Hall, 1992.
3. Biochemical Engineering Fundamentals by Bailey and Ollis, McGraw Hill, Second Edition, 1986.
4. Bioprocess Engineering Principles by Pauline M. Doran, Academic Press, 1995.

COURSE OUTCOMES (COs)

1. Select bioreactor for a given criteria and describe scale-up process.
2. Apply kinetics equations using different methods to determine chemical and biochemical reaction rates and residence time distributions in reactors. (PO1)
3. Identify, interpret and Analyse design equations for different reactors at steady state and solve reactor engineering, scale-up and microbial kinetics problems. (PO2)
4. Comprehend research articles based on reaction kinetics and individually interpret the methods and results. (PO9, PO10)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	GENETIC ENGINEERING										Credits	4		
Course Code	2	2	B	T	5	P	C	G	E	N	L - T - P	3	0	1

COURSE PRE-REQUISITES: Cell & molecular biology, Biochemistry, Basics of Biomolecules, Microbiology.

COURSE DESCRIPTION: The course describes various tools and techniques available for detection, isolation, amplification and manipulation of genes. The course deals with the biological, chemical and physical gene transfer methods as well as factors influencing gene expression. The course concludes with the applications of genetic engineering in production of GMOs.

COURSE OBJECTIVES: To impart in depth knowledge on strategies of gene cloning and its applications as well as giving hands on experience in gene manipulation.

PART A– THEORY

UNIT – 1

MOLECULAR TOOLS FOR GENE CLONING

[6L]

Scope and objectives of gene cloning, Method of creating recombinant DNA molecules; Enzymes for gene manipulation: Nucleases (exo- and endonucleases, RNAses), polymerases (DNA and RNA polymerases, reverse transcriptases), Ligases, Restriction enzymes, Modifying enzymes: Alkaline phosphatases, polynucleotide kinases, terminal transferases. Methylases: CpG Methylase, Dam Methylase, Dcm Methylase. Linkers and adaptors.

UNIT - 2

VECTORS FOR GENE CLONING

[10L]

Purpose, rationale of construction, cloning vectors: bacterial (plasmids, bacteriophages, cosmids, phagemids), yeast (yEPs, yIPs, yRPs, YACs), Shuttle vectors, viral vectors (retro and adeno), Plant vectors (Ti and Ri plasmids) and expression vectors (bacterial, animal cell and plant), Heterologous gene expression: strong and weak promoters, regulators. Factors influencing translational efficiency- RB sites, SD sequences, codon optimization, host cell biology in folding, solubility and post translational modification compatibilities.



DEPARTMENT OF BIOTECHNOLOGY

UNIT – 3

TECHNIQUES FOR NUCLEIC ACID ISOLATION, DETECTION, LABELING, AMPLIFICATION

[10L]

Isolation and purification of nucleic acids (genomic/plasmid/phage DNA and RNA), Polymerase chain reaction (PCR) variants and applications, Nucleic acid detection: Labeling (DNA and RNA by radio- and fluorescent methods), Southern blotting, northern blotting, Southwestern blotting and western blotting. Nucleic acid mutagenesis in vivo and in vitro, Construction of cDNA library, Construction of Genomic library, Screening of DNA libraries: Sequence-dependent screening (colony and plaque hybridization) and immunological screening.

UNIT - 4

GENE TRANSFER TECHNIQUES

[6L]

Biological methods: Bactofection and Transduction. Chemical methods: Calcium phosphate, DEAE dextran, Cationic Lipid and poly-L-lysine (PLL). Physical: Electroporation, Microinjection, Particle Bombardment, Sonoporation, Laser induced. Biological: Agrobacterium mediated gene transfer in plants (Ti & Ri plasmids), Chloroplast transformation: Vector design and applications.

UNIT - 5

APPLICATIONS

[7L]

Plants: Herbicide, pest and stress resistant plants, improvement of nutritional quality and Increase in shelf life, methods of producing transgenic animals (mice) and their uses. Gene therapy- types of gene therapy, gene therapy for SCID and cancer, Animal cloning. Gene targeting, RNAi technology, Genome editing: CRISPR technology.

PRIMARY REFERENCES

1. Introduction to Genetic Engineering by Nicholl. Cambridge Low Price Edition.
2. Principles of Gene Manipulation and Genomics by S.B. Primrose and R.M. Twyman, 7th edition
3. Gene Cloning and DNA Analysis: An Introduction 6th Edition by T. A. Brown. Blackwel Publications
4. Molecular cloning:a laboratory manual by Green and sambrook
5. Current protocols in Molecular biology by Frederic Ausubel

SECONDARY REFERENCES

1. From Genetics to Gene Therapy – the molecular pathology of human disease by David S Latchman, BIOS scientific publishers, 1994.
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Glick, B R, Pasternak .J J, 2003, Third edition, DC ASM Press.



DEPARTMENT OF BIOTECHNOLOGY

e- BOOKS

1. Molecular Biology of the Cell. 4th edition. Alberts B, Johnson A, Lewis J, et al. New York: Garland Science; 2002.
2. Molecular Cell Biology. 4th edition. Lodish H, Berk A, Zipursky SL, et al. New York: W. H. Freeman; 2000.

MOOCs

1. <http://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinantdna/>
2. <http://nptel.ac.in/courses/102103013/3>

PART B: GENETIC ENGINEERING AND IMMUNOTECHNOLOGY

LABORATORY

1. DNA quantification (Plant/Animal/Bacteria)
2. PCR: gene /DNA amplification
3. Restriction digestion, agarose gel electrophoresis and size determination.
4. Transformation.
5. Phage titration
6. Agglutination Techniques
7. Single Radial Immunodiffusion (SRID)
8. Ouchterlony Double Diffusion (ODD)
9. Rocket & Counter current immune-electrophoresis (RIEP)
10. Qualitative ELISA
11. Dot ELISA
12. Western blot (demo)

COURSE OUTCOMES (COs)

1. Understand, Relate, compare and contrast application of various tools in gene manipulation. (PO1)
2. Apply a suitable gene transfer methods and factors influencing its expression. (PO1, PO5)
3. Apply a suitable approach for isolation, purification, amplification and detection of nucleic acids as well as for design and construction of a DNA/cDNA library. (PO1, PO5)
4. Apply the concepts and tools for gene manipulation in development of GMOs. (PO1, PO5, PO12) Design and conduct experiments related to gene manipulation as well as analyse and interpret data. (PO4)

**DEPARTMENT OF BIOTECHNOLOGY**

Course Title	BIOINFORMATICS										Credits	4			
Course Code	2	2	B	T	5	P	C	B	I	N	L-T-P-S	2	1	1	0

COURSE PRE-REQUISITES: Basics of computer concepts and applications, Molecular Biology, Basics of Biomolecules, Biochemistry.

COURSE DESCRIPTION: This course emphasizes on bioinformatics resources, biological databases, various bioinformatics tools and techniques to analyze and interpret the biological data. Students will be exposed to fundamentals and applications of drug design and discovery process.

COURSE OBJECTIVES: This course is designed to impart good operational knowledge on basics of bioinformatics, biological databases, various tools and techniques for the computational analysis of biological data. This course also portrays the fundamentals and applications of drug design and discovery. Further students will comprehend the importance of database and tools to generate biological data and critically analyze the results and derive valid conclusions.

PART A: THEORY**UNIT - 1 BIOINFORMATIC RESOURCES AND SEARCH TOOLS****[7L+ 1T]**

Introduction to Bioinformatics, Bioinformatics resources: NCBI, EBI, ExPASy, RCSB; Significance of databases towards informatics projects, Sequence and structure databases: GenBank, DDBJ, EMBL, PIR, Uniprot-KB, SWISS-PROT, and TrEMBL. Biomolecular sequence file formats: Gene bank flat file, Protein Data Bank (PDB) flat file, FASTA Format, PIR Format, MMDB, SCOP, Pfam. Specialized databases: OMIM, Medical databases, KEGG, EST databases.

UNIT - 2 SEQUENCE ANALYSIS**[6L+4T]**

Sequence similarity search: Introduction; FASTA, BLAST, Low-Complexity Regions, Repetitive Elements. scoring matrices: Amino acid scoring matrices; PAM, BLOSUM, Comparison between PAM and BLOSUM,. Sequence Alignment: Introduction, The evolutionary basis of sequence alignment. Alignment algorithms: Pair wise alignment – Dotplot, Global alignment ,local alignment, Gaps, Gap scores and Gap penalties, Dynamic Programming - Needleman & Wunch, Smith & Waterman, Statistical significance of Alignments. Multiple sequence alignment: Progressive pair wise methods, Iterative methods, profile based methods- PSSM; Conceptual numericals.

UNIT - 3 PHYLOGENETIC ANALYSIS AND PREDICTIVE METHODS**[6L+4T]**

Introduction to Phylogenetic analysis: Tree terminologies, Forms of tree representation- Rooted and Unrooted trees; Steps in Phylogenetic data analysis; Tree building Methods: Distance based v/s character based – UPGMA, NJ, FM and Maximum likelihood, Maximum parsimony; Assessing tree reliability: Bootstrapping. Phylogenetic softwares: CLUSTALW, PAUP, PHYLIP etc. Profiles and Hidden Markov Models: PSSM. Profiles. Markov Model and HMM. Protein Motif and Domain Prediction: Identification of Motif and Domains in MSA. PROSITE. Motif and Domain Databases using Statistical Models (PRINTS, BLOCKS, ProDom, Pfam, SMART) Conceptual numericals.



DEPARTMENT OF BIOTECHNOLOGY

UNIT - 4 ANALYTICAL TOOLS FOR GENOMIC AND PROTEOMIC STUDIES

[3L+2T]

Predictive Methods: Genomic and proteomic sequence acquisition and analysis, Web based tools; Restriction mapping: Utilities, various steps involved, Web based tools; Primer design: need for tools, Primer design tools;

Structure Visualization and Graphical representation of molecular structures, Usages of visualization software available in public domain like Rasmol, Pymol, SpdbViewer, Cn3D. Conceptual numericals.

UNIT - 5 CHEMINFORMATICS, MOLECULAR MODELING, DRUG DESIGN AND DISCOVERY

[4L+2T]

Cheminformatics: Introduction, How to Represent the Molecule Structure, molecular datasets, tools and libraries, Large-Scale Data Mining, Molecular Properties, Combinatorial chemistry. Molecular dynamics- modeling and simulations: basic concepts including force fields, protein-protein, protein-nucleic acid, protein- ligand interaction; Drug design and discovery: an overview. Role of AI in drug discovery, Protein Structure Prediction and critical Assessment, Superposition of proteins using different tools, RMSD, protein conformational analysis. QSAR. Docking and Virtual Screening. Energy Calculations (no derivation). Pharmacophore prediction based on the docking analysis.

PRIMARY REFERENCES

1. Bioinformatics- Sequence and Genome Analysis by David W Mount, Cold Spring Harbor Laboratory, Second edition, 2004
2. Bioinformatics- A Practical Guide to the Analysis of Genes and Proteins by Andreas D Baxevanis and B.F. Francis Ouellette, A John Wiley and Sons, Second edition, 2001
3. Essentials Bioinformatics, by Jin Xiong Cambridge University Press, Second edition, 2006
4. Discovering Genomics, Proteomics, and Bioinformatics by A. Malcolm Campbell, Laurie J. Heyer, First edition, 2004

SECONDARY REFERENCES

1. Analytical Tools for DNA, Genes & Genomes: by Arseni Markoff, New Age, 2007
2. BIOINFORMATICS – METHODS AND APPLICATIONS: GENOMICS, PROTEOMICS AND DRUG DISCOVERY BY S C RASTOGI, N MENDIRATTA & P RASTOGI, PHI, 2006
3. BIOINFORMATICS: A biologist's guide to biocomputing and the internet. Stuart M Brown, NYU Medical Center, NY USA. 2000.

e- BOOKS

1. <http://www.springer.com/in/book/9781447167013>
2. <http://www.e-booksdirectory.com/details.php?ebook=4481>

MOOCs

1. <https://www.mooc-list.com/course/bioinformatics-introduction-and-methods>
2. <http://nptel.ac.in/courses/102103044/40>



DEPARTMENT OF BIOTECHNOLOGY

COURSE OUTCOMES

1. Comprehend various bioinformatics resources, biological databases, file formats, sequence analysis, restriction site mapping, primer designing, visualization and drug discovery.
2. Apply the various techniques to construct sequence alignment, phylogenetic analysis, restriction site mapping, primer designing, visualization of protein structures and Insilico drug discovery. (PO5)
3. Analyse the sequence alignment, phylogenetic map to interpret the data and derive valid conclusions. (PO2)
4. Design restriction site map, primer and drug discovery through Insilico approach. (PO3)
5. Conduct experiments to perform sequence analysis, phylogenetic analysis, restriction site mapping, primer designing, visualization of protein structures, Insilico drug discovery.(PO4)

PART B: BIOINFORMATICS LABORATORY

1. Sequence retrieval and similarity search (FASTA and BLAST) from nucleic acid and protein databases
2. Pair wise and multiple alignments of sequences – Analysis of parameters affecting alignment.
3. Evolutionary studies / Phylogenetic analysis
4. HMM construction and searches using protein database
5. Restriction site mapping and analysis.
6. Primer Design- Factors affecting primer design.
7. Assign SCOP domains to sequences using the SUPERFAMILY hidden Markov models.
8. Pattern elucidation in Proteins using PROSITE.
9. PDB Structure retrieval, Visualization and analysis of Protein Ligand interactions
10. Secondary structure prediction of proteins
11. 3D Structure prediction by Homology Modeling and Validation of modeled 3D structures – Structural analysis.
12. Superposition of structures – Calculation of RMSD and analysis.
13. Lead identification and Molecular docking.
14. UALCAN for cancer genomic data analysis
15. cBioprotal for cancer genomic and proteomic data analysis.



DEPARTMENT OF BIOTECHNOLOGY

COURSE TITLE	BIOANALYTICAL TECHNIQUES														
COURSE CODE	2	2	B	T	5	P	C	B	A	T	Credits	04	L-T-P	2-1-1	
CIE	100 marks (50% weightage)										SEE	100 marks 50% weightage)			

COURSE PRE-REQUISITES: Engineering Physics, Engineering Chemistry, Engineering Mathematics, Basics of Biomolecules

COURSE DESCRIPTION: this course deals with the principle, instrumentation and application of various biophysical techniques used for the separation of biomolecules and characterization of these biomolecules. It also describes the various methods used for the separation and purification of the various biomolecules.

COURSE OBJECTIVES: To enable the students to gain knowledge on the various techniques for separation, purification and characterization of biomolecules.

PART A– THEORY UNIT – 1 CHROMATOGRAPHIC TECHNIQUES [6L+2T]

Classification of chromatography, Basic parameters: partition coefficient, retention time and volume, elution time and volume, column efficiency, resolution and related numerical, internal and external standards. Planar Chromatography: Principle, apparatus, solvent system, detection and applications of Paper chromatography (ascending, descending and 2D) and Thin layer chromatography.

Column chromatography: Principle, instrumentation, matrices, solvent system: detection and applications of Ion exchange chromatography, Gel filtration chromatography, Affinity chromatography, Gas liquid chromatography and High-performance liquid chromatography.

UNIT - 2 ELECTROPHORESIS [5L+2T]

Principle, horizontal and vertical gel electrophoresis, isoelectric focusing, native PAGE, SDS-PAGE, Pulse field electrophoresis, application of electrophoresis in analysing macromolecules.

UNIT - 3 BIOPHYSICAL TECHNIQUES

[6L+3T]

Principle, instrumentation and applications of, analytical and preparative ultracentrifugation, , Scanning tunneling microscopy, AFM, luminescence (fluorescence & phosphorescence), , Isothermal and differential calorimetry, Mass spectrometry: LC-MS, MALDI-TOF.

UNIT - 4 STRUCTURAL INVESTIGATION OF MACROMOLECULES [6L+3T]

Principle, instrumentation and application of X-ray (single crystal diffraction), ESR / EPR, NMR, CD, UV, IR, Raman Spectroscopy.

UNIT - 5 RADIOISOTOPIC TECHNIQUES [4L+2T]

Basic concepts, GM and scintillation counter, autoradiography, safety aspects and applications in biological science.



DEPARTMENT OF BIOTECHNOLOGY

PRIMARY REFERENCES

1. Biophysical Chemistry by Cantor R., and Schimmel P.R
2. Physical Biochemistry by David Freifelder (N H Freeman and Company)
3. Biophysical Principles of Structure & Function by Fred M. Snell & Sidney Shulman
4. Separation processes in biotechnology by Asenjo J and M. Dekker, CRC Publishers. 1993.
5. Bioseparations by Belter P.A and Cussier E. Wiley. 1985.
6. Bioseparations by Harrison R.G. Todd P. Rudge S.R. and D.P. Petrides. Science and Engineering Oxford University Press, 2004.
7. Basic separation techniques in biochemistry by Peter D. Boylston and Robert H. O'Brien. International. 1998.
8. Physical Chemistry: Principles and Applications in Biological Sciences by Tinoco and others

SECONDARY REFERENCES

1. Biophysics – An Introduction by Cotterill, Wiley Student Edition
2. Foundations of Biophysics by A.L. Stanford.
3. Principles of protein structure by G Schulz and R H Schirmer (Springer Verlag)
4. Principles of nucleic acid structure by Sanger (Springer Verlag)
5. Introduction to Protein Science by Arthur M Lesk (OUP)
6. Biological Spectroscopy by J. D. Campbell and R. A. Dwek
7. Proteins – Structure & Molecular Properties by Creighton **e-BOOKS**

1. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson
<https://books.google.co.in/books?isbn=052165873X>
2. Biophysical Techniques by Iain Campbell
<https://0b9411cb7057497b22db0cd9f69e827bce11ede8.googleusercontent.com/host/0B5XjjBGDoIrhNIFVcVhQWjA2a1k/Biophysical-Techniques-Iain-Campbell-ebook-51iBvNTIHhL.pdf>

1. <http://nptel.ac.in/courses/102106022/>

2. <http://nptel.ac.in/courses/102103044/>

PART B: BIOANALYTICAL TECHNIQUES LABORATORY (2hrs/week)

1. Separation of mixture of amino acids /sugars/plant pigments etc by TLC
2. Separation of proteins by Gel filtration
3. Determination of a metabolite by HPLC
4. Separation of phytochemicals by HPLC
5. Resolving of proteins by native PAGE
6. Determination of molecular weight of proteins by SDS PAGE
7. Isoelectric focussing of proteins
8. Resolve nucleic acids by agarose gel electrophoresis
9. Determine melting temperature and % GC content of the given DNA sample
10. Investigating Protein: Nucleic Acid Interactions by Electrophoretic Mobility Shift Assay (EMSA)

COURSE OUTCOMES (COs)

1. Select technique (s) that can be applied for a biomolecule separation and elucidate the principle and method. (PO1,5)
2. Select technique (s) that can be applied for a biomolecule purification and elucidate the principle and method. (PO1,5)
3. Select and apply suitable techniques for identification of biomolecules. (PO1,5,12)
4. Select and apply suitable techniques for characterization of biomolecules. (PO1,5,12)
5. Design, conduct experiments related to quantitative analysis of biomolecules and interpret data (PO 4)
6. Engage in independent learning and work effectively as an individual to carry out literature search effectively, design, conduct experiments & interpret data and write a technical report (PO4,9,10)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	IMMUNOTECHNOLOGY										Credits	3		
Course Code	2	2	B	T	5	P	C	I	M	M	L-T-P	3	0	0

COURSE PREREQUISITE: Cell and Molecular Biology, Basics of Biomolecules and Biochemistry, Microbiology.

COURSE DESCRIPTION: course includes structure and function of immune cells and organs, detailed aspects of immune response, the molecular mechanisms of immunity. The course also deals with role of immune system in health and disease, preventive therapies and modern techniques in immunology

COURSE OBJECTIVES: To impart Knowledge on immune mechanisms operating in the body for combating infections and role of immune system in health disease. The student will be able to understand the intricacies of vaccine Design, transplant rejection and production of antibodies.

UNIT I INTRODUCTION TO IMMUNE SYSTEM

[6 L]

Historical development, Overview of immune response, Classification of immune system. innate and acquired immunity, Passive and active immunity humoral and cellular immunity. Cells of immune system- role of macrophages, neutrophils, Basophils, eosinophils and Dendritic cells. primary and secondary lymphoid organs. Antigens- chemical and molecular nature, clonal selection theory.

UNIT II

[10 L]

B-Cells: Types, structure and function of Immunoglobulins, development of B-Cells, B cell receptor, recognition of antigen, activation and differentiation. Genetic organization of Immunoglobulin Genes, expression and secretion. Antigen processing and presentation. Major Histocompatibility Complex and HLA.

T-CELLs and NK cells: Types of T-cells, Activation and function of T-cells, T cell receptors, Co receptors and other surface markers, antigen presenting cells, antigen processing and presentation, Major histocompatibility Complex- MHC Class I and II molecules, CTLs and NK cells: activation, differentiation and function.

UNIT III IMMUNE SYSTEM IN HEALTH & DISEASE

[10 L]

The Complement System: Classical, Alternate and MBL pathways. Hypersensitivity Reactions: Type I, II, III and IV. Immunodeficiency disorders- Primary and Secondary. Autoimmunity- autoimmune disorders and examples (autoimmune haemolytic anemia, multiple sclerosis, rheumatoid arthritis). Transplantation and Tumor Immunology - Relationship between donor and recipient, role of M H C molecules in graft rejection. Bone marrow and hematopoietic stem cell transplantation. Tumor antigens, categories of tumor antigens. Cancer Immunotherapy, CAR-T cells.

UNIT IV VACCINES AND THERAPEUTIC ANTIBODIES

[6 L]

Vaccines: Design strategies, Whole organism, Subunit and synthetic vaccines. RNA vaccines. Therapeutic Antibodies: Immuno-toxins, antibody hetero-conjugates, chimeric and humanized minibodies, antibody mimics (adnectins, affibodies). Production of polyclonal antibodies, production of monoclonal antibodies by hybridoma technology.



DEPARTMENT OF BIOTECHNOLOGY

UNIT V IMMUNOTECHNIQUES

[7 L]

Antigen – Antibody Reactions, Affinity, Avidity, Cross-Reactivity, Immunoprecipitations, Precipitation Reactions, Agglutination Reactions, Radioimmunoassay, Enzyme-linked Immunosorbent Assay, Western Blot, Immuno-electrophoresis. Immuno-fluorescence, fluorescence activated cell sorting analysis, cytotoxicity assay.

PRIMARY REFERENCES

1. Kuby Immunology by Kindt, Thomas J., Osborne, Barbara A., Goldsby, Richard A. W.H. Freeman & Co, Fifth edition, 2003.
2. The Principles of Immunology by H.T. Karsner, E.E. Ecker. Publisher: Lippincott 1921 ISBN/ASIN: B005GEE560

SECONDARY REFERENCES

1. Immunology 4th Edition by Ivan Roitt (Author), David Male (Author), Johathan Brostoff (Author). ISBN-10: 0723421781
2. Review of Medical Microbiology and Immunology by Warren Levinson ,Lange Medical Books, 13th Edition.

e-BOOKS

1. Immunology: With STUDENT CONSULT Online Access, 8e (Immunology (Roitt)) 8th Edition by David Male MA PhD (Author), Jonathan Brostoff MA DM DSc(Med) FRCP FRCPath (Author), David Roth MD PhD (Author), Ivan Roitt.
2. Janeway, Charles A., et al. Immunobiology: The Immune System in Health and Disease. New York, NY: Garland Science, 2004. ISBN: 9780443073106.

MOOC

1. <https://www.mooc-list.com/course/bioc3721x-fundamentals-immunology-part-1-edx?static=true>
2. https://onlinecourses.swayam2.ac.in/cec23_bt13/preview

COURSE OUTCOMES (COs)

1. Distinguish various types of antibody molecules and explain their production and applications as therapeutics (PO1)
2. Draw structure of immune cells, organs and molecules, relate their role in immune defence (PO1)
3. Describe the role of immune system in health, disease and transplantation (PO1 and PO6)
4. Describe various parameters in design of vaccines (PO12 and PO6)
5. Conduct experiments involving detection and quantification of antigens, antibodies and pathogens. (PO4)



DEPARTMENT OF BIOTECHNOLOGY

Professional Elective Courses

COURSE TITLE	METABOLIC ENGINEERING (Stream: Pharma BT)														
COURSE CODE	2	2	B	T	5	P	E	M	T	E	Credits	03	L-T-P	3-0-0	
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PRE-REQUISITES: Basics of Biomolecules, Biochemistry and Bioenergetics, Cell and Molecular Biology, Genetic Engineering, and Process Engineering Thermodynamics and Biostatistics.

COURSE DESCRIPTION: This course includes methods for metabolic characterization (genome, transcriptome, proteome, metabolome and fluxome), comprehensive models for cellular reactions, regulation of metabolic pathways, metabolic flux analysis and applications of metabolic flux analysis. This course also includes methods for the experimental determination of metabolic fluxes by isotope labelling, metabolic control analysis, metabolic design (gene amplification, gene-disruption, randomized and targeted strain development) and metabolic Engineering in practice.

COURSE OBJECTIVES: This course provides insight into the fundamentals of metabolic engineering in strain improvement programs to increase the yield of a target product or reduce or eliminate the production of undesired impurities. This course imparts knowledge on development of optimization procedures for strain improvement, optimizing metabolic flux by up-regulation of a target pathway and/or knock-out of competing pathways and heterologous expression of foreign gene / gene cluster to introduce metabolites for biosynthesis of target product.

UNIT - 1 METABOLIC CHARACTERIZATION AND MODELS FOR CELLULAR REACTIONS [7 L]

Overview to the field with illustrating examples. Central Metabolism: Fueling metabolism, Supply of biomass precursors, Anabolism, Anaplerosis. Coordination of metabolic reactions: Feedback inhibition, Energy charge, Methods for metabolic characterization: Genome, Transcriptome, Proteome, Metabolome and Fluxome. Comprehensive models for cellular reactions: Stoichiometry of cellular reactions, Reaction rates, Dynamic mass balance.

UNIT – 2 REGULATION OF METABOLIC PATHWAYS AND METABOLIC FLUX ANALYSIS [9 L]

Regulation of metabolic pathways: Regulation of Enzymatic Activity and Enzyme concentration, Regulation at whole cell level, Regulation of Metabolic networks. Metabolic flux analysis: Overdetermined and undetermined systems, Sensitivity analysis.

UNIT – 3 METHODS FOR METABOLIC FLUX ANALYSIS AND ITS APPLICATIONS [7 L]

Methods for Metabolic Flux Analysis; Metabolite Balancing, Tracer Experiments, MS and NMR in labelling measurement. Applications of metabolic flux analysis.



DEPARTMENT OF BIOTECHNOLOGY

UNIT - 4 METABOLIC CONTROL ANALYSIS [9 L]

Metabolic control analysis (MCA): Determination of Flux control coefficients, MCA of Linear and Branched pathways.

UNIT - 5 METABOLIC ENGINEERING IN PRACTICE (Case studies) [7 L]

Engineering the isobutanol biosynthetic pathway in *Escherichia coli* by comparison of aldehyde reductase /alcohol dehydrogenase genes; Compartmentalization of metabolic pathways in yeast mitochondria improves the production of branched-chain alcohols; Metabolic engineering of *Escherichia coli* to increase NADH availability by overexpressing an NAD⁺-dependent formate dehydrogenase; Engineering *Escherichia coli* for production of functionalized terpenoids using plant P450s; Industrial production of amino acids by coryneform bacteria; Engineering of *Escherichia coli* for fuel production (Microdiesel).

PRIMARY REFERENCES

1. G. Stephanopoulos, A. Aristidou and J. Nielsen, Metabolic Engineering Principles and Methodologies, Academic Press, 1998.
2. David Fell, Understanding the Control of Metabolism, Portland Press, London, 1997.

SECONDARY REFERENCES

1. S. Y. Lee & E.T. Papoutsakis, Metabolic Engineering, Marcel Dekker, New York, 1999.
2. R. Heinrich and S. Schuster, The Regulation of Cellular Systems, Chapman & Hall, 1996.
3. E.O. Voit, Computational Analysis of Biochemical Systems. Cambridge University Press, 2000.

e- BOOKS

1. https://books.google.co.in/books/about/Metabolic_Engineering.html?id=9mGzkso4NVQC
2. [http://onlinelibrary.wiley.com/doi/10.1016/S0307-4412\(97\)87557-7/abstract](http://onlinelibrary.wiley.com/doi/10.1016/S0307-4412(97)87557-7/abstract)

MOOCs

1. <http://www.nptel.ac.in/syllabus/102103014/>

COURSE OUTCOMES

1. Elucidate central metabolic reactions and models used for cellular reactions (PO1).
2. Comprehend regulation of metabolic pathways at different levels and analyze metabolic flux for real time applications (PO2, PO3).
3. Describe the metabolic control analysis and plan a suitable metabolic design for maximizing product yield (PO5).
4. Relate applications of metabolic engineering for current research/industrial practices (PO12).

**DEPARTMENT OF BIOTECHNOLOGY**

Course Title		SIGNAL TRANSDUCTION (Stream: Computational Biology)									Credits	3		
Course Code	2	2	B	T	6	P	E	S	T	N	L-T-P	3	0	0

COURSE PRE-REQUISITES : Cell And Molecular Biology, Human Physiology, Basics Of Biomolecules and Immunotechnology

COURSE DESCRIPTION: This course gives a comprehensive Account of Cell Signaling and Signal Transduction. It explains the biochemical basis of the transmission of molecular signals from a cell's exterior to its interior and how these can affect cellular behavior and gene expression. It also gives an overview of cell signaling w.r.t tumor biology

COURSE OBJECTIVES: The course aims to give a basic knowledge of mechanisms of signal transduction and the significance of signal transduction in physiology and pathophysiology.

UNIT - 1**SIGNAL TRANSDUCTION****[9 L]**

Signal Transduction: Definition, Signals, Ligands and Receptors. Endocrine, Paracrine and Autocrine Signaling. Sensory Transduction : Nerve Impulse Transmission – Nerve Cells, Synapses, Reflex Arc Structure, Resting Membrane Potential, Nernst Equation, Action Potential, Voltage Gated Ion-Channels, Impulse Transmission, Neurotransmitters, Neurotransmitter Receptors.

Rod And Cone Cells In The Retina, Biochemical Changes In The Visual Cycle, Photochemical Reaction And Regulation Of Rhodopsin. Odor Receptors.

UNIT - 2**RECEPTORS AND SIGNALING PATHWAYS****[9 L]**

Cell Signaling, Cell Surface Receptors. G Protein Coupled Receptors- Structure, Mechanism Of Signal Transmission, Regulatory Gtpases, Heterotrimeric G Proteins And Effector Molecules Of G Proteins. Signaling Molecules-Camp, Cgmp, Metabolic Pathways For The Formation Of Inositol Triphosphate From Phosphatidyl Inositol Diphosphate, Ca²⁺, DAG And NO As Signaling Molecules, Ryanodine And Other Ca²⁺ Receptors, Phospho-Regulation Of Inositol And The Calcium Channel Activation. Ser/Thr-Specific Protein Kinases and Phosphatases. Receptor Tyrosine Kinases, Role of Phosphotyrosine in SH2 Domain Binding. Signal Transmission via Ras Proteins and MAP Kinase Pathway

UNIT - 3**SIGNALING RECEPTORS****[7 L]**

Signaling By Nuclear Receptors: Ligands, Structure and Functions of Nuclear Receptors, Nuclear Functions for Hormones/Metabolites - Orphan Receptors; Cytoplasmic Functions and Crosstalk with Signaling Molecules, Signaling Pathway of the Steroid Hormone Receptors. Cytokine Receptors- Structure and Activation of Cytokine Receptors, Jak-Stat Path Way, Janus Kinases, Stat Proteins.



DEPARTMENT OF BIOTECHNOLOGY

UNIT - 4

REGULATION OF THE CELL CYCLE

[7 L]

Overview Of The Cell Cycle, Cell Cycle Control Mechanisms, Cyclin-Dependent Protein Kinases (Cdks), Regulation Of Cell Cycle By Proteolysis, G1/S Phase Transition, G2/M Phase Transition, Cell Cycle Control Of DNA Replication, DNA Damage Check Points.

UNIT - 5

SIGNAL TRANSDUCTION IN HEALTH AND DISEASE

[7 L]

Errors in Function of Signal Proteins And Tumorigenesis. Oncogenes, Proto-Oncogenes and Tumor Suppressor Genes. Tumor Suppressor Protein P53 and Its Role in Tumor Suppression. Tumor Suppressor APC and Wnt/ β -Catenin Signaling. Current Research in Oncogenes And Suppressor Genes, Recent Scenario Of Signaling Pathways In Interleukins And Cell Surface Receptors.

PRIMARY REFERENCES

1. Molecular Biology- David Freifelder, Narosa Publishing House Pvt. Limited, 2005
2. Biochemistry Of Signal Transduction And Regulation. 3rd Edition. Gerhard Krauss, 2003 WILEY- VCH Verlag Gmbh & Co. Kgaa, Weinheim ISBN: 3-527-30591-2
3. Molecular Biology Of The Cell, 4th Edition, Bruce Alberts. New York: Garland Science; 2002. ISBN- 10: 0-8153-3218-1 ISBN-10: 0-8153-4072-9

SECONDARY REFERENCES

1. Molecular Cell Biology, 4th Edition, Harvey Lodish. New York: W. H. Freeman; 2000. ISBN-10: 0-71673136-3
2. Principles Of Cell And Molecular Biology- Lewis Kleinsmith, 2nd Edition, Illustrated, Harpercollins, 1995.

e- BOOKS

1. Biochemistry of Signal Transduction and Regulation, Second Edition Author(s): Gerhard Krauss First published: 17 July 2001 Print ISBN: 9783527303786 | Online SBN: 9783527600052 | DOI: 10.1002/3527600051 Copyright © 2001 Wiley VCH Verlag GmbH
2. Biochemistry, 5th edition Jeremy M Berg, John L Tymoczko, and Lubert Stryer. New York: W H Freeman; 2002. ISBN-10: 0-7167-3051-0 <https://www.ncbi.nlm.nih.gov/books/NBK21154/>

MOOCs

1. <https://Www.Open.Edu/Openlearn/Science-Maths-Technology/Cell-Signalling/ContentSection-0?Active-Tab=Description-Tab>

COURSE OUTCOMES (COs)

1. Elucidate the basic principles of signal transduction mechanisms in health and disease (PO1)
2. Identify the different types of Extracellular/intracellular Signals And Receptors and correlate to their functional significance in health and disease (PO 2)
3. Design the mechanisms by which different receptors may be regulated by ligands (PO 3, PO 5 & PO 12)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	MICROBIAL BIOTECHNOLOGY (Stream: Advanced BT)								Credits	3		
Course Code	2	2	B	T	5	P	E	M	B	T	L-T-P	3 0 0

COURSE PRE-REQUISITES: Cell and Molecular biology, Basics of biomolecules, Biochemistry and bioenergetics, Microbiology and Environmental Biotechnology

COURSE DESCRIPTION: This course includes microbial growth kinetics, production of bio-pharmaceuticals, primary & secondary metabolites as well as energy from biomass and organic waste. This course also imparts knowledge on microbial bioremediation and bioleaching.

COURSE OBJECTIVES: This course enables students to understand microbial metabolism and growth kinetics and apply the concepts to generate energy from biomass and organic waste as well as to engineer the microbes for production of biopharmaceuticals, green chemicals and novel compounds.

UNIT - 1 PRODUCTION OF PRIMARY AND SECONDARY METABOLITES FROM MICROBES [10 L]

Producer organisms, metabolic pathways, media employed and fermentation process for production of Solvents - Alcohol, Glycerol. Organic acids – Citric acid, acetic acid, L-ascorbic acid, lactic acid. Antibiotics – Penicillins (Penicillin), Cephalosporins (cephalosporin), Aminoglycosides (streptomycin), Tetracyclines (chlortetracycline), Macrolides (erythromycin A). Amino acids – L-glutamic acid, L-lysine, L-tryptophan. Vitamins – Vitamin B12, Riboflavin, Beta-carotene. Beverages from microbes, Microbial polysaccharides and polymers.

UNIT – 2 APPLICATIONS OF MICROBES IN DAIRY, BIOPHARMACEUTICALS, BREWERY AND FOOD INDUSTRIES [6 L]

Probiotics and prebiotics: Fundamental aspects and health benefits. Microbiology and technology of fermented dairy products: Cheese making: Cheese varieties, manufacture of cheddar cheese, Sources and properties of rennets; Yoghurt making. Production of vaccines and Beer brewing. **UNIT - 3**

GREEN CHEMICALS FROM MICROBES [6 L]

Green chemicals and their advantages, Biosurfactants: Definition, classes, producer microbes, Biosynthesis, Large scale production (Medium components and conditions) and applications (domestic and industrial). Biopolymers: Polysaccharides- Bacterial and fungal (composition and producer organisms), structural properties, Bioplastics - PHAs (PHBs), Producer organisms, metabolic pathways, media source and production.

UNIT – 4 BIOMASS AND ORGANIC WASTE TO ENERGY [7 L]

Biomass and organic waste-Introduction, Sources, Composition and microbial metabolic processing. Microbial processing of biomass and spent liquor from sugar industry- molasses and its composition, metabolic pathway, processing of molasses to ethanol or alcohol (Flow/block diagram), Algal biofuels. Lignocellulosic biomass: Sources and composition, methods of pre-processing and post-processing, role of microbes and their enzymes. Microbial fuel cells: Definition, design and compartments, principal mechanism, liquid wastes as substrates, process of electricity generation and its economics.

UNIT - 5 BIOREMEDIATION AND BIOLEACHING [10 L]

Uses of Bacteria in Bioremediation – Biodegradation of hydrocarbons, Granular sludge consortia for bioremediation, crude oil degradation by bacteria, Immobilization of microbes for bioremediation, Methanotrophs, PCB dechlorination, Genetic engineering of microbes for bioremediation. Phytoremediation – plants capable of assimilating heavy metals. Case Studies of Pyrite Dissolution in Pachuca Tanks and Depression of Pyrite Flotation by Bacteria, Factors affecting Microbial Coal Solubilization, Sulfur Leaching by



DEPARTMENT OF BIOTECHNOLOGY

Thermophilic Microbes of Coal Particles, DVEaPrAyRinTgMiEnNsTizOeF, BMIOicTreOcbHionlOogLOicGaYl
Production of Ferric Ion for Heap and Dump Leaching, New Bacteriophage which infects Acidophilic, Heterotrophic Bacteria from Acidic Mining Environments, Treatment of Coal Mine Drainage with Constructed Wetlands.

COURSE OUTCOMES

1. Apply microbial techniques for production of metabolites, chemicals and bio-products (PO1).
2. Formulate bioengineering strategies for large scale-production of metabolic intermediates, biopharmaceuticals, industrial and recombinant products (PO2, PO3, PO5).
3. Apply the mechanism of microbial metabolism in generating energy by sustainable utilisation of biomass and organic waste (PO7).
4. Relate the applications of microbes in Bioremediation and Bioleaching (PO6).

PRIMARY REFERENCES

1. Microbial Biotechnology Second edition, Alexander N. Glazer, Hiroshi Nikaido
2. Biofuels and Bioenergy, Processes and technologies, Sunggyu Lee and YT Shah

SECONDARY REFERENCES

1. Principles of Fermentation technology, Second edition, Stanbury and A. Whitaker
2. Biofuels, Methods and protocols, Jonathan R. Mielenz **e- BOOKS**
1. <http://www.freebookcentre.net/biology-books-download/Environmental-Biotechnology.html>
2. <https://www.amazon.in/Microbial-Biotechnology-Applications-Yuan-Kun-ebook/dp/B0058QN37S>

MOOCs

1. <https://www.mooc-list.com/course/tbp01x-technology-biobased-products-edx?static=true>
2. <http://ocw.mit.edu/courses/biology/7-341-harnessing-the-biosphere-natural-products-and-biotechnology-fall-2012/>



COURSE TITLE	FOOD MICROBIOLOGY (Stream: Food Technology)														
COURSE CODE	2	2	B	T	6	P	E	F	M	B	Credit s	04	L- T-P	3- 0-0	
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PRE-REQUISITES: Basics of Biomolecules, Biochemistry, Microbiology, Cell and Molecular Biology and Genetic Engineering

COURSE DESCRIPTION: This course deals with diversity of microbes and its association with food. The course content involve microbes and their habitat, food parameters and their influence on microbial types, desirable and undesirable effects microbes in food, detection and controlling of microbes for improvement of food quality.

COURSE OBJECTIVES: The course mainly emphasize on microbes and their association with food leading to various biochemical reactions. The course imparts knowledge on principles behind food spoilage, food conversions leading to desirable products and the current status of fermented foods. Further students will learn the conventional and the advanced techniques to detect and control the microorganisms in foods.

PART A:

THEORY UNIT – 1 Microbial Consortia of Food: Origin, sources and intrinsic and extrinsic parameters [6L]

Synopsis of common food borne microbes and their sources. Microbes in water, soil and air (Bacteria and Fungi). Micro-organisms of Plants, Micro-organisms of Animal Origin (Skin, Nose and Throat).

Factors Affecting the Growth and Survival of Micro-organisms in Foods: Microbial Growth, Intrinsic Factors (Substrate Limitations)- water activity, Nutrient Content, pH and Buffering Capacity, Redox Potential, Eh, Antimicrobial Barriers and Constituents. Extrinsic Factors (Environmental Limitations): Relative Humidity, Temperature, Gaseous Atmosphere. Implicit Factors.

UNIT - 2 Food Spoilage: General indications, Microbial interactions with foods, Biochemical reactions and their products [7H]

Classification of foods based on spoilage, common indications of spoilage. Composition, Microflora, Biochemical reactions and their products, signs of spoilage of foods: Milk, Meat, Poultry, Fish, Plant products (Fresh, processed and preserved). Undesirable metabolic activities involving carbohydrates, lipids and proteins. **UNIT - 3 Detection of Food borne microbes: Common food pathogens, food borne infections, conventional and advanced detection methods [10H]**

Food Hazards, Significance of Foodborne Disease, Incidence of Foodborne Illness, Risk Factors Associated with Foodborne Illness, The Changing Scene and Emerging Pathogens, The Site of Foodborne Illness. The Alimentary Tract: Its Function and Microflora , The

Pathogenesis of diarrheal disease. Characteristics, pathogenesis, clinical features, isolation and identification of bacteria: *S. aureus*, *Salmonella typhi*, *Shigella sp.*, *Yersinia enterocolitica*, *E.coli*, *C.perfringens* and *C. botulinum*. Mycotoxins of fungi (*Aspergillus*, *Penicillium* and *Fusarium*), Food borne viruses (Polio, Hepatitis A and E, Gastroenteritis viruses).



DEPARTMENT OF BIOTECHNOLOGY

Detection of food pathogens: Indicator Organisms, Direct Examination, Cultural Techniques Conventional and advanced (selective, differential and enrichment media), Enumeration Methods: Plate Counts, Most Probable Number Counts. Alternative Methods: Dye-reduction Tests, Electrical Methods, ATP Determination. Rapid Methods for the Detection of Specific Organisms and Toxins: Immunological Methods, DNA/RNA Methodology, Subtyping.

UNIT - 4

Microbial food products: Microbes and Fermented foods with major biochemical reactions. [10H]

Introduction, Yeasts. SCP and Probiotics. Lactic acid Bacteria (LAB): Activities of LAB in Foods, Antimicrobial Activity of LAB, Health-promoting Effects of LAB-Probiotics, The Malolactic Fermentation. Fermented Milks: Yoghurt, Other Fermented Milks. Cheese: Types, composition, bacteria and fungi in cheese processing. Fermented Vegetables: Sauerkraut and Kimchi, Olives, Cucumbers. Fermented Meats, Fermented Fish. Beer, Vinegar, Mould Fermentations, Tempeh, Soy Sauce and Rice Wine, Mycoprotein.

UNIT - 5 Control of microorganisms in foods [6H]

Heat Processing: Pasteurization and Appertization, Quantifying the Thermal Death of Micro-organisms: D and z Values, Heat Sensitivity of Micro-organism, Describing a Heat Process, Spoilage of Canned Foods, Aseptic Packaging. Irradiation: Microwave Radiation, UV Radiation, Ionizing Radiation, High-Pressure Processing–Pascalization, Low-Temperature Storage: Chill Storage, Freezing. Chemical Preservatives: Organic Acids and Esters, Nitrite, Sulfur Dioxide, Natamycin, 'Natural' Food Preservatives.

PRIMARY REFERENCES

1. Food Microbiology by Martin R Adams Maurice O Moss, 3rd edition, RSC Publishing.
2. Food Microbiology, by W. M. Foster, CBS Publishers & Distributors, 2019.

SECONDARY REFERENCES

1. Textbook of Food Microbiology by Veerendrakumar pandey, INSC International Publisher (IIP), 2021.
2. Food Microbiology by N. Ramanathan, New India Publishing Agency (NIPA), 2021.
3. Modern Food Microbiology, By James M. Jay. Springer Netherlands, 2012.

e- BOOKS

1. Applications of Biotechnology in Traditional Fermented Foods. By 'Panel on the Applications of Biotechnology to Traditional Fermented Foods, National Research Council'
2. Food Microbiology (Sie) by Frazier, Tata McGraw-Hill Education, 1987
3. Modern Food Micro-Biology: James M. Jay, (2005), CBS Publishers.

MOOCs

1. Food Security and Sustainability: Crop production (edX) <https://www.mooclist.com/course/food-securityand-sustainability-crop-production-edx?static=true>
2. Nutrition and Health Part 3: Food Safety (edX). <https://www.mooc-list.com/course/nutritionand-health-part-3-food-safety-edx?static=true>



COURSE OUTCOMES (COs)

1. Understand the sources, factors affecting and deleterious effects of microbes and their products in foods (PO1).
2. Assess the major biochemical reactions and the products responsible for the desirable and undesirable effects of microbes in foods (PO2, PO6).
3. Evaluate the different conventional and advanced strategies to detect the microbes in real time and control their growth in foods (PO2, PO5).
4. Survey, compare and contrast the data, generate a report and communicate effectively (PO1, PO9, PO10& PO12).



DEPARTMENT OF BIOTECHNOLOGY

Course Title	VACCINES AND CANCER IMMUNOTHERAPY (Vaccines & Regenerative Biology/Medicines)										Credits	3		
Course Code	2	2	B	T	6	P	E	V	C	I	L-T-P	3	0	0

COURSE PRE-REQUISITES: Immunology, Cell and Molecular Biology, Biochemistry, Genetic Engineering, Bioinformatics and Genomics & Proteomics.

COURSE DESCRIPTION: This course emphasizes on various aspects pertaining to viral immunology and Vaccines. This course also provides immunological applications of treating cancer and various other diseases.

COURSE OBJECTIVES: This course is designed to impart good basic knowledge of viral immunology, vaccines, their types and usage for treating cancer and other diseases.

UNIT I

IMMUNOLOGICAL CONCEPTS IN VACCINOLOGY

[9L]

Short history of vaccination, requirements for induction of immunity, Epitopes, linear and conformational epitopes, characterisation and location of APC, MHC and immunogenicity, Rationale of vaccine design based on clinical requirements: Hypersensitivity, Immunity to Infection, Autoimmunity, immunodeficiency, mechanism of adjuvant action, Scope of future vaccine strategies.

UNIT II

CLASSIFICATION OF VACCINES AND ITS PREPARATIONS

[9L]

Active and passive immunization; Viral/bacterial/parasite vaccine differences, methods of vaccine preparation – Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein-based vaccines, plant-based vaccines, edible vaccines, reverse vaccinology, combination vaccines, therapeutic vaccines; Peptide vaccines, conjugate vaccines; Cell based vaccines.

UNIT III VIRAL IMMUNOLOGICAL CONCEPTS [7 L]

Introduction to Viruses, Viral Pathogenesis, Methods of Immune Evasion, T Cell Exhaustion, Passive Immunotherapy, Adjuvants and Immune Activation, Viral Invasion, Viral Replication, Immune Responses to Viruses, cytokine storm.



UNIT IV CANCER IMMUNOTHERAPY [7 L]

Basic biology of Cancer, Hallmarks of cancer, Incidences of cancer occurrence and prevalence of various types of cancers, immune check point inhibitors and Monoclonal antibodies, Monoclonal antibodies use in cancer treatments and examples, CAR-T cell technology and usage for cancer treatment, Cancer vaccines and examples, dendritic cell therapy.

UNIT V

ANIMAL TESTING, COMMERCIALISATION, QUALITY CONTROL

[7L]

Quality control and regulations in vaccine research, In-vitro experimental validations for predictions of vaccines by software, Animal testing, Rational design to clinical trials, Large scale production, Commercialization, ethics.

PRIMARY REFERENCES:

1. Epidemiology and Prevention of Vaccine-Preventable Diseases. The Pink Book: Course Textbook - 14th Edition (2021), CDC, USA
2. Plotkin's Vaccines. 8th Edition - December 21, 2022, Authors: Walter A. Orenstein, Paul A. Offit, Kathryn M. Edwards, Stanley A. Plotkin, ISBN: 9780323790581
3. Cancer Immunotherapy Principles and Practice Textbook, 2nd Ed. Lisa H. Butterfield, Howard L. Kaufman, Francesco M. Marincola, MD

E-B BOOKS:

1. Pinkbook Course Book: Epidemiology of Vaccine ... – CDC
2. THE VACCINATION BOOKLET FOR EVERYONE https://www.impfen-info.de/download/5295-1628523810-BMG_Impfbuch-fuer-alle_EN.pdf/
3. Cancer immunotherapy: a promising dawn in cancer research. Banashree Bondhopadhyay1*, Sandeep Sisodiya1 <https://e-century.us/files/ajbr/10/6/ajbr0123367.pdf>

MOOCS:

1. Vaccinology (FUN). Institut Pasteur
2. The COVID-19 Pandemic and the Use of mRNA Vaccines, edx

Course outcomes (COs)

1. Differentiate innate, passive, and active immunity (PO1)
2. Classify vaccine types and components (PO1)
3. Develop a strategy for vaccine development for various diseases(PO1)
4. Evaluate the process of vaccines safety (PO1 and 12)



DEPARTMENT OF BIOTECHNOLOGY

VI Semester

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PC-14	22BT6PCGAP	Genomics and Proteomics	3	0	0	3	3
PC-15	22BT6PCETK	Enzyme Technology and Kinetics	2	1	1	4	6
PC-16	22BT6PCBPT	Bioprocess Technology	3	0	1	4	5
PE-2	22BT6PEPE-2	Professional Elective -2	3	0	0	3	3
OE-1	22BT6OEOE-1	Open Elective -1	3	0	0	3	3
PW-2	22BT6PCPW-2	Project -2	0	0	2	2	4
INT-2	22BT6SRIN2	Internship-Based Seminar	0	0	1	1	2
HS-7	22BT6HSPME	Project Management and Entrepreneurship	2	0	0	2	2
NCMC-4	22BT6NCIPR	Personality development, Aptitude Skills (or any other)				PP/NP	
		Details of 20 AICTE Activity Points					
TOTAL:-			16	1	5	22	28

Professional Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-2	22BT6PESYB	Systems Biology	3	0	0	3	3
PE-2	22BT6PETAP	Toxicology & Pharmacology	3	0	0	3	3
PE-2	22BT6PEPBT	Plant Biotechnology	3	0	0	3	3
PE-2	22BT6PEAFC	Advances in Food chemistry	3	0	0	3	3
PE-2	22BT6PEBIM	Biomaterials	3	0	0	3	3

Open Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
OE-1	22BT6OEIMA	Instrumental Methods of Analysis	3	0	0	3	3
OE-1	22BT6OEBBI	Biosensors & Bioinstrumentation	3	0	0	3	3
OE-1	22BT6OEBTE	Battery Technology	3	0	0	3	3



DEPARTMENT OF BIOTECHNOLOGY

Course Title	GENOMICS AND PROTEOMICS										Credits	3		
Course Code	2	2	B	T	6	P	C	G	A	P	L-T-P	3	0	0

COURSE PRE-REQUISITES: Basics of Biomolecules, Biochemistry and Bioenergetics, Cell and Molecular Biology, Genetic Engineering and Bioinformatics.

COURSE DESCRIPTION: The course gives comprehensive view on the genetic organization of living organisms and contemporary high through put approaches for genome sequencing. The course also deals with high through put methods for genome, transcriptome and proteome analysis.

COURSE OBJECTIVES:

The objective of this course is to provide insights into high-throughput analysis by various methods of fundamental biomolecules such DNA, RNA and proteins. This course provides a platform to understand the networks underlying the cellular functions of living organisms.

UNIT I GENOME SEQUENCING.

[7 L]

Genome organization, sizes and C-value paradox, need for whole genome sequencing. First generation sequencing techniques and approaches: fluorescent automated method, shot gun and clone contig approaches. Next generation sequencing technologies: steps involved in MPS. Pyro sequencing, illumina sequencing methods. Third generation sequencing: Nanopore sequencing.

UNIT II GENOME MAPPING

[6 L]

Need for mapping, Genetic and physical techniques for mapping: Restriction mapping-double digestion, partial digestion, optical mapping, FISH and FISH amplification in mapping, Sequence alignment and software packages.

UNIT III GENOME ANALYSIS

[10 L]

Finding genes in genomes, assigning function to new genes. Importance of non-coding sequences- micro RNAs, Sh RNAs, PiWi and RNA interference. Molecular markers: RFLPs, RAPD, AFLP, micro and mini satellite markers, SNPs- types, methods of analysis and applications. Methods of measurement of mRNA expression- DNA micro arrays, RNA sequencing, DDRT-PCR, Quantitative- PCR.

UNIT IV QUANTITATIVE PROTEOMICS

[10 L]

Protein extraction, quantification, Cell-free protein production, Gel-based quantitative proteomics: Fluorescence 2-D Difference Gel Electrophoresis (DIGE), Gel-free mass spectrometry based quantitative proteomics, MALDI, and SELDI, Tandem Mass Spectrometry for Protein Identification and Peptide Mass finger printing.

Stable Isotope Labeling by Amino acids in Cell culture (SILAC), Isotope Coded Affinity Tag (ICAT), Isobaric Tagging for Relative and Absolute Quantitation (iTRAQ), multidimensional protein identification technology (MudPIT). Proteolytic labeling with [18O]-water, MS for PTM analysis, proteomic data analysis, Application of quantitative proteomics, Merits and demerits of gel-free quantitative proteomic techniques

UNIT V INTERACTOMICS

[6 L]

Techniques to study protein-protein Interactions (Yeast Two-Hybrid (YTH), Immunoprecipitation (IP), Protein microarrays (Abundance-based microarrays and function-based microarrays), Protein-protein interactions to understand biological Systems, pros and cons of using various interactomics techniques, **Label- free nanotechnologies in proteomics:** Surface Plasmon Resonance (SPR), Atomic Force Microscopy (AFM), carbon nanotubes & nanowires.



DEPARTMENT OF BIOTECHNOLOGY

PRIMARY REFERENCES

1. Genomes by Brown T A, 2006, Fifth edition, Blackwell Science
2. Gene Cloning & DNA Analysis: An Introduction by Brown T A, 2006, Fifth edition, Blackwell Science.
3. Introduction to Proteomics: Tools for the New Biology, D.C. Liebler, Humana Press, 2002.
4. Proteomics: From Protein Sequence to Function, S. R. Pennington, Michael J. Dunn. Garland Science,
5. Principles of Proteomics, R.M. Twyman, Bios Scientific Pub., 2004.

SECONDARY REFERENCES

1. A Primer of Genome Science by Greg Gibson and Spencer V, Third Edition, Muse, February 2009
2. Proteomics in Practice: A Guide to Successful Experimental Design, R. Westermeier, T. Naven, H-R. Håkansson, Wiley-VCH, 2008.

e-BOOKS

1. Genomes by Brown T A, 2006, Fifth edition, Blackwell Science
2. Principles of gene manipulation by S. B. Primrose, Richard M. Twyman, R. W. Old – 2001.

MOOCs

1. <http://www.nptel.ac.in/courses/102103017/30>
2. <http://www.nptel.ac.in/syllabus/102101007/>

COURSE OUTCOMES (COs)

1. Select and describe techniques and approaches for genome sequencing. Analyze and interpret related data (PO1, 5, 12).
2. Select and describe applications of various contemporary genome mapping techniques as well as interpret related data (PO1, 5, 12).
3. Select and describe applications of contemporary high-throughput techniques for analysis of genomes, transcriptomes and Proteomes. (PO 5, 12).
4. Differentiate the application of contemporary high-throughput techniques for protein protein interaction studies.(PO1,12)



DEPARTMENT OF BIOTECHNOLOGY

COURSE TITLE	ENZYME TECHNOLOGY AND KINETICS														
COURSE CODE	2	2	B	T	6	P	C	E	T	K	Credits	04	L-T-P	2-1-1	
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PRE-REQUISITES: Basics of Biomolecules, Biochemistry and Bioenergetics, Cell and Molecular Biology, and Genetic Engineering

COURSE DESCRIPTION: This course deals with one of the largest group of biomolecules what we know as enzymes. This course will cover various methods of extraction and purification of enzymes followed by activity determination. It also includes determination of kinetic parameters, various mechanism of enzyme action, immobilization techniques and effect of immobilization on the kinetic parameters and methods of creating novel enzymes.

COURSE OBJECTIVES: This course is designed to give insights on fundamentals of enzyme technology and applied biocatalysis. The course imparts knowledge on basic biochemical principles governing enzyme reactions, the mathematical models used to represent enzyme kinetics. Students will learn different types of enzyme mechanisms and applications of enzymes in medicine and industry.

PART A: THEORY UNIT – 1

FUNDAMENTALS OF ENZYME ACTIVITY AND METHODS OF EXTRACTION AND PURIFICATION

[6L+2T]

] Introduction and scope to enzyme science & engineering, characteristic features of enzymes, enzymes as biocatalysts, classification and nomenclature, types of enzyme specificities, Extraction of enzymes: Extraction of soluble enzymes and membrane-bound enzymes, nature of extraction medium and conditions of extraction. Purification of enzymes: preliminary and secondary purification procedures, degree of purification and criteria of purity of enzymes, uses of parameters such as specific activity, fold purification and % yield in purification, determination of molecular mass of enzymes, uses of molecular weight information, conceptual numerical.

UNIT- 2

ENZYME KINETICS

[5L+2T]

Units of enzyme activity, Enzyme kinetics, initial velocity studies, formation of ES complex, derivation of Michaelis-Menton equation, definition of K_m , V_{max} , K_{cat} , K_{cat}/K_m Lineweaver-Burk and Eadie-Hofstee plots, deviation from hyperbolic enzyme kinetics, role of effector molecules in enzyme kinetics, effect of temperature and pH on enzyme activity. Enzyme inhibition: competitive, uncompetitive and non-competitive; Regulations – allosteric and feedback regulation. Conceptual numericals. Methods for investigating the kinetics of enzyme catalyzed reactions – Initial velocity studies, rapid-reaction techniques.

UNIT - 3

BIOCATALYTIC FUNCTIONS

[6L+3T]

Mechanism of enzyme action: active site, activation energy and the reaction coordinate binding energy contribution to reaction specificity and catalysis. Catalytic mechanisms: Acid-base catalysis (ribonuclease A),



DEPARTMENT OF BIOTECHNOLOGY

Covalent catalysis (chymotrypsin), Metal ion catalysis (Carbonic anhydrase), catalysis through proximity and orientation effects, Substrate strain (lysozyme) & entropy effects. Mechanism of coenzymes (NAD⁺/NADP⁺, FAD/FADH, PLP, Coenzyme A, TPP, Biotin).

UNIT - 4 ENZYME IMMOBILIZATION TECHNIQUES [4L+3T]

Immobilization of enzymes: Techniques of enzyme immobilization physical adsorption, ionic binding, covalent binding, chelation, entrapment, encapsulation and cross-linking, kinetics of immobilized enzymes, effect of solute partition & diffusion on the kinetics, applications of immobilized enzymes with case studies.

UNIT - 5 ENZYME ENGINEERING [5L+3T]

Reaction engineering for enzyme-catalyzed biotransformation, biocatalysis in nonconventional media; enzymes in organic solvents, advantages of biocatalysts in organic media, biocatalysts from extreme thermophilic and hyperthermophilic microorganisms (extremozymes), artificial enzymes, catalytic antibodies, ribozymes, methods for the design and construction of novel enzymes.

PRIMARY REFERENCES

1. Fundamentals of Enzymology by Nicholas C Price and Stevens Oxford Press. (1999).
2. Enzymes – Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer.
3. Biotransformations in organic synthesis by Faber.
4. Enzymes in Industry: Production and Applications by W. Gerhartz (1990), VCH Publishers, NY
5. Enzyme Technology by M.F. Chaplin and C. Bucke, CUP, Cambridge, 1990

SECONDARY REFERENCES

1. Enzyme Technology by Messing.
 2. Purifying Proteins for Proteomics by Richard J Simpson, IK International, 2004
 3. Proteins and Proteomics by Richard J Simpson, IK International, 2003
 4. Enzymes by Dixon and Webb. IRL Press.
 5. Principles of Enzymology for technological Applications by Butterworth Heinemann Ltd. Oxford (1993).
 6. Biocatalyst for Industry by J.S. Dordrick (1991), Plenum press, New York.
- e-BOOKS**
1. <http://trove.nla.gov.au/version/45240099>
 2. http://biotech.unigreifswald.de/assets/downloads/3527304975_c01.pdf
 3. <http://as.wiley.com/WileyCDA/WileyTitle/productCd-3527329897.html>
 4. <https://global.oup.com/academic/product/fundamentals-of-enzymology->

MOOCs

1. <http://nptel.ac.in/courses/102102033/28>

PART B: ENZYME TECHNOLOGY LABORATORY

I Isolation of enzymes

1. Isolation of amylase from germinated mung beans/sweet potato.
2. Isolation of protease from papaya or pineapple.

- II Purification and characterization of enzymes
1. Ammonium sulphate fractionation.
2. Purification of amylase by column chromatography (demo).
3. Determination of molecular mass of enzyme by SDS-PAGE.

III Enzyme kinetics

1. Determination of K_m and V_{max}
2. Effect of temperature.



DEPARTMENT OF BIOTECHNOLOGY

3. Effect of pH.
4. Determination of specific activity.
5. Effect of inhibitors.

VI Immobilized enzymes

1. Immobilization of enzymes by gel entrapment (alginate/ carrageenan).
2. Kinetics of immobilized enzymes.

COURSE OUTCOMES (COs)

1. Evaluate appropriate methods for isolation, purification and characterization of enzymes and analyse and solve related problems(PO1 & PO2).
2. Analyze and solve problems related to kinetics of enzymatic reactions(PO2).
3. Compare and contrast methods in enzyme catalysis and interpret the related data (PO1).
4. Illustrate immobilization techniques and their applications (PO1 & PO7).
5. Comprehend the applications of nonconventional media in enzyme catalysis and design the methods for the creation of novel enzymes(PO1 & PO3).
6. Design, conduct experiments, analyse and interpret results related to enzyme reaction kinetics (PO1, PO3, PO4 & PO7).



DEPARTMENT OF BIOTECHNOLOGY

Course Title	BIOPROCESS TECHNOLOGY										Credits	4			
Course Code	2	2	B	T	6	P	C	B	P	T	L-T-P-S	3	0	1	0

COURSE PRE-REQUISITES: Microbiology, Basics of biomolecules, Unit operations, Biochemistry, Genetic engineering, Bio analytical techniques, Reaction engineering.

COURSE DESCRIPTION: This course emphasizes on applications of microorganisms in fermentation industry. Students will be introduced to various fermentation processes, basic design of the fermenter, media formulation and different aseptic techniques used in the fermentation industries. Student will be exposed to various downstream processing techniques to recover and purify value added products.

COURSE OBJECTIVES: This course is designed to illustrate the applications of micro-organisms in fermentation industry. This course also imparts good operational knowledge on design of fermenter, aseptic operations and separation techniques to develop and recover value added products from living organisms. Further students will be able to handle fermenter, design media, optimize process parameters and differentiate between different separations techniques to design a combination of downstream techniques for a given process to provide bioprocess engineering solutions.

PART A– THEORY

UNIT - 1 ISOLATION, STRAIN IMPROVEMENT AND DEVELOPMENT OF MICROBIAL INOCULA

[5L+2T]

The Range of Fermentation processes, industrially important microorganisms, screening of Microorganisms, Preservation and strain improvement (Mutant selection, Recombinant DNA methods) of industrially important Micro-organisms. Development of inocula for industrial fermentations – criteria for inoculum transfer, development of inocula for yeast, bacterial and mycelia processes.

UNIT - 2 MEDIA FORMULATION AND PROCESS OPTIMIZATION [6L+4T]

Functional requirements of Fermenters and Basic design, types of fermenters, Aseptic operation and Containment; Media formulation and optimization, Design of batch and continuous sterilization. Achievement and maintenance of aseptic condition: Sterilization of fermenter(SIP,FSIP,ESIP), air supply and exhaust gas from a fermenter, addition of inoculum, nutrients and other supplements, sampling, feed ports, sensor probes. Aeration and Agitation. Instrumentation and Control of various operational parameters (pH, Temperature, Pressure, Agitation, Antifoam, P_{O2}).

UNIT - 3 SCOPE OF DOWNSTREAM PROCESSING

[5L+3T]

Role and importance of downstream processing. criteria for selection of bio-separation techniques. Characteristics of biological mixtures, Process design Criteria with flow charts for various classes of byproducts (Cases studies for high volume-low value products and low volume-high Value products), Cell disruption methods for intracellular products. Filtration methods.

UNIT - 4 MEMBRANE ENRICHMENT OPERATIONS

[5L+2T]

Use of membrane diffusion as a tool for separating and characterizing naturally occurring Polymers; solute polarization and cake formation in membrane ultra-filtration – causes, consequences and control techniques; enzyme processing using ultra filtration membranes; separation by solvent membranes; ultra-filtration and reverse osmosis; Membrane – based separations (Micro- and Ultra-filtration) theory; design and configuration of membrane separation equipment; applications; precipitation methods with salts, organic solvents and polymers, supercritical extraction; In-situ product removal/integrated bioprocessing.



DEPARTMENT OF BIOTECHNOLOGY

UNIT - 5 SECONDARY PRODUCT SEPARATION TECHNIQUES AND PRODUCT RECOVERY

[5L+2T]

Liquid-liquid extractions, Crystallization: Principles of crystallization, crystallization equipment. Drying: Various types of drying methods, principles of drying, various types of industrial dryers and their criteria for choice. Freeze drying technique.

PRIMARY REFERENCES

1. Principles of Fermentation Technology by P.F. Stanbury, A. Whitkar and S.J. Hall, 1997, Aditya Book, New Delhi.
2. Bioseparation – Downstream processing for biotechnology by Belter P.A., Cussier E. and WeiShan Hu., Wiley Interscience Pub, 1988.
3. Bioseparations by Belter P.A. and Cussier E., Wiley, 1985.
4. Product Recovery in Bioprocess Technology - BIOTOL Series, VCH, 1990

SECONDARY REFERENCES

1. Biochemical Engineering by Bailey and Ollis, McGraw Hill Publisher.
2. Fermentation advances by Perlman. D (Ed), Aca press, New York.
3. Bioprocess Engineering by Shuler and Kargi Prentice Hall, 1992.

e- BOOKS

1. <http://www.springer.com/us/book/9780751403640>
2. http://ebookszones.blogspot.in/2011/05/principles-of-fermentation-technology_23.html

MOOCs

1. <http://nptel.ac.in/courses/102106022/>
2. <https://www.class-central.com/tag/bioprocess>

COURSE OUTCOMES

1. Comprehend and apply the inoculum development and strain improvement techniques for a desired fermentation process. (PO1)
2. Select a fermenter and formulate suitable media for a desired fermentation process. (PO1, PO3)
3. Apply techniques and processes for batch and continuous sterilization and solve related problems. (PO1, PO2, PO5)
4. Apply various downstream techniques for product isolation, separation and purification. (PO1, PO5)
5. Conduct experiments for production, isolation and recovery of bio - products. (PO4)

PART B – BIOPROCESS TECHNOLOGY LABORATORY

1. Cell disruption techniques
2. Solid – Liquid separation methods: Filtration
3. Solid – Liquid separation methods: Centrifugation
4. Phytochemical extraction and estimation.
5. Callus induction and preparation of artificial seed.
6. Separation of Amino acids / Carbohydrates by TLC
7. Production and estimation of Citric acid from fermented broth
8. Production and estimation of Penicillin.
9. Medium Design – a) PLACKETT – BUKMAN design for media.
b) Response surface methodology for media design



DEPARTMENT OF BIOTECHNOLOGY

- 10.** Sodium sulphite oxidation method for determination of Mass Transfer coefficient.
- 11.** Dynamic gassing method for determination of Mass Transfer coefficient.
- 12.** Qualitative and quantitative analysis of biomolecules by HPLC (demo) **13.** Freeze drying technique for product concentration (demo)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	PROJECT MANAGEMENT AND ENTREPRENEURSHIP										Credits	2		
Course Code	2	2	B	T	6	H	S	P	M	E	L-T-P	2	0	0

COURSE PRE-REQUISITES: Basics of management

COURSE DESCRIPTION: This course deals with planning, scheduling, organizing, and managing projects and information systems, Primary emphasis is on the project management process and tools used by professional management organizations serving manufacturing process and IT industry. Specifically, the focus is on the nine project management areas as defined by the Project Management Institute. These include project integration, scope, time, cost & cost controls, tradeoffs, quality, human resources, communications, risk, and procurement management.

COURSE OBJECTIVES: This course enables students to follow a structured approach for managing the projects.

UNIT 1 PROJECT IDENTIFICATION & FORMULATION [4L]

Characteristics of project, Functional management, Project Life cycle & its phases, project selection process, defining the project charter, project feasibility, Roles and responsibility of project manager and team members.

UNIT 2 PROJECT PLANNING, SCHEDULING & FINANCING [7L]

Work breakdown structure, Bar chart, Gantt chart, developing project schedule: scheduling techniques, terminologies in networking and networking convention: PERT, CPM, Sources of finance, role of financial institution in project financing, financial analysis of projects, financial risk assessment and risk mitigation planning.

UNIT 3 PROJECT EXECUTION, CO-ORDINATION, CONTROL, EVALUATION & BLOCKCHAIN [7L]

Communication in a project, Management Information system (MIS), cost control, resource allocation, balance sheet, basics of agile project management. Termination & closeout responsibilities, performance indicators, Project post audit: phases & types, agencies for post audit.

Introduction to blockchain and its applications in biotechnology, influence of blockchain in revolutionizing project management and smart contract management.

UNIT 4 INTRODUCTION TO ENTREPRENEURSHIP [4L]

Meaning & Importance of Entrepreneurship in India. Its barriers, agencies in entrepreneurship management and future of entrepreneurship. Women entrepreneur – Concept & steps to develop Women Entrepreneur.

UNIT 5 IDEA GENERATION AND SKILL SETS [4L]

Self-Assessment of Qualities, Skills, Resources and Dreams, Generation of Ideas; Business Ideas vs. Business Opportunities, Opportunity Assessment – Factors, Micro and Macro Market Environment, Feasibility Study, practical & economic feasibility, Business Plan Preparation; Execution of Business Plan, Business practice risk assessment, Role of networking in entrepreneurship, Relevant case studies: strategy development exercise in business development



DEPARTMENT OF BIOTECHNOLOGY

PRIMARY REFERENCES

1. **Project Management:** S.Chodhary, Tata McGraw Hill Publication.
2. **Project Management:** K.Nagarajan, Sixth edition, New Age International Publishers.
3. **Entrepreneurship and Management-** S Nagendra and V S Manjunath- Pearson Publication 4 /e, 2009.
4. **Dynamics of Entrepreneurial Development and Management-**Vasant Desai-Himalaya Publishing House.

SECONDARY REFERENCES

1. **Project Management Planning and Control Techniques:** Rory Burke, Fifth Edition, Wiley India edition.
2. **Project Management The Managerial Process:** Clifford F Gray and Erik W Larson, Fifth Edition, McGraw Hill publication.
3. **Project Management for Business, Engineering and Technology:** John.M.Nicholas and Herman Steyn, Third edition, Elsevier publication.
4. **Entrepreneurship Development** – Poornima M Charanthimath Pearson Education 2006.
5. **Entrepreneurship and management** - Shashi k Gupta- Kalyani publishers, Latest edition.

e- BOOKS

1. <http://www.free-management-ebooks.com/Principles of project management-Powl Newton & Helon Bristol>

MOOCs

1. Fundamentals of Project Planning and Management (Coursera)
2. Financial Decision Rules for Project Evaluation (edX)

COURSE OUTCOMES (COs)

1. Comprehend the various aspects of project management including role of project manager.
2. Apply scheduling and financing techniques for given project to estimate project cost and duration. (PO1)
3. Analyze the performance of project by applying suitable evaluation methods (PO2)
4. Develop work breakdown structure, organization structure and construct project life cycle chart for given biotechnology process. (PO3)
5. Identify, analyze and formulate the solution for biotechnology problem applying the concepts of project management (PO3, PO11)
6. Work individually or in a team in using the project management concepts and communicate the findings as oral presentations and report submission. (PO9, PO10)



DEPARTMENT OF BIOTECHNOLOGY

PROFESSIONAL ELECTIVES

Course Title	SYSTEMS BIOLOGY (Computational Biology)														
Course Code	2	2	B	T	6	P	E	S	Y	B	Credits	03	L – T – P	3 – 0 – 0	
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PREREQUISITES: Molecular biology, Biochemistry, Enzyme technology and kinetics, Process Engineering thermodynamics, Mathematical concepts.

COURSE DESCRIPTION: Systems biology is the scientific discipline that studies the systemic properties and dynamic interactions in a biological object. This course is designed to provide an overview of systems biology as a rapidly developing field with established and emerging tools and methods. Students will be able to learn how to formulate mathematical models of biological processes, how to analyse them, how to use experimental data and other types of knowledge to make models more precise, and how to interpret their simulation results. **COURSE OBJECTIVES:** Systems biology is an emerging field that aims to understand biological systems and organisms at the systems level rather than focusing on only a small number of components. This helps understand the biological mechanisms at a deeper level which is necessary for effectively developing applications that would benefit the human society. Systems biology is interested in investigating the working principles of transcriptional, signal transduction and metabolic networks and how organisms utilize them for sensing and responding to environmental signals

UNIT – 1 Introduction to Systems Biology

7L

What is a Model, Dynamic Mathematical Model, why it is needed, how they are used, Basic Features, Dynamic Mathematical Models in Molecular Cell Biology: Drug target prediction in *Trypanosoma brucei* metabolism, Identifying the source of oscillatory behaviour in NF- κ B signalling, Model-based design of an engineered genetic toggle switch, Establishing the mechanism for neuronal action potential generation. Analysis of Dynamic Mathematical Models: sensitivity analysis, parameter fitting.

UNIT – 2 Model Fitting, Reduction, and Coupling

7L

Parameter Estimation, Regression, Estimators, and Maximal Likelihood, parameter Identifiability, Bootstrapping, Probability Distributions for Rate Constants, Optimization Methods, Model Selection, The Problem of Model Selection, Selection Criteria, Model Reduction, Model Simplification, Reduction of Fast Processes, Quasi-Equilibrium and Quasi-Steady State, Global Model Reduction.

UNIT – 3 Structural Modeling and Analysis of Biochemical Networks:

9L

System Equations, Information Encoded in the Stoichiometric Matrix, The Flux Cone, Elementary Flux Modes and Extreme Pathways, conservation relations – Null Space of NT

Constraint-Based Flux Optimization: Flux Balance Analysis, Geometric Interpretation of Flux Balance Analysis, Thermodynamic Constraints, Applications and Tests of the Flux Optimization Paradigm, Extensions of Flux Balance Analysis, Exercises, Basic Components of ODE Models, Illustrative Examples of ODE Models.



DEPARTMENT OF BIOTECHNOLOGY

UNIT – 4 Data Formats, Simulation Techniques, and Modeling Tools

9L

Simulation Techniques and Tools: Differential Equations, Stochastic Simulations, Simulation Tools: MATLAB Simbiology toolbox, Cell designer, COPASI.

Standards and Formats for Systems Biology: Systems Biology Markup Language, BioPAX, Systems Biology Graphical Notation.

Data Resources for Modeling of Cellular Reaction Systems: General-Purpose Databases, Pathway Databases, Model Databases.

Sustainable Modeling and Model Semantics: Standards for Systems Biology Models , Model Semantics and Model Comparison, Model Combination, Model Validity.

UNIT – 5 Models of metabolic and signalling Systems

7L

Metabolic Systems: Basic Elements of Metabolic Modeling, Toy Model of Upper Glycolysis, Threonine Synthesis Pathway Model

Signalling Pathways: Function and Structure of Intra- and Intercellular Communication, Receptor–Ligand Interactions, Structural Components of Signalling Pathways, analysis of Dynamic and Regulatory Features of Signalling Pathways.

Text books:

1. Systems Biology: A Textbook, 2nd Edition (Wiley). Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald.
2. Mathematical Modelling in Systems Biology: An Introduction. The MIT Press. Brian Ingalls

Course Outcomes

1. Comprehend the concepts of systems biology.
2. Able to create and design model of biochemical systems. (PO3)
3. Able to apply the tools and techniques. (PO1, PO5)
4. Analyse and optimize the model system. (PO2)



DEPARTMENT OF BIOTECHNOLOGY

COURSE TITLE	TOXICOLOGY & PHARMACOLOGY (Stream: Pharma BT)														
COURSE CODE	2	2	B	T	6	P	E	T	A	P	Credits	00	L-T- P	3-0-0	
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PRE-REQUISITES: Biochemistry, Molecular Biology, Basics of Biomolecules, Bioinformatics, Genetic Engineering.

COURSE DESCRIPTION: This course includes concepts on mechanisms of action of drugs from the level of the cell, to the organ, and to the organism as a whole. It also deals with concepts related to identification of potential drug targets, and define adverse effects of chemicals such as drugs, industrial chemicals and environmental pollutants. It also describes important toxicological principles, and mechanisms of toxicity.

COURSE OBJECTIVES:

This course provides fundamental information and the general principles of pharmacodynamics and pharmacokinetics. It explains the basis of Drug dosage and target specificity and the role of various drugs on Metabolic processes as well as principles of toxicology and toxicity assessment

UNIT I INTRODUCTION TO PHARMACOLOGY

(7L)

Nature and source of drugs, routes of drug administration and their advantages. Drug absorption, distribution, metabolism, and excretion, Bioavailability, first pass metabolism, excretion and Bio equivalence, biological half-life of drug and its significance.

UNIT II PHARMACODYNAMIC AND TARGET SPECIFICITY

(6L)

Principles and mechanism of drug action, factors affecting drug action. General considerations, pharmacological classification, mechanism of action with case studies, tolerance and dependence.

UNIT III PRINCIPLES PHARMACOKINETICS AND PHARMACOTHERAPY

(10L)

Basic concepts, Adverse Drug Reactions and treatment of poisoning. Basic Concepts of Pharmacotherapy, Clinical Pharmacokinetics and individualization of Drug Therapy, drug Use During Infancy and in the Elderly (Pediatrics & Geriatrics), Drug use during Pregnancy, drug induced Diseases.

UNIT IV PRINCIPLES OF TOXICOLOGY

(9L)

Brief history, scope, different areas of modern toxicology, classification of toxic Substances, various definitions of toxicological significance. Effect of duration, frequency, route and site of exposure of xenobiotics on its toxicity. Characteristic and types of toxic response.



DEPARTMENT OF BIOTECHNOLOGY

UNIT V EVALUATION OF TOXICITY

(7L)

Dose response curve, various types of dose response relationships, assumptions in Deriving dose response, LD50, LC50, TD50 and therapeutic index.

PRIMARY REFERENCES

1. Cassarett and Duoll's Toxicology: The basic science of poison. 8th edition (2013) C. D. Klaassen; McGraw Hill Publishers, NewYork. ISBN: 9780071769235.
2. Cassarett and Doull's "Essentials of Toxicology", 7th Edition (2010), C. Klaassen and J. B. Whatkins; McGraw Hill Publisher, ISBN: 978-0071622400.
3. Principles of Toxicology. (2015) 2nd edition by D. E. Pratt and A. R. TM. E. N. T. S. O. F. N. B. I. O. A. N. T. D. E. C. T. H. N. M. O. L. B. O. G. R. O. Y. W. N.; CRC press, ISBN: 9781466503427.
4. Pharmacology, 7th edition (2011), H.P. Rang, M. M. Dale, J. M. Ritter and P. K. Moore; Churchill Livingstone, ISBN: 9780702045042.

COURSE OUTCOMES

1. Understand the importance drug dosage, exposure and target specificity
 2. Distinguish different phases of drug and toxicants metabolism (PO1)
 3. Demonstrate the principles of pharmacodynamics and pharmacokinetics (PO5)
- Illustrate toxicity risk assessment and fate of toxicants in humans. (PO5, PO12)



Course Title	PLANT BIOTECHNOLOGY (Stream: Advanced BT)													
Course Code	2	2	B	T	6	P	E	P	B	T	Credits	03	L – T – P	3– 0 – 0

COURSE PRE-REQUISITES: Cell and Molecular Biology, Microbiology, Environmental Biotechnology and Genetic Engineering

COURSE DESCRIPTION: This course is designed as a comprehensive exploration to the field of Plant Biotechnology. The course explains applications of modern biotechnological tools that have resulted in greater advances for agriculture and society. It's an interdisciplinary course and involves basic knowledge of Cell Biology, Genetic Engineering, Bioinformatics and Biochemistry. This course covers the methods, applications, and implementation of plant biotechnology in agriculture. The topics covered include technical as well as regulatory and policy aspects of aspects of plant biotechnology.

COURSE OBJECTIVES: The aim of the course is to give insights into classical and modern plant biotechnology approaches and procedures for the production of genetically improved traits in crops. Further students will be explored to the biotechnological procedures in pharmaceutical and food industry.

UNIT - 1 PLANT CELL CULTURE AND METABOLITE PRODUCTION [6 L]

Totipotency; Regeneration of plants; Plant growth regulators and elicitors; Tissue culture and Cell suspension culture system: methodology, kinetics of growth and, nutrient optimization; Production of secondary metabolites by plant suspension cultures; Plant products of industrial importance

UNIT – 2 TECHNIQUES FOR GENE TRANSFER [7L]

Gene transfer technique, Introduction to Plant vectors (*A. tumefaciens* and *A. rhizogenes*), Particle bombardment, electroporation, microinjection, Agrolistic. Screening and selection of transformants – Antibiotic selection and reporter assays, PCR and hybridization methods, plastid transformation. Mechanism of transgene interaction: Transgene stability and gene silencing. Generation and maintenance of transgenic plants.

UNIT – 3 TRANSGENIC PLANTS FOR BIOTIC AND ABIOTIC STRESSES [7 L]

Biotic stresses & types: Application of plant transformation – Bt genes, Structure and function of Cry proteins – mechanism of action, critical evaluation. Non-Bt like protease inhibitors, alpha amylase inhibitor, Baculoviruses as biopesticides, Transgenic technology for development of virus, bacterial and fungal resistance plants. Abiotic stress – Introduction to drought and salinity stresses, transgenic strategies for development of drought resistant plants, case studies. Post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, barstar and barnase systems. Herbicide resistance - phosphinothricin, glyphosate, atrazine; insect resistance. Biosafety regulations and evaluation of transgenics contained conditions. Implications of gene patents.



DEPARTMENT OF BIOTECHNOLOGY

UNIT - 4 MOLECULAR FARMING AND MARKERS IN PLANTS

[9 L]

Plant metabolic engineering and industrial products (fatty acids, industrial oils, flavonoids, carotenoid and provitamin), Molecular farming for the production of industrial enzymes, biodegradable plastics, polyhydroxybutyrate, antibodies, edible vaccines. Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding molecular breeding; Genomics and 108 genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression.

UNIT - 5 NITROGEN FIXATION, ALGAL TECHNOLOGIES AND SEED TECHNOLOGY

[10 L]

Nitrogen fixation and biofertilizers- Diazotrophic microorganisms, nitrogen fixation genes. Hydrogenase - Hydrogen metabolism. Genetic engineering of hydrogenase genes. Blue-green algae and Azolla - Identification of elite species and mass production for practical application. Algae as a source of food, feed, single cell protein, biofertilizers; industrial uses of algae. Mass cultivation of commercially valuable marine macroalgae for agar agar, alginates and other products of commerce and their uses. Seed technology and its importance; production processing and testing of seeds of crop plants; seed storage, seed certification; role of NSC in production; New seed policy and seed control order, Terminator Technology.- Impact of The High Yielding And Short Duration Varieties On Cropping Patterns

PRIMARY REFERENCES

1. Plant Cell Culture: A Practical Approach by R.A. Dixon & Gonzales, IRL Press
2. Plant biotechnology the genetic manipulation of plants, Nigel W. Scott, Mark R, Fowler, 2nd Edition

SECONDARY REFERENCES

1. Molecular Biotechnology: Principles and Practices by Channarayappa, 2006, University Press.
2. Plant Tissue Culture: Applications and Limitations by S.S. Bhojwani (1990), Elsevier,
3. Amsterdam. TJ Fu, G Singh and WR Curtis (Eds): Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic Press, 1999.
4. Biotechnology in Agriculture, MS Swamynathan, McMillian India Ltd. 5. Gene Transfer to Plants 1995 Polyykus I and Spongernberg, G.Ed.Springer Scam.
6. Genetic Engineering with Plant Viruses, 1992 T Michael, A Wilson and JW Davis, CRC Press.
7. Molecular Approaches to Crop Improvement 1991. Dennis Liwelly Eds.
8. Plant Cell and Tissue Culture- A Laboratory manual 1994. Reinert J and Yeoman MM, Springer.

e-BOOKS

1. <http://onlinelibrary.wiley.com/doi/10.1002/9780470282014.fmatter/pdf>
2. https://books.google.co.uk/books/about/Introduction_to_Plant_Biotechnology.html?id=RgQLISN8zT8C

MOOCs

Applications of plant biotechnology in crop improvement, <http://nptel.ac.in/courses/102103016/>



COURSE OUTCOMES

1. Apply various plant transformation techniques to develop transgenic (PO1, PO5).
2. Usage of ideal genetic engineering strategies for the improvement of agriculture and production of novel biopharmaceuticals compounds (PO6, PO7)
3. Compare modern genomics tools with traditional genetics for improving crop traits (PO5).
4. Implementation of current regulations for the production and use of GMOs (PO8).



DEPARTMENT OF BIOTECHNOLOGY

Course Title	ADVANCES IN FOOD CHEMISTRY (Stream: Food Technology)										Credits	3		
Course Code	2	2	B	T	6	P	E	A	F	C	L-T-P	3	0	0

COURSE PRE-REQUISITES: biochemistry, botany, microbiology, nutritional science, biotechnology, molecular biology and chemistry

COURSE DESCRIPTION: Food chemistry is an interdisciplinary course encompassing basic and advanced science disciplines like biochemistry, botany, microbiology, nutritional science, biotechnology, molecular biology and chemistry. The knowledge of the chemical composition and properties of food is of primary importance to ensure product quality. This course provides students with a knowledge base of advanced food chemistry topics, with an emphasis on chemical changes during processing and storage. The key topics covered include food enzymology, food proteins, food colloids, food additives, food flavours, food colorants, functional foods and bioactives. Students will be able to understand the importance of analytical techniques to assess these components and associated chemical reactions.

COURSE OBJECTIVES: This course is designed to provide an overview of advanced food chemistry topics and analytical techniques involved in assessing food samples. Students will be able to gain knowledge on novel product development and value addition of foods which will prepare the students be well versed with recent trends in industry. **UNIT-1**

OVERVIEW OF FOOD CHEMISTRY

[8L]

Basics of Food chemistry, General Properties of Major and minor food Components, Chemical Properties and applications of Food Additives: Preservatives, Dietary Ingredients, and Processing Aids. Chemical Properties and Applications of Food Additives: Flavor, Sweeteners, Food Colors, and colloids, Analytical techniques used for detection of food components.

UNIT-2 PHYSICOCHEMICAL PROPERTIES OF BIOMOLECULES

[10 L]

Physical and Chemical Properties of biomolecules, Solute effects on water: state of water in foods, Kinetic principles, Water activity: principles, measurement, control, effects, related concepts. Acid-base chemistry of foods and common additives. Effects of food processing: changes occurring in chemical, functional & nutritional properties of proteins, Nitrite function, chemistry and nitrosamine formation. Factors affecting reaction rate; characteristics of enzymatic reactions, Deleterious enzymes in food systems. Simple sugars, sugar derivatives and oligosaccharides; Basic chemistry; conformation, anomeric forms, equilibria, reactivity, sweetness. Sugar derivatives: sugar alcohols, glycosides, etc. Dietary fiber: components, properties, analysis Modification of fats: Hydrolytic rancidity & oxidative rancidity.

UNIT-3

CHEMICAL COMPOSITION OF FOOD COMMODITIES

[7 L]

Principles of Chemical Analysis of Food Components, Classical Wet Chemistry Methods. Chemical



Composition of Bakery Products, Beverages, milk and milk products, egg and egg products, Food Products from Genetically Modified Organisms, Meat and Meat Products, Sugar and Confectionery Products, Organic Food Products.

DEPARTMUENNITT-O4F

NUTRITIONAL AND TOXICOLOGICAL ASPECTS DURING PROCESSING [7 L]

Chemical Changes of Nutrients during processing; Drying, freezing, heating and Pressure-Assisted Thermal Processing, nutritional changes during storage of food, bioavailability and stability, Environmental and physical factors affecting these changes.

UNIT-5

NUTRACEUTICALS AND FOOD NANOTECHNOLOGY [7 L]

Bioactive substances from plant, microbial, animal origin, synthetic bioactive substances. Introduction to Food Nanotechnology, importance and recent trends in food industry. Concept of Nano foods, commercial products, application of nanotechnology in developing biosensors, nanosensors for food Safety, Nanomaterials for Food Processing.

PRIMARY REFERENCES

1. Peter C.K. Cheung Handbook of Food Chemistry-Springer
2. Owen R. Fennema Food Chemistry Third Edition University of Wisconsin Madison

MOOCs

1. https://onlinecourses.swayam2.ac.in/cec20_ag10/preview Course Outcomes:
1. Comprehend the physico-chemical characteristics and basics of food chemistry.
2. Apply biotechnological tools and principles to understand the chemical reactions of biomolecules (PO1, PO5).
3. Determine and assess food components during processing and storage (PO2, PO5).
4. Analyse, compile and present individually the case studies or real world food related concepts (PO9, PO10, PO12).



DEPARTMENT OF BIOTECHNOLOGY

COURSE TITLE	BIOMATERIALS (Stream: Vaccines & Regenerative Biology/Medicines)													
COURSE CODE	2	2	B	T	6	P	E	B	I	M	Credits	00	L- T-P	3- 0-0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

COURSE PRE-REQUISITES: Knowledge of basic cell and molecular biology, Human physiology, Chemistry, Basics of Biomolecules.

COURSE DESCRIPTION: this course deals with the concepts and different types of biomaterials, artificial organs available/development, regulatory aspects pertaining to use of biomaterials as biological/ biocompatible scaffolds in medicine and wound healing.

COURSE OBJECTIVES: To enable the students to understand the nature and applications of biomaterials and usage of biocompatible materials in medicine and wound healing.

UNIT – 1

CHARACTERISTICS OF BIOMATERIALS

[6 L]

Introduction to Materials Science: mechanical properties, Strength and ductility, viscoelasticity Classification of bio-materials (inert, bioactive and biodegradable) Materials Used In Medicine: Metals; Polymers; Hydrogels; Bioresorbable and Biodegradable Materials, organic functional groups needed for biomaterials.

UNIT - 2

IMPLANT MATERIALS

[7 L]

Metallic implant materials, stainless steels, co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite and glass-ceramics, polymers, dental materials.

UNIT-3

BIOCOMPATIBILITY & HOST REACTIONS TO BIOMATERIALS

[7 L]

Protein adsorption to materials, Inflammation; Wound healing and the Foreign body response; Systemic toxicity and Hypersensitivity; Blood coagulation and Blood-materials Interactions; Tumorigenesis. Degradation of Materials in Biological Environment: Degradation of Polymers, Metals and Ceramics.



UNIT- 4

ARTIFICIAL ORGANS AND IN VIVO SYNTHESIS OF TISSUES

[10L]

Artificial Heart, Prosthetic Cardiac Valves, Limb prosthesis, Externally Powered limb Prosthesis, Dental Implants. In vivo synthesis of skin, peripheral nerves. Rules for in vivo synthesis. Regulatory aspects related to tissues, blood products and tissue Engineering.

UNIT -5

SCAFFOLDING

[9 L]

Architectural, biological, and mechanical features of scaffolds, Biological scaffolds (collagen, lamin, glycosaminoglycans, elastin, fibroin). Natural polysaccharides (alginate, dextran, Chitosan, cellulose). Hydrogels, polymer microspheres, Scaffold design fabrication, 3D printing

PRIMARY REFERENCES

1. Introduction to Biomaterials by Joon Park and RS Lakes.
2. Biomaterials by SV Bhat, Springer's publication.

SECONDARY REFERENCES

1. Handbook of Materials for Medical Devices by J R Davis.
2. Biomaterials Science and Engineering by Park JV, Plenum Press, 1984.
3. Catalysis in Chemistry by William Jenck.
4. Bioconjugate Techniques by Greg Hermanson.
5. Biomaterials and regenerative medicine in ophthalmology by T VChirila, Queensland Eye Institute. **e-BOOKS**
1. Cells and Biomaterials in Regenerative Medicine (<http://www.intechopen.com/books/cellsand-biomaterials-inregenerative-medicine>) ml
2. <http://genome.tugraz.at/biomaterials.shtml>

MOOCs

1. <http://nptel.ac.in/syllabus/syllabus.php?subjectId=113104009>
2. <http://nptel.ac.in/syllabus/syllabus.php?subjectId=102106036>

COURSE OUTCOMES (COs)

1. Comprehend the use of various biomaterials (PO1, PO2)
2. Evaluate the use of suitable biomaterials for various applications and their biocompatibility (PO1, PO2)
3. Analyse the role of implants in artificial organs (PO1, PO2, PO5)
4. Illustrate use of implants in tissue replacement (PO2)



DEPARTMENT OF BIOTECHNOLOGY

OPEN ELECTIVES

COURSE TITLE	INSTRUMENTAL METHODS OF ANALYSIS														
COURSE CODE	2	2	B	T	6	O	E	I	M	A	Credits	00	L-T-P	3-0-0	
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PRE-REQUISITES:

Engineering Physics, Engineering Chemistry, Engineering Mathematics, and basic knowledge about Biological Science.

COURSE DESCRIPTION:

The field of biotechnology has become more quantitative and interdisciplinary as research in biotechnology continues to grow at a tremendous rate with broader and complex applications in medicine, agriculture, the environment and nano biotechnology. As biological concepts and models become more quantitative, biological research will be increasingly dependent on concepts and methods drawn from other scientific disciplines. Similarly, students from other discipline (mechanical, electrical, civil, chemical, computer science, metallurgical, etc.,) can be interested to explore biological systems to develop new technologies, tools and products that are useful in research, industry and agriculture. This course is designed to exclusively for students of other disciplines to gain the knowledge on the principle, instrumentation and applications of various biophysical techniques used for the separation, purification and characterization of various biomolecules.

COURSE OBJECTIVES:

1. To develop and reinforce connections between biology and other scientific disciplines
2. To enable the students of other disciplines to gain the knowledge on the various biophysical techniques used for bimolecular separation, purification and characterization.

UNIT I

ADVANCED MICROSCOPIC TECHNIQUES

[9 L]

Electron Microscopy: Scanning electron microscope, Transmission Electron microscope. Scanning probe microscopy: Atomic force microscopy.

UNIT II

COLORIMETRY AND SPECTROPHOTOMETRY

[8 L]

General features of absorption – spectroscopy, transmittance, absorbance, and molar absorptivity. Beer Lambert's law and its limitations, difference between Colorimetry and Spectrophotometry

Instruments – Single beam UV- Visible Spectrophotometer, Double beam UV- Visible Spectrophotometer.

Lamps used as energy sources. Verification of Beer's law. IR Spectrophotometer: Principle, Sources of Radiations, Sampling, Block diagram of FT-IR Spectrophotometer, Fluorescence spectroscopy, NIR spectroscopy, CD spectroscopy.



DEPARTMENT OF BIOTECHNOLOGY

UNIT III BIOPHYSICAL TECHNIQUES

[8 L]

Rayleigh scattering, NMR, EPR Xray, (single crystal diffraction,) Atomic absorption and Flame emission spectroscopic techniques, and Mass spectroscopy (Only principle, Instrumentation and applications and no derivation required).

UNIT IV ELECTROANALYTICAL METHODS

[7 L]

Types of Electroanalytical Methods. I) Interfacial methods – a) Potentiometry: Numerical Problems. Application of Potentiometry b) Voltametry –; Introduction to types of voltametric techniques, micro electrodes, Over potential and Polarization. II) Bulk methods – Conductometry, Conductivity Cell, Specific Conductivity, Equivalent Conductivity. Numerical Problems. Applications of conductometry.

UNIT V CENTRIFUGATION TECHNIQUES

[7L]

Basic principles, Different types of centrifuges, Analytical and Preparative Ultracentrifugation methods. (Only principle, Instrumentation and applications and no derivation required).

TEXT BOOKS

1. Biophysical Chemistry by Cantor R., and Schimmel P.R
2. Physical Biochemistry by David Freifelder (N H Freeman and Company)
3. Biophysical Principles of Structure & Function by Fred M. Snell & Sidney Shulman

REFERENCE BOOKS

1. Biophysics – An Introduction by Cotterill, Wiley Student Edition
2. Foundations of Biophysics by A.L. Stanford.

E-BOOKS

1. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson <https://books.google.co.in/books?isbn=052165873X>
2. Biophysical Techniques by Iain Campbell <https://0b9411cb7057497b22db0cd9f69e827bce11ede8.googleusercontent.com/host/0B5XjjBGDoIrhNIFVcVhQWjA2a1k/Biophysical-Techniques-IainCampbell-ebook-51iBvNTIHhL.pdf> MOOCs

<http://nptel.ac.in/courses/102107028/>

<http://nptel.ac.in/courses/102103044/>

COURSE OUTCOMES

1. Ability to understand and remember the principles and applications of various techniques used in the purification and analysis of biomolecules. (PO1)
2. Ability to select and apply appropriate tools and techniques in the purification and analysis of biomolecules. (PO 5)
3. Ability to critically analyze different techniques used for the purification and analysis of biomolecules. (PO 2)
4. Ability to design solution to problems by applying suitable components of bio-analytical techniques. (PO 3, 7)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	BIOSENSORS AND BIOINSTRUMENTATION										Credits	3		
Course Code	2	2	B	T	6	O	E	B	B	I	L-T-P	3	0	0

Pre-requisites:

Knowledge of Human Physiology, Engineering Physics, Basics of Electrical and Electronics

COURSE DESCRIPTION: This course deals with the fundamentals of measurement science are applied to optical, electrochemical, and mass and pressure signal transduction. This course also examines the principles, technologies, methods and applications of biosensors and bioinstrumentation by bridging engineering principles to understanding of biosystems in sensors and bioelectronics. The Biosensors and Instrumentation course examines the methods used to interface sensors for biological and biomedical applications with electronics.

COURSE OBJECTIVES: To enable the students to gain knowledge on the various biosensors and bioinstrumentation techniques which are used in biomedical engineering field.

UNIT 1

[08 hrs]

FUNDAMENTALS OF MEDICAL INSTRUMENTATION

Sources of biomedical signals, Design of medical instruments, components of the biomedical instrumentation system, General constraints in design of medical instrumentation systems, Regulation of medical devices; Principles of EEG, ECG and EMG, Origin of bioelectric signals, Recording electrodes - Electrode-tissue interface, metal electrolyte interface, electrolyte - skin interface, Polarization, Skin contact impedance, Silver – silver chloride electrodes, Electrodes for ECG, EEG, EMG. Physiological Transducers: Introduction, classification of transducers, performance characteristics of transducers, Classification, displacement, position, motion, pressure, temperature, photoelectric, optical fibre sensor transducers; Conceptual numerical. Electrical Hazards & their Prevention - Physiological effects of electrical currents, preventive measures to reduce shock hazards, leakage current, isolation of patient circuit, open ground problems and earthing methods.

UNIT 2

[07 hrs]

MEDICAL IMAGING SYSTEMS AND BIOINSTRUMENTATION FOR CARDIOVASCULAR CONDITIONS

Medical Imaging Systems: X-Ray, computed tomography and MRI. Biomedical telemetry. Overview of the Heart and cardiovascular system; The Heart; The measurement of heart rate; measurement of pulse rate; Types of blood pressure measurement: Indirect and Direct measurements; measurement of blood flow rate: Electromagnetic induction, ultrasound transmission, Thermal conversion, Radiographic principles, Indicator dilution; Blood gas analyzers: Blood pH measurement, Measurement of Blood pCO₂, pO₂; Plethysmography; Pacemakers(Need for Cardiac pacemaker, External pacemaker, Implantable pacemaker, Programmable pacemakers); Defibrillators(DC defibrillator, AC defibrillator and Implantable Defibrillator) , Conceptual numericals.

UNIT 3

[07 hrs]

BIOMEDICAL DEVICES FOR RESPIRATORY SYSTEM

Overview of respiratory system; The Physiology of the Respiratory system; Tests and instrumentation for the mechanics of breathing: Lung volumes and Capacities, Mechanical measurements, instrumentation for measuring the mechanics of breathing; gas exchange and distribution: measuring of gaseous exchange and diffusion, measuring of gas distribution; Respiratory therapy equipments; Anesthesia machines: related instrumentation of equipments involved and sensors, Conceptual numericals.



DEPARTMENT OF BIOTECHNOLOGY

UNIT 4

[06 hrs]

BIOSENSORS & BIOCHIPS

Introduction to biosensors - History and overview of Biosensors, definition and concept, components of a biosensor, consideration, commercial requirement and oDbEstPaAclReTsMinEbNiTosOenFsBoIrOdTeEvCeHloNpOmLeOnGt;YTypes of biosensors;

Biochip-Introduction and structure of DNA Chips, design and operating principles, related instruments; BIA core- an optical biosensor.

UNIT 5

[09 hrs]

APPLICATIONS OF BIOSENSORS

Biosensors for Health Applications: Introduction, Biosensors for diabetes applications, Biosensors for cardiovascular diseases applications, Biosensors for cancer applications. Nanobiosensor for Health Care: Nanobiosensors based on gold nanoparticles (GNPs) (Glucose biosensors, Cholesterol biosensors, Tyrosinase biosensors, Urease biosensors, Acetylcholinesterase biosensors, Horseradish peroxidase). Biosensors for Environmental Applications: Introduction, Heavy metals, Biochemistry Oxygen Demand (BOD), Nitrogen compounds, PCBs, Phenolic compounds, Endocrine disruptors and hormones, Organophosphorus compounds (OP). use of biosensors for pollution control; Biosensors in aquatic and soil samples; Benefits of biosensors to bioprocess and its challenges; Electrochemical sensors, chemical fibre sensors, ion selective FETs, Micro Electromechanical sensors(MEMS) and the commercial development of biosensors,

PRIMARY REFERENCE BOOKS:

1. **Biomedical instrumentation and Measurements** by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Second edition, 2009
2. **Bioinstrumentation and Biosensors** by Donald L Wise, Marcel Dekker Inc. 1991
3. **Biosensors** by Cooper J.M, Oxford publication, 2004.

SECONDARY REFERENCE BOOKS:

1. **Hand Book of Biomedical Instrumentation** by R. S. Khandpur, Second Edition, Tata McGraw- Hill, 2008

e-books:

1. <http://www.intechopen.com/books/biosensors-for-health-environment-and-biosecurity>
2. <http://www.intechopen.com/books/environmental-biosensors>
3. <http://www.intechopen.com/books/biosensors-emerging-materials-and-applications>

4. <http://www.e-booksdirectory.com/listing.php?category=366> Moocs:

<https://www.mooc-list.com/tags/biomedical> 2. <https://www.class-central.com/tag/biosensors>

Course Outcomes:

1. Comprehend the principle, components, functions and applications of different biomedical devices
2. Select and apply the knowledge of different types of biomedical devices for various measurements related to cardiovascular system and respiratory system (PO1)
3. Apply the principle, functions and applications of different biosensors and their components and select the components to design a biosensor (PO3, PO5)
4. Analyse the output of various biomedical devices to diagnose the diseases (PO2)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	BATTERY TECHNOLOGY													
Course Code	2	2	B	T	6	O	E	B	T	N	Credits	04	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

COURSE DESCRIPTION: Energy markets are undergoing game-changing changes in the modern world. In our daily life, batteries are used for a variety of things. Mobile phones, inverters, electric cars, automotive applications, solar energy storage systems, and many other products require batteries. This course deals with the fundamentals of batteries, classifications, performance characteristics, energy, and power measurement. Further, it focuses on the chemistry of primary batteries, their types, and chargedischarge characteristics. The next segment of the course deals with the construction and working of rechargeable or secondary batteries. The course emphasizes the need and functioning of various types of fuel cells. The construction and working of lithium-ion battery packs used in electrical vehicles are discussed in this course.

COURSE OBJECTIVES: The course objective is to enable students to differentiate between various types of batteries. Students will be able to understand the performance of primary and secondary batteries by understanding the electrochemistry. Students will also know about the importance of safe protocols need to be followed in the battery operations.

UNIT 1

Fundamentals of batteries

[6L]

Introduction to batteries. Classifications: Primary and Secondary, Characteristics of battery: Ohm's law, energy density, current density, power density, capacity, life cycle, efficiencies, Battery cell, Module and stacks.

UNIT 2

Primary batteries

[6L]

Electrochemistry of primary batteries, Zinc air batteries, Zinc carbon batteries, Zinc MnO₂ batteries, Primary Lithium batteries. Advantages and Disadvantages of Primary Batteries.

UNIT 3

Secondary batteries

[9L]

Electrochemistry of Secondary batteries, Construction, working and applications: Lead acid batteries, NiCd batteries, Nickel Metal hydride batteries,
Lithium ion batteries: Construction, working, and applications. Types of cathode materials

UNIT 4

Fuel cells

[9L]

Chemistry, Working principle, Classifications, Construction, working and applications: Polymer electrolyte fuel cell, alkaline fuel cell, molten carbonate fuel cell, Solid oxide fuel cell



DEPARTMENT OF BIOTECHNOLOGY

UNIT 5

Battery safety

[9L]

Background, Battery Management Systems (BMS) Lithium ion battery hazards, Best storage and handling practices, Safe

Disposal

TEXT BOOKS

DEPARTMENT OF BIOTECHNOLOGY

- a. Understanding Batteries, by Dell R M and Rand D A J, Royal Society of Chemistry, 2001
- b. Battery Technology Crash Course: A Concise Introduction by Slobodan Petrovic, Springer, 2020

REFERENCE BOOKS

- i. Battery Technologies: Materials and Components by Jianmin Ma, Wiley, 2022
- ii. Modern Battery Engineering: A Comprehensive Introduction by Kai Peter Birke, 2019.

COURSE OUTCOMES (COs)

1. Apply the electrochemistry of primary and secondary batteries to real-life cases.
2. Analyze the performance characteristics of primary, secondary batteries and fuel cells
3. Design the battery module and stack of suitable secondary batteries for the given power requirement (PO3, 5, 6)
4. Develop safety protocols for hazardous batteries and submit the report (PO7, 9, 10)



DEPARTMENT OF BIOTECHNOLOGY

VII Semester

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
AE-4	22BT7AEIL	Industry Skill Development	0	0	1	1	2
PC-17	22BT7PCED	Bioprocess Equipment Design and CAED	3	0	1	4	5
PE-3	22BT7PEPE-3	Professional Elective -3	3	0	0	3	3
PW-3	22BT7PCPW-3	Project -3	0	0	3	3	6
OE-2	22BT7OEOE-2	Open Elective -2	3	0	0	3	3
HS-8	22BT7HSBFS	Biotechnology for Society	2	0	0	2	2
NCM C-5	22BT7NCMC1	MOOCs Course -1				PP/ NP	
		<i>Details of 20 AICTE Activity Points</i>					
TOTAL:-			11	0	5	16	21

Professional Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-3	22BT7PEGN	Genome Informatics	3	0	0	3	3
PE-3	22BT7PEBB	Biologics & Biopharmaceuticals	3	0	0	3	3
PE-3	22BT7PEAT	Animal BT	3	0	0	3	3
PE-3	22BT7PEFC	Food Processing and quality control	3	0	0	3	3
PE-3	22BT7PETN	Tissue Engineering	3	0	0	3	3

Open Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
OE-2	22BT7OEIPR	IPR in Engineering	3	0	0	3	3
OE-2	22BT7OEEEM	Ecology and Environmental Management	3	0	0	3	3
OE-2	22BT7OESEN	Sustainability Engineering	3	0	0	3	3



DEPARTMENT OF BIOTECHNOLOGY

VIII Semester

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-5	22BT8PEPE-4	Professional Elective -4	3	0	0	3	3
P W-4	22BT8PCP W-4	Project -4	0	0	6	6	12
OE-3	22BT8OEOE-3	Open Elective -3	3	0	0	3	3
HS-9	22BT8HSB EB	Bioethics and Biosafety	2	0	0	2	2
INT-3	22BT8SRIN3	Internship-Based Seminar	0	0	2	2	4
NCMC-6	22BT8NCMC2	MOOCs Course - 2				P/NP	
		<i>Details of 20 AICTE Activity Points</i>					
TOTAL:-			8	0	8	16	24

Professional Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-4	22BT8PEBDA	Biological Data Analytics	3	0	0	3	3
PE-4	22BT8PEDRD	Drug discovery	3	0	0	3	3
PE-4	22BT8PEABP	Advanced BT processes and Products	3	0	0	3	3
PE-4	22BT8PEFWM	Food waste management	3	0	0	3	3
PE-4	22BT8PENAT	Nanotechnology	3	0	0	3	3

Open Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
OE-3	22BT8OEFRS	Forensic Science	3	0	0	3	3
OE-3	22BT8OEHAN	Health and Nutrition	3	0	0	3	3



DEPARTMENT OF BIOTECHNOLOGY

Course Title	BIOPROCESS EQUIPMENT DESIGN AND CAED										Credits	4		
Course Code	2	2	B	T	7	P	C	E	Q	D	L-T-P	3	0	1

COURSE PRE-REQUISITES: Unit Operations, Reaction Engineering, Elements of Engineering Drawing and Elements of Mechanical Engineering

COURSE DESCRIPTION: The course deals with study of various components used in bioprocess plant. This emphasizes on detail design of major equipment used in bioprocess industry.

COURSE OBJECTIVES: The objective of the course is to make students understand the working of various components used in process plant. Students will be able to design the major equipment used in bioprocess industry.

PART

A:THEORY+TUTORIAL

UNIT 1

INTRODUCTION TO BIOPROCESS DESIGN

[6L]

Nature of design, the anatomy of biochemical manufacturing process, organization of biochemical engineering project, codes and standards, factors of safety, degrees of freedom & design variables, optimization, basic considerations in design, piping and instrumentation, material of construction, symbols of equipment used in process flow diagram.

UNIT 2

BIOPROCESS COMPONENTS

[7L]

Welding Joints, pipe fittings, Flanged pipe joint, Gland & Stuffing box expansion joint Ball valve, Gate valve, Non- return valve, Diaphragm valve, Centrifugal pump, Bioreactors, types, Importance of Single use bioreactors, Filtration units: Normal flow and tangential flow (TFF) filtration systems and design criteria.



DEPARTMENT OF BIOTECHNOLOGY

UNIT 3

PROCESS EQUIPMENT DESIGN AND CAED

[26L]

Detailed process and mechanical design of the following equipment

- I. Shell and tube exchangers
- II. Fermenter
- III. Distillation Column-Packed bed
- IV. Extractor

PART B: LABORATORY

CAD of

1. Flanged pipe joint
2. Gland & Stuffing box expansion joint
3. Ball valve
4. Gate valve
5. Non- return valve
6. Diaphragm valve
7. Centrifugal pump
8. Shell and tube exchangers
9. Fermenter
10. Distillation Column-Packed bed
11. Extractor

COURSE OUTCOMES

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													1	
CO2			3		3									2	
CO3			3	3										2	
CO4			3		3		2		2	2		1		2	



DEPARTMENT OF BIOTECHNOLOGY

1. Identify the various symbols used in process flow diagrams (PO1).
2. Draw the sketches of pipe joints, stuffing box, valves, pumps and bioprocess vessels using CAED (PO2, PO3).
3. Design shell & tube heat exchanger, distillation column and Fermenter for given parameters (PO3, PO4).
4. Create process flow diagram and design major equipment for large scale production bioactive materials, and present the report (PO3, PO5, PO7)

PRIMARY REFERENCES

1. **Process equipment design** by M V Joshi., V.V Mahajani
2. **Chemical Engineering** by Coulson and Richardson, Vol. 6, 1993.
3. **Principles of fermentation Technology** by P.F. Stanbury and A. Whitaker, Pergamon Press, 1984.

SECONDARY REFERENCES

1. **Process Equipment Design** by Brownell LE and Young EH, John Wiley and Sons, Inc. 2009 **Fermentation and Biochemical Engineering Handbook** by Celeste C. Todaro and Henry C. Vogel 3rd edition, 2014
2. **Bioreactors: Analysis and Design**, by Tapobrata Panda. 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011
3. **Perry's Chemical Engineers' Handbook** by Perry, R.H. Green, D.W. McGraw-Hill. Seventh Edition, 1997.
4. **Unfired pressure vessel** I S Code 2825
5. **Shell and tube heat exchanger specifications**, I S Code 4503

E-books

1. http://buc.edu.in/sde_book/bio_process.pdf

MOOCs

1. <http://nptel.ac.in/courses/103103027/>
2. <https://online-learning.tudelft.nl/courses/industrial> biotechnology

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes three CIEs, homework, assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): Includes written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE



DEPARTMENT OF BIOTECHNOLOGY

Course Title	Biotechnology for Society										Credits	2		
Course Code	2	2	B	T	7	H	S	B	F	S	L-T-P	2	0	0

COURSE PRE-REQUISITES:

Basic knowledge in biochemistry, cell biology and genetic engineering.

COURSE DESCRIPTION:

To enable the students to understand the interactions of biotechnology and society and the debates, controversies, fears, and hopes that have shaped how we think about bodies, organisms, and life in the twenty-first century. It enables the students to gain knowledge on the various topics such as genetically modified foods, cloning, and stem cells; genetic testing and the potential for discrimination; fears of (and, in some cases, hopes for) designer babies; personal genomics; biosecurity; and biotech art.

COURSE OBJECTIVES:

This course enables the students to understand the interactions of the biotechnology, its products with society. It also helps students to understand the debates, controversies and fears pertaining to biotechnological applications for the society.

UNIT - 1

LIMITS OF BIOTECHNOLOGY AND GENETIC ENGINEERING

[4L]

Introduction to Biotechnology, Long History of Biotechnology; Inventing Genetic Engineering, Recombinant DNA Debates

UNIT - 2

OWNING LIFE, GENETICALLY MODIFIED FOODS AND THE BOUNDARIES OF BODILY LIFE

[5L]

Biotechnology and Business, Patenting Life; Risk, Regulation, and Our Food, Economics of Eating; Owning Part of You, Freezing, Banking, Crossing



DEPARTMENT OF BIOTECHNOLOGY

UNIT - 3

MAPPING GENES, MAKING SOCIETY, GENETIC TESTING, DISCRIMINATION, AND BIOETHICS [6L]

Eugenics, Human Genome Project; Genetic Testing, Disability, and Discrimination, Bioethics and Medicine

UNIT - 4

VIRGIN BIRTHS, RE-ROUTING LIFE, MINDING YOUR OWN BIOLOGICAL BUSINESS [6L]

From the Pill to IVF, Cloning; Stem Cells, Designer Babies; Drugs and Designer Bodies, Personal Genomics

UNIT - 5

DIVERSITY OF BIOTECHNOLOGY AND BIOLOGICAL FUTURES [5L]

Biotechnology and Race, Bioprospecting and Biocolonialism; Synthetic Biology and Bioterrorism, Biotechnology and Art, Eternal Life and the Posthuman Future.

Primary references:

1. Biotechnology and society an introduction: Hallam Stevens. 2016, university of Chicago press.

Secondary references:

1. Book title: New Perspectives on Technology, Values, and Ethics, Part II. Chapter 7: Biotechnology, Ethics, and Society: The Case of Genetic Manipulation. Pages 123-144. 2015. Springer international publishing.
2. Biology is Technology: The Promise, Peril, and New Business of Engineering Life by Robert H. Carlson. Harvard University Press. 2010

COURSE OUTCOMES

1. Describe how scientific and technological developments in the field of biotechnology affect society And the environment. (PO1)
2. Apply knowledge of biotechnology to solve the societal issues in both focused and broad interdisciplinary contexts. (PO1,6)
3. Identify and analyse the impact of biotechnological solutions in societal and environmental context. (PO2,7)
4. Evaluate the development of biotechnological solutions for the societal needs with appropriate consideration for the public health and safety and legal, cultural and environmental issues. (PO3)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	GENOME INFORMATICS									Credits	3			
Course Code	2	2	B	T	7	P	E	G	N	L-T-P-S	3	0	0	0
CIE	100 marks (50% weightage)									SEE	100 marks (50% weightage)			

COURSE PRE-REQUISITES: Biostatistics and probability, Basics of Computer applications, Cell and Molecular Biology, Genetic Engineering, Bioinformatics and Genomics & Proteomics.

COURSE DESCRIPTION: This course emphasizes on various next-generation sequencing techniques, assembling the sequencing data, de Novo assembling algorithms for assembly and visualization of sequence data. The course also includes applications of NGS in cancer and other diseases.

COURSE OBJECTIVES: This course is designed to impart good operational knowledge of various nextgeneration sequencing tools and algorithms for sequencing, assembling, analysing and visualizing the sequence data. Further students will comprehend the importance of NGS in cancer and other diseases.

UNIT – 1

EMERGENCE OF NEXT-GENERATION SEQUENCING

Pyrosequencing; Illumina (Solexa) Genome Analyzer; Applied Biosystems SOLiD; Ion Semiconductor (Ion Torrent Sequencing); Heliscope (Single Molecule Sequencing). Third generation sequencing: Nanopore Sequencing, Single Molecule Real Time DNA Sequencing ; Comparison of Next-Generation Sequencing Techniques; Shortcoming of NGS Techniques: Short-Reads and Reads Accuracy Issues, NGS File Formats.

UNIT – 2

THE ASSEMBLY OF SEQUENCING DATA

[6L]

De Novo Genome Sequence Assembly; Challenges of Genome Assembly; Use of Paired-End Reads in the Assembly; Data Pre-processing Methods and Sequence Read Correction Methods; Assembly Errors; Evaluation of Assembly Methods; NGS Data Visualization using Genome Browsers – UCSC and Ensemble genome browsers.

UNIT – 3

ASSEMBLY ALGORITHMS

[7L]

Mapping Assembly to a Graph Problem, The Overlap Graph Approach; De Bruijn Graph Approach; Classification of De Novo Assembly Algorithms; Greedy Algorithms; Overlap Layout Consensus (OLC) Algorithms; De Bruijn Graph-Based Algorithms; Comparison of Algorithms; Working methodologies with NGS data: Data acquisition, Quality check, Trimming, Assembly, Mapping and Visualization.



DEPARTMENT OF BIOTECHNOLOGY

UNIT – 4

NEXT GENERATION SEQUENCING IN CANCER RESEARCH

[10L]

Applications of NGS in RNA

biomarker discovery in cancer research;; NGS for high-throughput RNA interference screens; RNAseq in prostate cancer research; cancer genomics and cancer epigenomics; Targeted sequencing strategies; Role of long non coding RNAs in cancer genome. MicroRNAs and cancer.

UNIT – 5

NEXT GENERATION SEQUENCING IN CLINICAL RESEARCH

[7L]

Neuropsychiatric and Neuroinflammatory Disorders : Polymorphisms in Major Depressive Disorders; Polymorphisms in ADHD; Polymorphisms in Neuroinflammatory Diseases; Multiple Sclerosis; Alzheimer's Disease; Parkinson's Disease; Role of the NGS in Early Diagnostic and Treatment.

PRIMARY REFERENCES

1. Ali Masoudi-Nejad, Zahra Narimani, Nazanin Hosseinkhan; “Next Generation Sequencing and Sequence Assembly”, Methodologies and Algorithms, Springer; 2013.
2. Mark I. Rees, “Challenges and Opportunities of Next-generation Sequencing for Biomedical Research”, Academic Press, 2012.
3. Wu, Wei, Choudhry, Hani (Eds.), “Next Generation Sequencing in Cancer Research: Volume 1: Decoding the Cancer Genome”, Springer, 2013.

SECONDARY REFERENCES

1. Genomes by Brown T A, 2006, Fifth edition, Blackwell Science
2. A Primer of Genome Science by Greg Gibson and Spencer V, Third Edition, Muse, February 2009

e-BOOKS

1. <http://www.springer.com/us/book/9781461477259>
2. <http://store.elsevier.com/Challenges-and-Opportunities-of-Next-Generation-Sequencing-for-Biomedical-Research/isbn-9780123942876/>
3. http://vufind.carli.illinois.edu/vf-rou/Record/rou_279168/TOC

MOOCs

1. <https://www.mooc-list.com/course/clinical-bioinformatics-unlocking-genomics-healthcarefuturelearn?static=true>
2. <https://www.mooc-list.com/tags/next-generation-sequencing?static=true>

COURSE OUTCOMES

1. Comprehend and compare various Next-Generation Sequencing Techniques.
2. Apply the tools for assembly of Sequencing Data. (PO5)
3. Acquire, analyse, assemble and visualize the genomic sequence data. (PO2, PO12)
4. Select and Apply the NGS technique in diagnosis and treatment of diseases. (PO1, PO5)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	Biologics & Biopharmaceuticals										Credits	3		
Course Code	2	2	B	T	7	P	E	B	N	B	L-T-P	3	0	0

Course Description

COURSE PRE-REQUISITES: Biochemistry, Molecular Biology, Basics of Biomolecules, Bioinformatics, Genetic Engineering, Signal Transduction, Pharmacology & Toxicology

COURSE DESCRIPTION: This course emphasizes on concept of biological and Biopharmaceuticals. Students will be introduced to the steps involved in the drug development process and various guidelines to be followed for its formulations and delivery.

The student will be exposed to bio therapeutic applications with a special emphasis on Immunotherapeutics.

COURSE OBJECTIVES: This course is designed to impart beneficial applications of Biotechnology in pharmaceutical industry that uses biological systems, living organisms, or derivatives for drug discovery and development process. This course also portrays knowledge of bio therapeutic applications

UNIT-1

6hrs

Introduction to Biopharmaceuticals and Biogenerics

Biopharmaceuticals: biologics and biosimilars. overview of life history for development of biopharmaceuticals. concept of Pharmacovigilance. Ethical and legal issues

UNIT-2

7hrs

Formulation of Biopharmaceuticals

Rational for formulation of biotherapeutics, formulation recipients: solubility enhancers, anti aggregating agents, buffers, cryoprotectants, antioxidants and preservatives etc significance with relevant examples. Methods to enhance shelf life protein based therapeutics. Packaging techniques and quality analysis of product.

UNIT-3

9hrs

APPLICATIONS OF BIOTHERAPEUTICS

Growth factors: IGF, EGF and Neurotrophic factors; Hormones: Production of human insulin by recombinant DNA technology, Formulation of insulin products, Engineered insulins; Therapeutic enzymes: asparaginase and thrombolytics (tPA, SK, UK);

UNIT-4

9hrs

Immunotherapeutics
Cytokines as biopharmaceuticals: classification with examples, production and medical uses of interferons (α, β, γ). Overview of antibody based therapeutics, CAR-T cell therapy, biologics for autoimmunity and inflammation, vaccine- adjuvant technology, genetically engineered vaccines, cancer vaccines, mRNA vaccines, present and future biologics.



DEPARTMENT OF BIOTECHNOLOGY

UNIT-5

8hrs

Biopharmaceuticals Based Delivery Systems

Novel drug delivery systems for biopharmaceuticals (rate controlled and site specific), Nanotechnology based miniaturization of biopharmaceuticals and therapeutics, peptides for intracellular targeting, delivery of nucleic acids and therapeutic peptides, concept of responsive or smart drug delivery system.

Text Books:

1. Gary Walsh (2003) Biopharmaceuticals: Biochemistry and Biotechnology, 2nd Edition, John Wiley & Sons, Inc.
2. Daan J A Crommelin (2010), Pharmaceutical Biotechnology, 2nd Edition, Taylor & Francis Group.

Reference Books:

1. Rodney J. Y. Ho (2013) Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, 2nd Edition, John Wiley & Sons, Inc.
2. Gary Walsh (2007) Pharmaceutical Biotechnology: Concepts and Applications. John Wiley & Sons, Inc.
3. Oliver Kayser, Heribert Warzecha (2012) Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, 2nd Edition. John Wiley & Sons, Inc.

COURSE OUTCOMES

1. Outline the drug development process, and regulatory guidelines. (PO6, PO8)
2. Describe the concepts of formulation and modes of drug delivery (PO6)
3. Relate application of biopharmaceuticals for different therapeutic conditions. (PO1, PO6)
4. Relate application of suitable drug delivery systems for different therapeutic conditions. (PO1, PO6)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	ANIMAL BIOTECHNOLOGY										Credits	3		
Course Code	2	2	B	T	7	P	E	A	B	T	L-T-P	3	0	0

COURSE PRE-REQUISITES: Cell and Molecular Biology, Human Physiology, Basics of Biomolecules , Biochemistry and Bioenergetics, Bio analytical Techniques, Immunotechnology and Genetic Engg.

COURSE DESCRIPTION: This course includes the history of Animal biotechnology, development and maintenance of animal cell, tissue and organ cultures. It also includes the latest advances in tissue culture techniques and the regulatory guidelines for animal cell culture.

COURSE OBJECTIVES: To empower graduates to understand current technologies applied in Animal cell culture and its applications

UNIT- 1

INTRODUCTION TO ANIMAL CELL CULTURE

[5L]

History, scope, advantages & limitations. Planning, Construction, layout of laboratory.

UNIT-2

ESSENTIALS FOR ANIMAL CELL CULTURE

[7 L]

Essential equipment and culture Vessels (types & designs).: Media and reagents Physicochemical properties, Balanced salt solutions, complete media, Serum, serum free media, MEM, DMEM, RPMI and Ham's medium, role of antibiotics in media. Principles of sterile techniques.

UNIT -3

ANIMAL CELL CULTURE TECHNIQUES

[7 L]

Establishment of primary cell cultures and cell lines, nomenclature, subculture, propagation and maintenance, suspension cultures & anchorage dependent cultures, Development and maintenance of Embryonic & adult stem cells, Organ and organotypic cultures, Contamination: Sources, types, Monitoring and Eradication, cryopreservation.

UNIT - 4

CHARACTERIZATION OF CELL LINES AND TISSUES

[10 L]

Behavior ,morphology, growth characteristics, chromosome analysis, DNA, RNA and Protein Content, Enzyme and Antigenic Markers, Transformation, Immortalization, Aberrant Growth Control, Tumorigenicity, Cell counting, Plating Efficiency, Labeling Index, Generation Time. Cytotoxicity assays: Viability and Survival assays, Micro-titration and Transformation assays.



DEPARTMENT OF BIOTECHNOLOGY

UNIT - 5

APPLICATIONS

[10 L]

Gene mapping, marker assisted selection and genetic improvement of desired characters of domestic animals, Commercial scale production of animal cells, Applications of animal cells: in-vitro testing of drugs and environmental pollutants, production of vaccines, growth factors and pharmaceutical proteins. Transgenic animals as bioreactors for production of proteins of pharmaceutical value. Ethical & legal issues

PRIMARY REFERENCES

1. Culture of Animal Cells by Freshney R I(2005), 5th Edn, Wiley-Liss.
2. Animal Cell Biotechnology by Spier RE and Griffiths JB (1988), Academic Press.6th edn.

SECONDARY REFERENCES

1. Molecular Biotechnology: Principles and Practices by Channarayappa (2006). University Press (India) Pvt.Ltd., Worldwide CRC Press,1st edn.
2. Molecular Biotechnology by Primrose; Blackwell scientific publication, 2nd edition
3. Animal Biotechnology by Murray Moo- Young (1989), Pergamon Press, Oxford, 1st edition
4. Introduction to cell & tissue culture by Jennie P. Mather & P.E.Robert, Springer-1st edition

e-BOOKS

1. Animal Cell Biotechnology Methods and Protocols, Editors: Nigel; ISBN: 978-0-89603-547-8(Print) 978-1-59259-486-3(Online), <http://link.springer.com/book/10.1385%2F0896035476>
2. Animal Biotechnology, 1st Edition Models in Discovery and Translation Editor(s):Verma & Singh eBook ISBN :9780123914347, <http://store.elsevier.com/Animal-Biotechnology/isbn9780124160026/>

MOOCs

1. <http://ocw.mit.edu> (<http://ocw.mit.edu/courses/biology/7-342-developmental-andmolecularbiology-of-regeneration-spring-2008/#>)

COURSE OUTCOMES (COs)

1. Draw sketches for layouts to design cell culture labs, (PO1, 3)
2. select and relate the usage of suitable equipment and media. (PO1, 3)
3. Differentiate the methods used for characterization of cultured cells. (PO1)
4. Relate the potential applications and merits & demerits of transgenic technologies in health and disease.(PO5,6, 12)
5. Select and describe the methodologies used for commercial scale production of animal cells and their products. (PO1,12)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	FOOD PROCESSING AND QUALITY CONTROL										Credits	3		
Course Code	2	2	B	T	7	P	E	F	P	C	L-T-P	3	0	0

COURSE PRE-REQUISITES: Chemistry, biology, microbiology, nutritional science, Unit operations, biotechnology.

COURSE DESCRIPTION: Food processing and quality control is a multidisciplinary course that involves study of all the technical aspects of food. This course will enable the students to understand sourcing and acquiring of raw materials (fruits, vegetables etc.), food processing systems, processes, relevant equipments, dairy products, fruits and vegetable processing, packaging and marketing, storage and transportation techniques etc. This course emphasizes on the importance for good quality food products for consumption as health is now a major concerned point due to the possibility of engaging in various diseases on account of consuming degraded food items. Students will also be updated with scope of this course in developing skills required in Food industry by learning various techniques used in food processing to produce better quality products.

COURSE OBJECTIVES. Students will be able to develop a greater understanding of the outcome of agricultural raw materials, and how such materials are processed and formulated before being presented to the consumer. Additionally, they will be updated on management of production of food products; and usage of scientific knowledge to develop new products maintaining its hygiene and safety.

UNIT-1

FOOD PROCESSING AND PRESERVATION

[7L]

Development of Food Process and Technology, Basic concepts, Processing by chemical method- Methods of fruit and vegetable preservation - Processing using sugar – Preparation of jam, jelly, marmalade, squash, RTS, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt – Brining - Preparation of pickles, chutney and sauces, ketchup. Minimal processing and fermentation, canning, bottling, processing of dairy and animal foods.

UNIT-2

FOOD PROCESS EQUIPMENTS

[7L]

Metals and non-metals, pressure vessels – cylindrical shell –internal and external pressure - under continued loadings. Materials for fabrication, mechanical properties, storage vessels, Unit operations for food processing- heat exchangers, mechanical separators, evaporators, Drying principles-different types, Principles of refrigeration, refrigeration cycles, cold storage and cryogenic freezing.



DEPARTMENT OF BIOTECHNOLOGY

UNIT-3

FOOD SAFETY AND QUALITY CONTROL

[10 L]

Concept of Food safety, Characterization and risk analysis, Food hazards: Physical, Chemical and biological systems for food safety. Hazard Analysis Critical Control Point (HACCP) and its implementation. Quality Assurance-Theoretical and practical considerations, description of different systems: GAP, GMP, TQM, ISO. Indian food standards- Voluntary and Obligatory standards (PFA, FPO, MMPO, AGMARK etc.) Codex alimentarius, Worldwide food safety issues. Sensory Evaluation-Requirements and methods. Sensory parameters: Colour, flavour, texture, taste, aroma, general acceptability. Subjective and Objective test of sensory parameters, Different sanitizers and detergents- Sanitation and hygiene in quality assurance in different food industries (Fruits and vegetables, Meat, Milk, Cereal Based), Cost of Quality, Supplier development.

UNIT-4

FOOD PACKAGING AND STORAGE

[8L]

Introduction to packaging. Packaging operation, package functions and design. Principle in the development of protective packaging, Deteriorative changes in food stuff and packaging methods for prevention, Shelf life of packaged food, storage and transportation techniques, methods to extend shelf life. Flexible packaging materials, Trends in latest packaging- Modified atmospheric packing (MAP), Controlled atmospheric packaging (CAP), Oxygen Scavengers, Shrink packaging, Aseptic and retortable pouches etc. Packaging of different food materials- Fruit and vegetables, meat, milk and egg products, oils, RTE foods etc.

UNIT-5

FOOD LABELING

[7 L]

Need for labeling – Developing labeling standards at the world level – Limitations of labeling safety issues – Labeling regarding methods of processing – Irradiated products – Products derived from modern biotechnology– organic produce -Genetically modified foods – EU rules on nutritional labeling – US rules on nutritional labeling – Health claims – Approach of US and EU.

PRIMARY REFERENCES

1. Kees A. van der Heijden and Sanford Miller. International Food Safety Handbook Science, 1999.
2. Government of India. Guide to the Food Safety and Standards Act. Tax-mann Allied Services Pvt. Ltd. 2006.
3. Mehta R. and George J. Food Safety Regulation Concerns and Trade- The Developing Country Perspective. Published by Macmillan India Ltd., New Delhi, 2005

MOOCs

1. https://onlinecourses.swayam2.ac.in/cec20_ag06/preview
2. <https://nptel.ac.in/courses/126105015>



DEPARTMENT OF BIOTECHNOLOGY

Course Outcomes:

1. Comprehend the concepts of food processing and technology.
2. Apply biotechnological principles to understand the chemical reactions of biomolecules in processed and packaged foods(PO1,2).
3. Selection and application of appropriate design of unit operation for food processing (PO1,3).
4. Provide solutions by applying HACCP principles and sensory parameters to maintain food Quality (PO1, 2).
5. Analyze, compile and present individually the case studies or real world food related concepts (PO4,9,10).



DEPARTMENT OF BIOTECHNOLOGY

COURSE TITLE	TISSUE ENGINEERING										CREDITS	3			
COURSE CODE	2	2	B	T	7	P	E	T	E	N	L T P	3	0	0	0
CIE	100 marks (50% weightage)										SEE	100 marks (weightage) 50%			

PRE-REQUISITES: Knowledge of basic cell and molecular biology, Human physiology, Chemistry, Basics of Biomolecules. Biomaterials and their properties.

COURSE DESCRIPTION: This course deals with the concept's cells and tissues manipulation and engineering for various biomedical applications and principles of tissue engineering.

COURSE OBJECTIVES:

1. To Make Students Understand The potential applications of tissue engineering
2. To enable students to develop various strategies of cell and tissue manipulations for solving biomedical issues.

UNIT-1

[7 hrs]

Tissue engineering introduction. Growth Factors; Extracellular Matrix: Structure, Function Mechanical Forces On Cells; Cell Adhesion; Cell Migration. Stem cells, types and their applications in tissue engineering.

UNIT-2

[10 hrs]

Cell growth characteristics, Cell counting, culturing, propagation and storage. Organ culture techniques, Scaffold For Tissue Engineering Applications; Biomimetic Materials; Nanocomposite Scaffolds for Tissue Engineering; Bioreactors; Regulatory Issues In Tissue Engineering.

UNIT-3

[10hrs]

Tissue organization, tissue types, Tissue repair, homeostasis, angiogenesis and its importance. Cellular fate processes, Cell differentiation, Cell migration - underlying biochemical process.

UNIT-4

[6 hrs]

Applications of tissue engineering: Overview :Synthesis of human Skin Substitute; Nerve Tissue Engineering; Musculoskeletal Tissue Engineering; Bone Tissue Engineering; Cartilage Tissue Engineering; Smooth Muscle Tissue Engineering; Oesophagus Tissue Engineering.

UNIT-5

[6 hrs]

Tissue engineering for vasculature, Cardiac Tissue Engineering; Heart Valve Tissue Engineering; Urologic Organ Tissue Engineering; Hepatic Tissue Engineering; Renal Tissue Engineering; Dental Tissue Engineering.



DEPARTMENT OF BIOTECHNOLOGY

PRIMARY REFERENCES

1. PRINCIPLES OF TISSUE ENGINEERING, 5TH EDITION by Robert Lanza
2. Tissue Engineering" by Palsson and Bhatia, 2016, ISBN-10 9332571791

SECONDARY REFERENCES

1. Clemens van Blitterswijk (2008), Tissue Engineering, Academic Press
2. Tissue engineering by Anil K Sharma and Raj K Keservani

MOOCS

1. https://onlinecourses.nptel.ac.in/noc24_bt49/preview
2. https://archive.nptel.ac.in/content/syllabus_pdf/102106036.pdf

COURSE OUTCOMES:

1. Understand the current status and potential uses of tissue engineering (PO1,12)
2. Design experiments for culturing and growth of cells and tissues (PO3)
3. Identify different scaffolds and materials for usage in tissue engineering (PO1)
4. Apply tissue engineering solutions for various biomedical applications. (PO1 and PO3,12)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	Intellectual Property Rights for Engineers									Credits	3			
Course Code	2	2	B	T	7	O	E	I	P	R	L-T-P	3	0	0

Course Description

COURSE PRE-REQUISITES: Basic sciences, Mathematics, Engineering sciences, Engineering core and elective courses

COURSE DESCRIPTION: This course emphasizes on concept of intellectual property and its forms. The contents mainly focus on Industrial designs and innovative articles that could get protected from patent law under IP. It also emphasizes on softwares and Internet of things, Trademarks and trade secrets the knowledge of which gets protected by copyright and other IP laws. The course designed to effectively transfer the knowledge with real-life case studies from the filed of IPR.

COURSE OBJECTIVES: This course is designed to benefit the engineering students in protecting innovative and new products and processes that originate from their research domain. The course also provides the in -depth knowledge of operation of IP forms and protection from possible infringement.

UNIT 1

5Hr

Intellectual Property Rights, different forms and their usefulness for Engineers

Concept of property and types (similarities and differences), Intellectual Property and its different forms : Patents, Copyright, Trademarks, Industrial Designs, Registration of Plant Varieties, Registration of Semiconductor Integrated Circuit Layout Design (SICLD); Registration of Geographical Indications and Trade Secrets. Important International Treaties for Protection of Intellectual Property. Usefulness of IPRs for engineers-introduction to new career opportunities/consultancy opportunities

Unit 2

10Hr

Determination of patentability of inventions - the TRISHUL test of novelty, inventive step and industrial application; Making a patent search map and performing a prior art search; literature and non-literature sources of information for prior art assessment. Forms, Fee and time lines- Frequently asked questions- Double patenting, provisional patenting, patent of addition, divisional patents and convention patent applications. Precautions. Patents-some myths and misconceptions; Practical aspects of filing a patent outside India (International Patenting-PCT)

Patents- usefulness for engineers viz. preventing duplication of work; helping in identification of hot areas of research; preventing exploitation; promoting revenue generation; giving access to rare technical information; preventing infringements and helping to avoid litigation; stimulating creativity. Patents- Significance for engineering professionals/ technopreneurs/ business managers; Patents- to file or not to file? Practical aspects of filing a Patent in India and Abroad. Enforcement of Patent Rights at National and Global level. Case study- Bajaj vs TVS. Annexures-Patent filing forms.



DEPARTMENT OF BIOTECHNOLOGY

UNIT 3

8Hr

Copyright and its usefulness in Engineering

Subject matter of copyright- Artistic, Literary, musical and cinematographic works; Definition, History, International Copyright Treaties; Internet treaties; Amendments in Indian Copyright Law and their significance; Protection of Software and digital innovations; Rights afforded by copyright law;

Case; Case Studies - The Manipal Academy Case (Supreme Court of India, 2009); R.G. Anand v. Delux Films (Supreme Court of India, 1978); Adobe and Microsoft (Delhi High Court, 2009). Forms, Fee, Timeline- Ownership issues, transfer and duration. Model Agreements between author and publisher Royalty, Assignment

Digital Innovations and Developments as Knowledge Assets

Significance of IP in Content for the Internet and Tech Sector-Symbols and trademarks as Business Assets in the Information Age; Internet and the Worldwide Web; Applications of computer technology - advantages/disadvantages of computers; Cyber Technology- e commerce and e governance; Electronic records digital signatures; The Employment Relationship in the Internet and Tech Sector - role of CDAs and contracts; Trolls, landmines and other metaphors; Cyber etiquette.

UNIT 4

6Hr

Registration of Industrial Design and its usefulness in Engineering

Illustrative story; Indian Law related to Registration of Industrial Designs; Essential Requirements for Registration of a Design in India- Limitations; American Law; International Agreements- The Hague System; Conflicts related to Registration of Design, Copyright or Trademark; Legal rights and advantages of Industrial Design Registration- The Tupperware Case.

Practical aspects of Industrial Design Registration in India and Abroad. How to file application for registration of Industrial Design- a ten step guides.

UNIT 5

10Hr

Trade Secrets- Importance for Engineers

Trade Secrets- Importance for Engineers; FAQs related to trade secrets; Elements of Trade Secrets- what is a trade secret and what is not? Laws relating to protection of Trade Secrets; Spring Board Doctrine; Case Study- Diljeet Titus Case; Documentation related to trade secrets-confidentiality agreement (CDA); Non-disclosure Agreement or NDA; non-compete agreement or NCA and Trade Secret Bonds or TSBs; Practical aspects of maintaining trade secrets; Maintaining Lab Notebooks as Trade Secret Documents. Annexures- Format of NDA/CDA and a Trade Secret Bond

Trademarks- Importance in Engineering industry; FAQs;

National Trademark Filing- Practical aspects-forms, fee, timelines, procedural aspects. International Trademark Filing-Madrid System-Madrid Agreement and Madrid Protocol;

Maintenance and Transfer; Dilution of ownership-likelihood of confusion; Case Study-Haldiram Bhujjiawala (Supreme Court of India, 2000); Trade mark claims and Litigation; Enforcement -

International trademark law. Case studies- Whirlpool (Supreme Court of India, 1996); Benz (Delhi High Court, 1993); Cadila (Delhi High Court, 2007); Distinction between Trademark and Domain name. Case Study- Satyam Infoway (Supreme Court of India, 2004). Annexures- Classification of goods and services; Format of form for Registration of Trademark (Form TM-1), Renewal of Trademark (TM-12)



DEPARTMENT OF BIOTECHNOLOGY

Text Books:

1. Fundamentals of Intellectual Property for Engineers, Kompal Bansal and Parikshit Bansal, BS Publications, 2013.
2. Intellectual Property, Roopinder Tiwari and Mamta Bharadwaj, Publication Bureau of Punjab University, 2021

Reference Books:

1. Intellectual Property Rights for Engineers, Vivien Irish, 2nd Edition, 2005, IET Publishers
2. A Textbook of Intellectual Property Rights, [Ramakrishna Chintakunta](#), Blue Hill Publications, 2022.

COURSE OUTCOMES

1. Understand the basic IP law pertain to filing for protection of products and processes. (PO1, PO6, PO12)
2. Assess and evaluate the possibility of technological developments for protection under patents, Industrial designs and trademarks (PO2, PO4, PO6)
3. Relate the implementation of IP guidelines into computer related applications (PO1, PO6).
4. Collect data, compile into report and present the controversial case studies relevant to IP protection (PO2, PO6, PO9, PO10, PO12)

https://onlinecourses.nptel.ac.in/noc22_hs49/preview

<https://www.asme.org/topics-resources/content/intellectual-property-and-engineers>

https://www.eit.edu.au/engineers-encourage-understanding-of-intellectual-property-in-engineering-industry/?_gl=1*yckmgn*_up*MQ..*_ga*MTA3MDI4MjI5MC4xNzIxNjI1MDE4*_ga_5JFFK72DLM

<https://www.wiley.com/en-us/Intellectual+Property+Law+for+Engineers%2C+Scientists%2C+and+Entrepreneurs%2C+2nd+Edition-p-9781119382010>

<https://shop.theiet.org/intellect-prop-rights-eng-2ed>



DEPARTMENT OF BIOTECHNOLOGY

COURSE TITLE	ECOLOGY AND ENVIRONMENTAL MANAGEMENT										CREDITS		3			
COURSE CODE	2	2	B	T	7	O	E	E	E	M	L	T	P	3	0	0
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)			

COURSE PRE-REQUISITES: Very basic knowledge about life forms, environment and ecology.

COURSE DESCRIPTION: The course covers various aspects of an ecosystem and its components, community characteristics and biogeochemical cycles. This course also includes general population attributes, their distribution and interaction of living components with each other and with environment. This course covers importance of the biodiversity, its protection and environmental issues, policies and regulations.

COURSE OBJECTIVES: To enable the students to gain knowledge on the various environmental issues and the application of biotechnological concepts in the management and sustainability of environment and the various policies and regulations involved.

UNIT – 1

[9hrs]

Introduction to Ecology, Community and Ecosystem: types of ecosystems. Interrelationship between the living world and environment: Ecological pyramids, trophic levels: Producers and consumers, Foodweb and food chain. Environmental concepts (theory of tolerance and limiting factors), Concepts of habitat and niche, Community characteristics, Primary and secondary ecological succession and biogeochemical cycles.

UNIT-2

Population and Community Ecology

[7hrs]

Population Attributes: Density, natality, mortality, age ratio, sex ratio, Dispersion of population, Exponential and logistic growth Simpsons index and examples and calculations.

UNIT-3

[6hrs]

Predation types, R and K selected species, Host parasite interactions, Social parasitism, Symbiosis with examples.,

UNIT-4

Biotechnology in environmental management:

[9hrs]

Biodiversity and conservation strategies, success stories conservation, Sustainable utilization, Red data book, rare, Endangered and threatened species, Germ plasm banks, Sustainable utilization of wastes, Biofertilizers, Ecofriendly biopesticides, Bioremediation, bio indicators.



DEPARTMENT OF BIOTECHNOLOGY

UNIT-5

Pollution, environmental impact and protection

[7 hrs]

Impact of urbanization and industrialization, Environmental impact assessment, Environmental Pollution, Global climatic changes, National and international guide lines, climate summits (Paris summit), Wild life act of India.

PRIMARY REFERENCES:

1. Environmental studies: Anubha kaushik, CP KAushik, New age international, 3rd edition.

SECONDARY REFERENCES:

1. Environmental studies selective and scientific books: Mishra A, New delhi, 2005
2. Basics of environmental science: Allaby. M , Routledge, 2002
3. Elements of Ecology: Smith, TM, Simth RC Istedn. Pearson publications, 2006
4. Environmental science: Miller GT, 11th edition Brooks/cole, 2006. E-Books:
1. Environmental studies: Erach Bharucha, Univeristy Grants Commission

MOOCs:

1. <http://nptel.ac.in/courses/122102006/>
2. Biodiversity and Global Change: Science & Action (Coursera):
<https://www.mooclist.com/course/biodiversity-and-global-change-science-action-coursera>
3. Environmental Challenges: Justice in Natural Resource Management (FutureLearn)
<https://www.mooc-list.com/course/environmental-challenges-justice-natural-resourcemanagementfuturelearn>
4. Environmental Studies: A Global Perspective (edX)
<https://www.mooclist.com/course/environmentalstudies-global-perspective-edx>

COURSE OUTCOMES:

1. Understand key ecological concepts and the ecological interactions which effect environment (PO1)
2. Analyse and predict the effects of ecological interactions amongst populations (PO3)
3. Understand the phytogeographical and zoogeographical distribution of the world (PO1)
4. Apply the knowledge of environmental management to solve industry related environmental issues (PO1, PO5 and PO12)

NOTE: Students of Biotechnology department are exempted from taking this course.



DEPARTMENT OF BIOTECHNOLOGY

Course Title	SUSTAINABILITY ENGINEERING													
Course Code											Credits		L – T – P	3– 0 – 0

COURSE PRE-REQUISITES: Applied Chemistry, Introduction to civil engineering, Environment Science, Introduction to sustainable engineering

COURSE DESCRIPTION: This course offers an introduction to the idea of sustainability. Various models, such as those for population increase, global food production, and global water resources, are discussed throughout the course. In addition, the course emphasises current issues like urbanisation, resource depletion, and land usage. The course describes strategies in circular product design and design integration both in daily activities as well as in workplace. Additionally, the course covers a variety of industrial models and methods for sustainable engineering, including environmental sustainability design indicators, pollution control strategies, and the use of mass and energy balances in the development of sustainable systems.

COURSE OBJECTIVES: Objective of this course is to inculcate in students an awareness of environmental issues and the global initiatives towards attaining sustainability. The student should realize the potential of technology in bringing in sustainable practices.

UNIT 1

AN INTRODUCTION TO SUSTAINABILITY [7 L]

Introduction, Sustainable development, concepts of sustainable development: three pillar model, egg of sustainability model, Atkisson's pyramid model, prism model, principles of sustainable development, sustainable engineering, threats for sustainability. Environmental Ethics and Legislations – Environmental ethics and education, multilateral environmental agreements and protocols, enforcement of environmental laws in India – The Water Act, The Air Act, The Environment Act

UNIT 2

RISK AND LIFE-CYCLE FRAMEWORKS FOR SUSTAINABILITY [6 L]

Risk, Risk Assessment, Risk-Based Environmental Law, Life-Cycle Frameworks, Life-Cycle Assessment, Life-Cycle-Based Environmental Law, Life-Cycle Assessment Tools.

UNIT 3

GREEN SUSTAINABLE MATERIALS [7L]

Environmental and Natural Resource Use Footprints of Material Extraction and Refining, Tracking Material Flows in Engineered Systems, Environmental Releases.

UNIT 4

DESIGN FOR SUSTAINABILITY: ECONOMIC, ENVIRONMENTAL, AND SOCIAL INDICATORS [10L]

Sustainable Engineering Design Principles, Economic Performance Indicators, Estimates of Environmental Costs, A Framework for Evaluating Environmental Costs, Environmental Performance Indicators.



DEPARTMENT OF BIOTECHNOLOGY

UNIT 5

SUSTAINABILITY PRACTICES

[9L]

Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport, Case studies

TEXT BOOKS

1. R. L. Rag and Lekshmi Dinachandran Remesh. Introduction to Sustainable Engineering. 2nd Edition, PHI Learning Pvt. Ltd., 2016.
2. Introduction to Sustainability for Engineers, Toolseeram Ramjeawon, CRC Press, 1st Edition., 2020

REFERENCE BOOKS

1. D. T. Allen and D. R. Shonnard. Sustainability Engineering: Concepts, Design and Case Studies, 1 st Edition, Prentice Hall, 2011.
2. A.S. Bradley, A. O. Adebayo, P.Maria. Engineering applications in sustainable design and development, 1st Edition, Cengage learning, 2016.

e-books

1. <https://dokumen.pub/sustainable-engineering-concepts-design-and-case-studies-1nbsped0132756544-2011041250-9780132756549.html>

MOOCs

1. <https://nptel.ac.in/courses/127105018>
2. <https://nptel.ac.in/courses/107103081/www.macfound.org>
3. <https://www.my-mooc.com/en/mooc/technology-innovation-for-sustainable-development/>
4. <https://www.edx.org/course/engineering-design-for-a-circular-economy>

COURSE OUTCOMES (COs)

CO1	Comprehend the concepts of sustainable development and different environmental agreements and protocols.
CO2	Apply life cycle assessment tools and sustainable materials
CO3	Analyze sustainability through various indicators and sustainability practices.
CO4	Work individually or in groups to identify real life sustainability practices and communicate the findings of the literature study and solution proposed, as oral presentations and report submission.



DEPARTMENT OF BIOTECHNOLOGY

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1										
CO2	3						3			
CO3		3					3			
CO4							2		2	2

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes mid-term tests, weekly/fortnightly class tests, homework, assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): Includes written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE.



DEPARTMENT OF BIOTECHNOLOGY

UPDATED ON 28.09.2024 UPTO 2.00 PM ON SATURDAY

8TH SEMESTER



DEPARTMENT OF BIOTECHNOLOGY

Course Title	BIOLOGICAL DATA ANALYTICS										Credits	3			
Course Code	2	2	B	T	8	P	E	B	D	A	L-T-P-S	3	0	0	0

COURSE PRE-REQUISITES: Basics of computer applications, Bioinformatics, Genome informatics, Statistics, Genomics and proteomics.

COURSE DESCRIPTION: This course emphasizes on basics of R programming and interfacing with statistics to analyze the data. It also portrays the fundamentals of Bioconductor an open source software tool for bioinformatics to analyze and interpret the Biological data.

COURSE OBJECTIVES: This course is designed to impart good operational knowledge on basics of R programming and interfacing with statistics for the computational analysis of data. This course also highlights the fundamentals and applications of Bioconductor an open source software tool for bioinformatics. Further students will inculcate these tools to critically analyze the data and derive valid conclusions.

Unit- I

[07hours]

R PROGRAMMING BASICS

Overview

of R programming, Environment setup with R Studio, R Commands, Variables and Data Types, Control Structures, Vectors, Factors, Functions, Matrices, Arrays and Lists.

Unit- 2

[07hours] INTERFACING

Interfacing R to other languages, Parallel R, Basic Statistics: Linear Model, Generalized Linear models, Non-linear models, Time Series, Autocorrelation and Clustering.

Unit- 3

[07hours]

INTRODUCTION TO BIOCONDUCTOR FOR SEQUENCE DATA

Sequencing Resources, Ranges Infrastructure, DNA /amino acid sequence from FASTA files, Reads from FASTQ files, Aligned Reads from BAM files, Called Variants from VCF files, Genome Annotations from BED, WIG, GTF files

Unit- 4

[09hours]

BIOLOGICAL DATA ANALYSIS

Preparing count matrices, The DESeqDataSet, sample information, and formula design, exploratory analysis and visualization, Differential expression analysis, Plotting results, Annotating and exporting results



DEPARTMENT OF BIOTECHNOLOGY

UNIT-5

MASS SPECTROMETRY AND PROTEOMICS DATA ANALYSIS

[09hours]

Exploring available infrastructure, Mass spectrometry data, Getting data from proteomics repositories, Handling raw MS data, Handling identification data, MS/MS database search, Analyzing search results, Analysis of peptide sequences, Trimming the data, Parent ion mass error, Filtering criteria, Filter optimization, High-level data interface, Quantitative proteomics, Importing third-party quantitation data, Data processing and analysis, Raw data processing, Processing and normalization, Statistical analysis, Machine learning: Classification, Clustering: k-means, Annotation.

I would revise the unit-5 as below:

PRIDE Database, Raw Data Acquisition, Quality Control, Data Preprocessing (Convert Raw Files, Peak Detection and Alignment), Peak Detection and Alignment (Search Database, Validate Results), Protein Quantification (Quantify Proteins, Normalization), Differential Expression Analysis (Statistical Analysis, Multiple Testing Correction (e.g., BenjaminiHochberg)), Functional Annotation (Gene Ontology (GO) Enrichment, Pathway Analysis), Data Visualization (Volcano Plot, Heatmap), Data Annotation and Export.

PRIMARY REFERENCES

1. An Introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics. W. N. Venables, D.M. Smith and the R Development Core Team. Version3.3.3.
2. Jared P. Lander, “R for Everyone: Advanced Analytics and Graphics”, Addison- Wesley Data & Analytics Series, 2013.

SECONDARY REFERENCES

1. Norman Matloff, “The Art of R Programming: A Tour of Statistical Software Design”, No Starch Press, 2011.
2. Avril Coghlan, “A Little Book of R For Bioinformatics”, Release 0.1

E-BOOKS:

1. <https://cran.r-project.org/doc/manuals/r-release/R-intro.pdf>
2. <https://www.bioconductor.org/>

MOOCs

1. <https://www.class-central.com/tag/r%20programming>
2. <https://www.edx.org/course/introduction-r-data-science-microsoft-dat204x-3>



DEPARTMENT OF BIOTECHNOLOGY

Course Title	DRUG DISCOVERY										Credits	3			
Course Code	2	2	B	T	8	P	E	D	R		D L-T-P-S	3	0	0	0

Unit 1

[07hours]

QUANTITATIVE STRUCTURE-ACTIVITY RELATIONSHIP (QSAR):

Database search methods: Chemical indexing, Proximity searching, 2D and 3D Structure and Substructure searching. Pharmacophores, Computational Models: Introduction, Historical Overview and Quantitative Structure-Activity Relationship Analysis: Model building, Model evaluation, Topological analysis 3DQSAR, 4D-QSAR.

Unit 2

[07hours]

CHEMOINFORMATICS:

Introduction to Chemoinformatics: - Small molecule database, molecular descriptors and chemical spaces, chemical spaces and molecular similarity, modification and simplification of chemical spaces. Compound classification and selection – cluster analysis, partitioning, support vector machines. Chemical structure drawing, 3-D chemical molecular conversion. (Data analysis problems).

Unit 3

[09hours]

COMPUTER - ASSISTED DRUG DISCOVERY AND MOLECULAR DYNAMICS SIMULATION

Introduction to the concept of receptors and drug receptor interactions Drug discovery and development process, Contributions and achievements of CADD groups, Introduction to Molecular Dynamics Simulation, Molecular dynamics simulation - simple modes, at constant temperature, pressure and solvent effects. Applications of MD Simulation

Unit 4

[09hours]

NETWORK BIOLOGY AND PATHWAY ANALYSIS

Biological Networks - Types of Biological Networks: Protein-Protein Interaction Networks, Gene Regulatory Networks, Metabolic Networks, Network Construction and Representation, Network Topology and Properties Pathway Analysis - Signaling Pathways, Metabolic Pathways, Pathway Databases and Tools , AI in Network and Pathway Analysis - Network-based Machine Learning, Predictive Modeling of Biological Pathways, Case Studies



DEPARTMENT OF BIOTECHNOLOGY

Unit 5

[07hours]

PERSONALIZED MEDICINE

Personalized Medicine - Genomics and Personalized Treatment, AI for Personalized Treatment Plans, Ethical and Practical Considerations. Ethical and Practical Considerations - Data Privacy and Security, Regulatory Issues, Case Studies.

PRIMARY REFERENCES

1. Young D. C. Computational Drug Design: A Guide for Computational and Medicinal Chemists, WileyInterscience, 2009.
2. Andrew R. Leach, An Introduction to Chemoinformatics, Publisher : SPRINGER (SIE) 2009
3. N. Claude Cohen, Guidebook on Molecular Modelling in Drug Design, Elsevier India; First Edition, 2008
4. "AI for Drug Development and Biomarker Discovery" by Ulrich Nielsch, Ulf Baginski, and Michael E. Beckmann

SECONDARY REFERENCES

1. Barry A. Bunin, Brian Siesel, Guillermo Morales, Jürgen Bajorath, Chemoinformatics: Theory, Practice, & Products, 2007.
2. Alexander Hillisch, Rolf Hilgenfeld, Birkhäuser. Modern Methods of Drug Discovery, 2003.
3. Hugo Kubinyi, Gerd Folkers, Yvonne C. Martin. 3D QSAR in Drug Design: Ligand-protein interactions and molecular similarity, Springer, 1998.
4. Personalized and Precision Medicine Informatics by Terrence Adam and Ryan A. Radev

COURSE OUTCOMES

1. Understand the guidelines for drug design, and fundamentals of QSAR and its parameters [L1]
2. Utilize in silico approaches to critically evaluate the pharmacophore for ligand- protein binding and its application to drug design. (PO3) [L3]
3. Analyze and interpret computer aided biopharmaceutical characterization using computer simulations during clinical development. (PO5) [L3]
4. To apprehend the importance of artificial intelligence in pharmaceutical applications (PO5 and PO12) [L3]



DEPARTMENT OF BIOTECHNOLOGY

Course Title	ADVANCED BIOPROCESSES & PRODUCTS									Credits	3		
Course Code										L-T-P	3	0	0

COURSE PRE-REQUISITES: Knowledge of Microbiology, Unit Operations, Biochemistry, Molecular Biology, Genetic Engineering and Bioprocess Technology

COURSE DESCRIPTION: This course offers an introduction to commercial potential of biotechnology. The course will give an insight into the advanced process technologies for primary and secondary products and other modern biotechnological products. It covers the current uses of bioprocessing, including the production of alcohol, organic acids, antibiotics, vaccines, and other products.

COURSE OBJECTIVES: The objective of the course is to impart basic knowledge on how to use microorganisms and enzymes to produce goods with enormous industrial value. It combines science, engineering, and other biochemical processes in a novel way to produce products from a variety of industries, including food, chemicals, and bioenergy. Instead of just covering theory, the course primarily focusses on applications, giving students the opportunity to learn about bioprocess in a real-world setting.

UNIT 1

INTRODUCTION

[4 L]

Biotechnology: Scope and importance, Commercial potential of Biotechnology in India. Historical overview of industrial fermentation process -traditional and modern Biotechnology. Characteristic and comparison of bioprocessing with chemical processing.

UNIT 2

PROCESS TECHNOLOGIES FOR PRIMARY METABOLITES

[8 L]

Process technology for the production of cell biomass and some primary metabolites: alcohols (ethanol, acetone-butanol), organic acids (citric acid, lactic acid, acetic acid), dextran and amino acids (glutamic acid and tryptophan). Production of secondary metabolites-penicillin and tetracycline

UNIT 3

PROCESS TECHNOLOGIES FOR SECONDARY METABOLITES

[8 L]

Process technology for the production of some secondary metabolites: penicillin, streptomycin, erythromycin and tetracycline, vitamins (Vitamin B12, Vitamin B2, Vitamin A)

UNIT 4

PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS

[10 L]

Production of industrial enzymes (glucose isomerase, amylases, proteolytic enzymes, pectinases, invertase), Production of biopesticides, Biofertilizers, biopreservative (Nisin), biopolymers (xanthan gum & PHB), cheese, SCP.



DEPARTMENT OF BIOTECHNOLOGY

UNIT 5

PRODUCTION OF MODERN BIOTECHNOLOGY PRODUCTS

[9 L]

Production of recombinant proteins having therapeutic and diagnostic applications (insulin, human growth hormone), Production of recombinant vaccines (Covid vaccine, Hepatitis B vaccine, cholera vaccine), production of monoclonal antibodies.

Note: Emphasis on Process Flow Diagram (PFD), block diagram to be given for process description wherever applicable.

TEXT BOOKS

1. Advanced Biotechnology by R C Dubey, S Chand publishers, 2022
2. Advances in Biotechnology by Indu Ravi, Mamta Baunthiyal, Jyoti Saxena, Springer, 2014
3. Industrial Microbiology by Prescott & Dunn, CBS Publishers, 1987.
4. Industrial Microbiology by Casida LE, Willey Eastern Ltd, 1989.

REFERENCE BOOKS

1. Bioprocess Technology-fundamentals and applications by Enfors SO and Hagstrom LRIT, Stockholm, 1992.
2. Biotechnology, Economic & social Aspects by Dasilva EJ, Ratledge C & Sasson. A Cambridge Univ. Press, Cambridge, 1992
3. Environmental Biotechnology by Foster CF and John ware DA. Ellis Horwood Limited. 1987.
4. Encyclopedia, Kirk and othmer, 2007
5. Fuels from waste by Larry Anderson and David A, TillmanAcademic Press, 1977.
6. Comprehensive Biotechnology by Young MY, Pergamon Press, 1985.
7. Biotechnology: A Text Book of Industrial Microbiology by Brock TD (1990), Smaeur Associates.

e-books

1. <https://pdfcoffee.com/industrial-microbiology-free-version-pdf-free.html>
2. https://biosafetysociety.ir/files/site1/files/Advances_in_Biotechnology_1081041355.pdf
3. https://www.researchgate.net/publication/264311523_Advanced_Biotechnology

MOOCs

1. https://onlinecourses.nptel.ac.in/noc19_bt20/preview

COURSE OUTCOMES (COs)

CO1	Understand the biotechnological concepts and process techniques required for production
CO2	Apply the concepts and techniques used for production of bioprocess and modern biotechnological products.
CO3	Identify and analyze the process technologies for different types of biotechnological products.
CO4	Work individually or in groups to identify research papers on advanced biotechnological processes or products and communicate the findings of the literature study as oral presentations and report submission.



DEPARTMENT OF BIOTECHNOLOGY

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														1
CO2	3													2
CO3		3												2
CO4									2	2		1		2

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes mid-term tests, weekly/fortnightly class tests, homework, assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): Includes written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE.



DEPARTMENT OF BIOTECHNOLOGY

COURSE TITLE	NANOTECHNOLOGY										CREDITS		3		
COURSE CODE	2	2	B	T	8	P	E	N	A	T	L T P	3	0	0	
CIE	100 marks (50% weightage)										SEE		100 marks (50% eightage)		

COURSE PRE-REQUISITES: Chemistry, Physics, Bioanalytical techniques, Biosensors and Bioinstrumentation, Molecular Biology, Basics of Biomolecules

COURSE DESCRIPTION: This course aims at teaching the fundamentals of nanotechnology and its applications in biomedical and biological research.

COURSE OBJECTIVES: This course will increase the student's competence in using technology applications for control of macromolecules processes.

UNIT - 1

INTRODUCTION

[7hrs]

A Brief History; Definition of a nano system; Dimensionality and size dependent phenomena: Surface to volume ratio, Fraction of surface atoms, Surface energy and surface stress-, surface defects; Properties at nanoscale (optical, mechanical, electronic and magnetic). Biomolecule-surface interactions.

UNIT - 2

NANOSTRUCTURES

[9 hrs]

Types of nano structures: Buckyballs, Nanotubes, Fullerenes, Carriers, Dendrimers, Nanoparticles, Membranes / Matrices, Nano shells, Quantum Dot, Nano crystals, hybrid biological/inorganic devices. Tools for nano structuring and characterization of nanostructures-Scanning tunneling microscopy, atomic force microscopy, X-ray spectroscopy, Surface enhanced Raman spectroscopy, Lithography. Biocompatibility of nanostructures. Interaction of nanoparticles with cells. Assessment of the toxic effects various tests.

UNIT - 3

NANODIAGNOSTICS

[7 hrs]

Function and application of DNA based nanostructures- DNA microarrays, Nanofabricated devices to separate and interrogate DNA-Nanopore sequencing. Protein arrays, Virus and bacterial Nano technology.

UNIT - 4

NANO THERAPEUTICS

[9 hrs]

Drug Discovery Using Nano crystals, Resonance Light Scattering (RLS) and Nano sensors. Benefits of Nano-Imaging Agents, Applications in Drug Delivery - Bioavailability, Sustained and targeted release, Benefits of Nano-Drug Delivery. Antibodies and conjugates, delivery of drugs through antibodies Nano robots. Health risks and challenges.

UNIT - 5

BIOMEMS

[6 hrs]

Introduction and Overview, Biosignal Transduction Mechanisms: Electromagnetic Transducers Mechanical Transducers, Chemical Transducers, Optical Transducers – Sensing and actuating mechanisms



DEPARTMENT OF BIOTECHNOLOGY

PRIMARY REFERENCES

1. A Textbook of Nanoscience and Nanotechnology, by Pradeep T, Tata McGraw Hill Education Pvt. Ltd., 2012.
2. Nanostructured Materials and Nanotechnology by Hari Singh Nalwa, Academic Press, 2002.
3. Nanotechnology – Basic Science & Emerging Technologies: Chapman & Hall/CRC 2002.

SECONDARY REFERENCES

1. Nanobiotechnology Protocols: Rosenthal, Sandra J and Wright, David W., Humana Press, 2005.
2. Nanotechnology: Richard Booker and Earl Boysen (Eds), Wiley dreamtech 2005 edition
3. Nanobiotechnology: Concepts, Applications and Perspectives (2004), Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
4. Nanotechnology – A gentle Introduction to the Next Big Idea: Mark Ratner and Daniel Ratner, Pearson Education, 2005.

E-BOOKS

1. <https://link.springer.com/book/10.1007%2F978-3-642-02525-9>
2. <https://link.springer.com/book/10.1007%2F978-1-59745-218-2>
3. <http://as.wiley.com/WileyCDA/WileyTitle/productCd-3527306587.html>

MOOCs

1. <https://www.mooc-list.com/tags/nanotechnology>
2. <https://www.mooc-list.com/course/nanotechnology-and-nanosensors-part-1-coursera>
3. <https://archive.nptel.ac.in/courses/118/107/118107015/>

COURSE OUTCOMES

1. Identify the Nano biomaterials and understand their properties. (PO1 and PO2)
2. Apply the concepts of nanotechnology for Nano analytics and characterize nanomaterial. (PO3 and PO12)
3. Comprehend the concept of nanotechnology and their role in a wide range of diagnostic and therapeutic applications (PO1 and PO3)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	BIOETHICS & BIOSAFETY										Credits	2		
Course Code	2	2	B	T	8	H	S	B	E	B	L-T-P	2	0	0

COURSE PRE-REQUISITES: Knowledge of Constitution of India and Professional Ethics, Microbiology, Genetic engineering, Pharmaceutical BT, Animal BT, Plant BT

COURSE DESCRIPTION: The course deals with impact of biotechnology on society, ELSI of biotechnology solutions, biosafety levels and regulations.

COURSE OBJECTIVES: On completion of the course, students will have fundamental knowledge on concepts of ELSI and safety issues governing a technology.

UNIT 1

BIOTECHNOLOGY AND SOCIETY

[3L]

Introduction to science, technology and society; biotechnology and social responsibility - public acceptance issues in biotechnology - issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, globalization and development divide. Case studies/experiences from developing (Bt cotton and Bt brinjal) and developed countries; Biotechnology and hunger: Challenges for the Indian Biotechnological research and industries.

UNIT 2

BIOETHICS AND CONFLICTS IN BIOTECHNOLOGY

[3L]

Introduction; Ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, bioethics vs. business ethics, Issue of technology transfers across the globe.

UNIT 3

BIOETHICS IN HEALTH CARE & RESEARCH

[7L]

Medical ethics - Basic principles of medical ethics; Bioethics in health-care - Patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation; Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Synthetic or artificial cell, HGP and its issues, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.

UNIT 4

BIOSAFETY CONCEPTS AND ISSUES

[8L]

Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels - GRAS organisms, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment;



DEPARTMENT OF BIOTECHNOLOGY

concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools; Bio-safety issues in clinical trials; Biological weapons - types and possible role of RDT in production of novel bioweapons; social, economic and ethical implications of bioterrorism.

UNIT 5

BIOSAFETY REGULATIONS AND GUIDELINES

[5L]

International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trials – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

COURSE OUTCOMES

1. Understand the basic structure of ethical principles of modern BT and biosafety practices.
2. Apply the concepts and guidelines of bioethics and biosafety practices in execution of research and projects. (PO1, PO6)
3. Analyze and interpret the case studies associated with inventiveness, ethics and biosafety in real world scenario. (PO2)
4. Reason, anticipate and evaluate appropriately the ethical, legal and social issues associated with biotechnological processes and products. (PO8)
5. Investigate the case study, conduct surveys, collect data associated with bioethics and biosafety practices, individually work and compile in a report the interpretations from the methods and results. (PO9, PO10)

PRIMARY REFERENCES

1. **Bioethics & Biosafety** by Sateesh MK (2008), IK Publishers.
2. **Biotechnology and Safety Assessment** by Thomas J.A., Fuch, R.L. (2002), Academic Press.

SECONDARY REFERENCES

1. **Biotechnologies in developing countries** by Sasson A, UNESCO Publishers, 1993.
2. **Biological safety Principles and practices** by Fleming, D.A., Hunt, D.L., (2000), ASM Press.

E-BOOKS

1. https://vufind.carli.illinois.edu/vf-tiu/Record/tiu_576971

MOOCs

1. <https://www.mooc-list.com/course/bioethics-law-medicine-and-ethics-reproductive-technologies-andgenetics-edx>



DEPARTMENT OF BIOTECHNOLOGY

Course Title	FORENSIC SCIENCE										Credits	3		
Course Code	2	2	B	T	8	O	E	F	R	S	L-T-P	3	0	0

PRE-REQUISITES: Knowledge of Human Physiology, Engineering Chemistry and Physics, Biology for Engineers.

UNIT 1

INTRODUCTION

[06 L]

Introduction to Forensics, Definition and scopes of forensics, History and chronology of the events in forensics, (Contribution of various scientists and forensic experts in forensic sciences), and important milestones in the forensics, importance and significance of court in forensics (procedure and protocol:- Inquest and different types, medical examiners systems, powers of courts, different documentary evidences and witness, Doctors guide to court), application of the forensics in various fields.

UNIT 2

CRIME LAB & THE CRIME SCENE

[10 L]

Crime lab: Organization of crime lab at various levels in India (Center and State), Basic services provided by full service crime laboratories (physical, biological unit, firearms unit, Document Examination unit, photograph unit, - functions and duties), optional services provided by full service crime laboratories (lie detector, toxicology, voice print analysis unit). The Crime Scene: Processing the crime scene (Crime scene, Preservation and record, methodic search for evidence, Collection and package of the evidences, maintain chain of custody, crime scene safety). Physical evidences: common types & sources of physical evidences, Handling, packing and labeling of evidence, Individual and class characteristics, significance of physical evidences.

UNIT 3

FORENSIC ANALYSIS

[10 L]

Glass (nature of information obtained, properties, glass fractures, collection and preservation of glass evidence); Soil (forensic characteristics, collection and preservation); Hairs (Morphology, Identification and comparison, collection), Fibers (Types, Identification), semen, paint (collection, nature & examination), Blood (stain patterns, preservation, characterization). Selecting an analytical technique to identify a organic substance (Gas Chromatography, High Performance Liquid Chromatography, Thin Layer Chromatography, Electrophoresis)

UNIT 4

FORENSIC BIOLOGY

[08L]

Forensic Pathology (Rigor mortis, Lovor mortis, Algor mortis); Forensic Anthropology, Forensic Entomology, Forensic Psychiatry, Forensic odontology, Forensic Engineering, DNA Analysis, Finger prints (Classification and patterns, ridge characteristics, Methods of detecting fingerprints).



DEPARTMENT OF BIOTECHNOLOGY

UNIT 5

COMPUTER CRIME & ETHICS IN FORENSICS

[05 L]

Computer crime: Introduction and definition, classification (Physical, Data & software related), computer crime prevention measures, overview of cyber forensics.

Ethics in forensic science: Introduction, The importance of professional ethics to science practitioners, Various models of codes of ethics (broad model and Detailed model), How ethical requirement, impact the daily work of a forensic scientist, ethical dilemmas and their resolution.

PRIMARY REFERENCE BOOKS

1. Criminalistics: An Introduction to Forensic Science by Richard Saperstein, Prentice Hall, 2001.
2. Forensic Science in Crime Investigation by B.S.Nabar, Asia Law House, 3rd edition, 2007

SECONDARY REFERENCE BOOKS

1. Principles of Forensic Medicine by Apurba Nandy, New central book agency (p) Ltd.
2. M.K.R.Krisnas's Handbook of Forensic Medicine including Toxicology by V. P. Patnaik, Pras Medical Books, 11th edition, 1999.

COURSE OUTCOMES

By the end of the course, students should be able to:

1. Comprehend the basic concepts of forensic sciences viz., legal procedure and protocols required to solve cases and ethics involved in forensic sciences.
2. Apply the concepts of forensic sciences to solve criminal cases. (PO1)
3. Analyze the crime scenes and physical evidences based on the nature of evidences. (PO2)
4. Identify a suitable case study, prepare a report and communicate effectively. (PO2, PO10)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	HEALTH AND NUTRITION										Credits	3		
Course Code	2	2	B	T	8	O	E	H	A	N	L-T-P	3	0	0

PRE-REQUISITES: Knowledge of Engineering Chemistry, Scientific foundation of health and Biology for Engineers.

COURSE DESCRIPTION: This course deals with the basics of health and nutrition of humans. The course emphasizes on importance of basic food nutrients in one's sustainable life. The course provides in depth knowledge about nutritional intake, dietary standards and food substitutes.

COURSE OBJECTIVES:

The objective of the course is to enable the students to gain knowledge on the various aspects of food nutrients, their intake and deficiency disorders.

UNIT 1

INTRODUCTION TO HUMAN NUTRITION

[7 L]

Concept and definition of terms -Nutrition, Malnutrition and Health, Scope of Nutrition, Basic classification of nutrients, Digestion, Absorption and Utilization of Nutrients, The Recommended Dietary Allowances, BMI, BMR, Calorie intake.

UNIT 2

FOOD PLANNING, PREPARATION AND ANALYSIS

[9 L]

Planning and preparation of adequate meal for different age groups with special reference to different physiological conditions: infants, preschooler, school children, adolescents, adults, pregnancy, lactation and old age, analytical techniques to evaluate food nutrients and food adulterants.

UNIT 3

DIET THERAPY

[9 L]

Adaptation of Normal Diet for Changing Needs, Principles of Diet Therapy, Role of Nutrition in Infections, Fever, Lung Diseases, Diabetes, Gastrointestinal diseases, cancer, stress and mental health. Involvement of nutrition in Addictive Behaviors in Anorexia Nervosa, Bulimia and Alcoholism, Nutrient Drug Interaction.

UNIT 4

FOOD SUBSTITUTES: NATURAL VS ARTIFICIAL

[6 L]

Nutritive and Non-Nutritive Sweeteners: Classification, uses, and impact; Food flavors: Classification, uses, and impact; Food colors: Classification, uses, and impact.



DEPARTMENT OF BIOTECHNOLOGY

UNIT 5

SOCIETAL FOOD HABITS

[8 L]

Studying food habits, Social and cultural influences on food choice, Changing food habits in the modern world; Nutritional recommendations for the general population : Recommended nutrient intakes, A lower diagnostic level for assessing adequacy of nutrient intake, An upper level (UL) to control high dosage of supplements, Estimated average requirement (EAR), Optimal intake range for some essential nutrients, Dietary goals and guidelines (DGGs), Dietary guidelines for children, WHO guide lines, Dietary goals and guidelines in developing countries, Integrating RNIs and DGGs in nutrition promotion, Reference numbers for nutrition labelling and food standards.

TEXT BOOKS

1. Introduction to human nutrition by Michael J Gibney, Susan A Lanham-New, Aedin Cassidy, Hester H Vorster, Second edition, Wiley Blackwell, 2009.
2. Essentials of Human Nutrition, by Jim Mann, A. Stewart Truswell, second edition, Oxford university press, 2002

REFERENCE BOOKS

1. Principles of Human Nutrition by Martin Eastwood Edinburgh, second edition, Blackwell Science Ltd, 2003. e-books
1. <http://faculty.sdmiramar.edu/faculty/sdced/mmcmahon/nutrition/>
2. http://www.freebookcentre.net/medical_books_download/Nutrition-in-Health-andDiseases.html
3. http://www.freebookcentre.net/medical_books_download/The-Chemistry-of-Food-andNutrition.html

MOOCs

1. <https://www.mooc-list.com/categories/food-nutrition>
2. <https://www.mooc-list.com/tags/nutrition>
3. <https://www.my-mooc.com/en/mooc/nutrition-health-part-1-macronutrients-wageningenxnutr101x-0/>
4. <https://www.edx.org/course/subject/food-nutrition>

COURSE OUTCOMES (COs)

CO1	Understand the components of basic food nutrients and their uses.
CO2	Apply appropriate diet as a therapy to manage metabolic diseases.
CO3	Analyze the nature of food habits and intake, societal behavior towards food and artificial food substitutes.
CO4	Work individually or in a team to identify and assess the case studies relevant to food habits and challenges across the globe and communicate the findings as oral presentations and report submission.



DEPARTMENT OF BIOTECHNOLOGY

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1														1	
CO2	3													2	
CO3		3				2								2	
CO4									2	2		1		2	

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes mid-term tests, weekly/fortnightly class tests, homework, assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): Includes written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE.



DEPARTMENT OF BIOTECHNOLOGY

VII Semester

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
AE-4	22BT7AEIDL	Industry Skill Development	0	0	1	1	2
PC-17	22BT7PCEQD	Bioprocess Equipment Design and CAED	3	0	1	4	5
PE-3	22BT7PEPE-3	Professional Elective -3	3	0	0	3	3
PW-3	22BT7PCPW-3	Project -3	0	0	3	3	6
OE-2	22BT7OEOE-2	Open Elective -2	3	0	0	3	3
HS-8	22BT7HSBFS	Biotechnology for Society	2	0	0	2	2
NCMC-5	22BT7NCMC1	MOOCs Course -1				PP/ NP	
		<i>Details of 20 AICTE Activity Points</i>					
TOTAL:-			11	0	5	16	21

Professional Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-3	22BT7PEGIN	Genome Informatics	3	0	0	3	3
PE-3	22BT7PEBNB	Biologics & Biopharmaceuticals	3	0	0	3	3
PE-3	22BT7PEABT	Animal BT	3	0	0	3	3
PE-3	22BT7PEFPC	Food processing and quality control	3	0	0	3	3
PE-3	22BT7PETEN	Tissue Engineering	3	0	0	3	3

Open Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
OE-2	22BT7OEIPR	IPR in Engineering	3	0	0	3	3
OE-2	22BT7OEEM	Ecology and Environmental Management	3	0	0	3	3
OE-2	22BT7OESEN	Sustainability Engineering	3	0	0	3	3



DEPARTMENT OF BIOTECHNOLOGY

VIII Semester

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-5	22BT8PEPE-4	Professional Elective -4	3	0	0	3	3
PW-4	22BT8PCPW-4	Project -4	0	0	6	6	12
OE-3	22BT8OEOE-3	Open Elective -3	3	0	0	3	3
HS-9	22BT8HSBEB	Bioethics and Biosafety	2	0	0	2	2
INT-3	22BT8SRIN3	Internship-Based Seminar	0	0	2	2	4
NCMC-6	22BT8NCMC2	MOOCs Course - 2				P/NP	
		<i>Details of 20 AICTE Activity Points</i>					
TOTAL:-			8	0	8	16	24

Professional Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-4	22BT8PEBDA	Biological Data Analytics	3	0	0	3	3
PE-4	22BT8PEDRD	Drug discovery	3	0	0	3	3
PE-4	22BT8PEABP	Advanced BT processes and Products	3	0	0	3	3
PE-4	22BT8PEFW M	Food waste management	3	0	0	3	3
PE-4	22BT8PENAT	Nanotechnology	3	0	0	3	3

Open Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
OE-3	22BT8OEFRS	Forensic Science	3	0	0	3	3
OE-3	22BT8OEHAN	Health and Nutrition	3	0	0	3	3



DEPARTMENT OF BIOTECHNOLOGY

Course Title	BIOPROCESS EQUIPMENT DESIGN AND CAED										Credits	4		
Course Code	2	2	B	T	7	P	C	E	Q	D	L-T-P	3	0	1

COURSE PRE-REQUISITES: Unit Operations, Reaction Engineering, Elements of Engineering Drawing and Elements of Mechanical Engineering

COURSE DESCRIPTION: The course deals with study of various components used in bioprocess plant. This emphasizes on detail design of major equipment used in bioprocess industry.

COURSE OBJECTIVES: The objective of the course is to make students understand the working of various components used in process plant. Students will be able to design the major equipment used in bioprocess industry.

PART A:THEORY+TUTORIAL

UNIT 1

INTRODUCTION TO BIOPROCESS DESIGN

[6L]

Nature of design, the anatomy of biochemical manufacturing process, organization of biochemical engineering project, codes and standards, factors of safety, degrees of freedom & design variables, optimization, basic considerations in design, piping and instrumentation, material of construction, symbols of equipment used in process flow diagram.

UNIT 2

BIOPROCESS COMPONENTS

[7L]

Welding Joints, pipe fittings, Flanged pipe joint, Gland & Stuffing box expansion joint Ball valve, Gate valve, Non- return valve, Diaphragm valve, Centrifugal pump, Bioreactors, types, Importance of Single use bioreactors, Filtration units: Normal flow and tangential flow (TFF) filtration systems and design criteria.

UNIT 3

PROCESS EQUIPMENT DESIGN AND CAED

[26L]

Detailed process and mechanical design of the following equipment

- IV. Shell and tube exchangers
- V. Fermenter
- VI. Distillation Column-Packed bed IV. Extractor



DEPARTMENT OF BIOTECHNOLOGY

PART B: LABORATORY CAD

1. Flanged pipe joint
2. Gland & Stuffing box expansion joint
3. Ball valve
4. Gate valve
5. Non- return valve
6. Diaphragm valve
7. Centrifugal pump
8. Shell and tube exchangers
9. Fermenter
10. Distillation Column-Packed bed
11. Extractor

COURSE OUTCOMES

CO-PO-PSO mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	
CO 1	3													1		CO 1
CO 2			3		3									2		CO 2
CO 3			3	3										2		CO 3
CO 4			3		3		2		2	2		1		2		CO 4

1. Identify the various symbols used in process flow diagrams (PO1).
2. Draw the sketches of pipe joints, stuffing box, valves, pumps and bioprocess vessels using CAED (PO2, PO3).
3. Design shell & tube heat exchanger, distillation column and Fermenter for given parameters (PO3, PO4).
4. Create process flow diagram and design major equipment for large scale production bioactive materials, and present the report (PO3, PO5, PO7)

PRIMARY REFERENCES

1. **Process equipment design** by M V Joshi., V.V Mahajani
2. **Chemical Engineering** by Coulson and Richardson, Vol. 6, 1993.
3. **Principles of fermentation Technology** by P.F. Stanbury and A. Whitaker, Pergamon Press, 1984.



DEPARTMENT OF BIOTECHNOLOGY

SECONDARY REFERENCES

1. **Process Equipment Design** by Brownell LE and Young EH, John Wiley and Sons, Inc. 2009
2. **Fermentation and Biochemical Engineering Handbook** by Celeste C. Todaro and Henry C. Vogel 3rd edition, 2014.
3. **Bioreactors: Analysis and Design**, by Tapabrata Panda. 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011
4. **Perry's Chemical Engineers' Handbook** by Perry, R.H. Green, D.W. McGraw-Hill. Seventh Edition, 1997.
5. **Unfired pressure vessel** I S Code 2825
6. **Shell and tube heat exchanger specifications**, I S Code 4503

E-books

1. http://buc.edu.in/sde_book/bio_process.pdf

MOOCs

1. <http://nptel.ac.in/courses/103103027/>
2. <https://online-learning.tudelft.nl/courses/industrial> biotechnology

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes three CIEs, homework, assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): Includes written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE



DEPARTMENT OF BIOTECHNOLOGY

Course Title	Biotechnology for Society										Credits	2		
Course Code	2	3	B	T	7	H	S	B	F	S	L-T-P	2	0	0

COURSE PRE-REQUISITES:

Basic knowledge in biochemistry, cell biology and genetic engineering.

COURSE DESCRIPTION:

To enable the students to understand the interactions of biotechnology and society and the debates, controversies, fears, and hopes that have shaped how we think about bodies, organisms, and life in the twenty-first century. It enables the students to gain knowledge on the various topics such as genetically modified foods, cloning, and stem cells; genetic testing and the potential for discrimination; fears of (and, in some cases, hopes for) designer babies; personal genomics; biosecurity; and biotech art.

COURSE OBJECTIVES:

This course enables the students to understand the interactions of the biotechnology, its products with society. It also helps students to understand the debates, controversies and fears pertaining to biotechnological applications for the society.

UNIT - 1

LIMITS OF BIOTECHNOLOGY AND GENETIC ENGINEERING [4L]

Introduction to Biotechnology, Long History of Biotechnology; Inventing Genetic Engineering, Recombinant DNA Debates

UNIT - 2

OWNING LIFE, GENETICALLY MODIFIED FOODS AND THE BOUNDARIES OF BODILY LIFE [5L]

Biotechnology and Business, Patenting Life; Risk, Regulation, and Our Food, Economics of Eating; Owning Part of You, Freezing, Banking, Crossing

UNIT - 3

MAPPING GENES, MAKING SOCIETY, GENETIC TESTING, DISCRIMINATION, AND BIOETHICS [6L]

Eugenics, Human Genome Project; Genetic Testing, Disability, and Discrimination, Bioethics and Medicine



DEPARTMENT OF BIOTECHNOLOGY

UNIT - 4

VIRGIN BIRTHS, RE-ROUTING LIFE, MINDING YOUR OWN BIOLOGICAL BUSINES

[6L]

From the Pill to IVF, Cloning; Stem Cells, Designer Babies; Drugs and Designer Bodies, Personal Genomics

UNIT - 5

DIVERSITY OF BIOTECHNOLOGY AND BIOLOGICAL FUTURES

[5L]

Biotechnology and Race, Bioprospecting and Biocolonialism; Synthetic Biology and Bioterrorism, Biotechnology and Art, Eternal Life and the Posthuman Future.

Primary references:

1. Biotechnology and society an introduction: Hallam Stevens. 2016, university of Chicago press.

Secondary references:

2. Book title: New Perspectives on Technology, Values, and Ethics, Part II. Chapter 7: Biotechnology, Ethics, and Society: The Case of Genetic Manipulation. Pages 123-144. 2015. Springer international publishing.
3. Biology is Technology: The Promise, Peril, and New Business of Engineering Life by Robert H. Carlson. Harvard University Press. 2010

COURSE OUTCOMES

1. Describe how scientific and technological developments in the field of biotechnology affect society and the environment. (PO1)
2. Apply knowledge of biotechnology to solve the societal issues in both focused and broad interdisciplinary contexts. (PO1,6)
3. Identify and analyse the impact of biotechnological solutions in societal and environmental context.] (PO2,7)
1. Evaluate the development of biotechnological solutions for the societal needs with appropriate consideration for the public health and safety and legal, cultural and environmental issues. (PO3)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	GENOME INFORMATICS										Credits	3			
Course Code	2	2	B	T	7	P	E	G	I	N	L-T-P-S	3	0	0	0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

COURSE PRE-REQUISITES: Biostatistics and probability, Basics of Computer applications, Cell and Molecular Biology, Genetic Engineering, Bioinformatics and Genomics & Proteomics.

COURSE DESCRIPTION: This course emphasizes on various next-generation sequencing techniques, assembling the sequencing data, de Novo assembling algorithms for assembly and visualization of sequence data. The course also includes applications of NGS in cancer and other diseases.

COURSE OBJECTIVES: This course is designed to impart good operational knowledge of various nextgeneration sequencing tools and algorithms for sequencing, assembling, analysing and visualizing the sequence data. Further students will comprehend the importance of NGS in cancer and other diseases.

UNIT – 1

EMERGENCE OF NEXT-GENERATION SEQUENCING

Pyrosequencing; Illumina (Solexa) Genome Analyzer; Applied Biosystems SOLiD; Ion Semiconductor (Ion Torrent Sequencing); Heliscope (Single Molecule Sequencing). Third generation sequencing: Nanopore Sequencing, Single Molecule Real Time DNA Sequencing ; Comparison of Next-Generation Sequencing Techniques; Shortcoming of NGS Techniques: Short-Reads and Reads Accuracy Issues, NGS File Formats.

UNIT – 2

THE ASSEMBLY OF SEQUENCING DATA

[6L]

De Novo Genome Sequence Assembly; Challenges of Genome Assembly; Use of Paired-End Reads in the Assembly; Data Pre-processing Methods and Sequence Read Correction Methods; Assembly Errors; Evaluation of Assembly Methods; NGS Data Visualization using Genome Browsers – UCSC and Ensemble genome browsers.

UNIT – 3

ASSEMBLY ALGORITHMS

[7L]

Mapping Assembly to a Graph Problem, The Overlap Graph Approach; De Bruijn Graph Approach; Classification of De Novo Assembly Algorithms; Greedy Algorithms; Overlap Layout Consensus (OLC) Algorithms; De Bruijn Graph-Based Algorithms; Comparison of Algorithms; Working methodologies with NGS data: Data acquisition, Quality check, Trimming, Assembly, Mapping and Visualization.



DEPARTMENT OF BIOTECHNOLOGY

UNIT – 4

NEXT GENERATION SEQUENCING IN CANCER RESEARCH [10L]

Applications of NGS in RNA biomarker discovery in cancer research;; NGS for high-throughput RNA interference screens; RNAseq in prostate cancer research; cancer genomics and cancer epigenomics; Targeted sequencing strategies; Role of long non coding RNAs in cancer genome. MicroRNAs and cancer.

UNIT – 5

NEXT GENERATION SEQUENCING IN CLINICAL RESEARCH [7L]

Neuropsychiatric and Neuroinflammatory Disorders : Polymorphisms in Major Depressive Disorders; Polymorphisms in ADHD; Polymorphisms in Neuroinflammatory Diseases; Multiple Sclerosis; Alzheimer's Disease; Parkinson's Disease; Role of the NGS in Early Diagnostic and Treatment.

PRIMARY REFERENCES

1. Ali Masoudi-Nejad, Zahra Narimani, Nazanin Hosseinkhan; “Next Generation Sequencing and Sequence Assembly”, Methodologies and Algorithms, Springer; 2013.
2. Mark I. Rees, “Challenges and Opportunities of Next-generation Sequencing for Biomedical Research”, Academic Press, 2012.
3. Wu, Wei, Choudhry, Hani (Eds.), “Next Generation Sequencing in Cancer Research: Volume 1: Decoding the Cancer Genome”, Springer, 2013.

SECONDARY REFERENCES

1. Genomes by Brown T A, 2006, Fifth edition, Blackwell Science
2. A Primer of Genome Science by Greg Gibson and Spencer V, Third Edition, Muse, February 2009

e-BOOKS

3. <http://www.springer.com/us/book/9781461477259>
4. <http://store.elsevier.com/Challenges-and-Opportunities-of-Next-Generation-Sequencing-forBiomedical-Research/isbn-9780123942876/>
5. http://vufind.carli.illinois.edu/vf-rou/Record/rou_279168/TOC

MOOCs

3. <https://www.mooc-list.com/course/clinical-bioinformatics-unlocking-genomics-healthcarefuturelearn?static=true>
4. <https://www.mooc-list.com/tags/next-generation-sequencing?static=true>

COURSE OUTCOMES

5. Comprehend and compare various Next-Generation Sequencing Techniques.
6. Apply the tools for assembly of Sequencing Data. (PO5)
7. Acquire, analyse, assemble and visualize the genomic sequence data. (PO2, PO12)
8. Select and Apply the NGS technique in diagnosis and treatment of diseases. (PO1, PO5)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	Biologics & Biopharmaceuticals									Credits	3		
Course Code	22	B	T	7	P	E	B	N	B	L-T-P	3	0	0

Course Description

COURSE PRE-REQUISITES: Biochemistry, Molecular Biology, Basics of Biomolecules, Bioinformatics, Genetic Engineering, Signal Transduction, Pharmacology & Toxicology

COURSE DESCRIPTION: This course emphasizes on concept of biological and Biopharmaceuticals. Students will be introduced to the steps involved in the drug development process and various guidelines to be followed for its formulations and delivery.

The student will be exposed to bio therapeutic applications with a special emphasis on Immunotherapeutics .

COURSE OBJECTIVES: This course is designed to impart beneficial applications of Biotechnology in pharmaceutical industry that uses biological systems, living organisms, or derivatives for drug discovery and development process. This course also portrays knowledge of bio therapeutic applications

UNIT-1

6hrs

Introduction to Biopharmaceuticals and Biogenics

Biopharmaceuticals: biologics and biosimilars. overview of life history for development of biopharmaceuticals. concept of Pharmacovigilance. Ethical and legal issues

UNIT-2

7hrs

Formulation of Biopharmaceuticals

Rational for formulation of biotherapeutics, formulation recipients: solubility enhancers, anti aggregating agents, buffers, cryoprotectants, antioxidants and preservatives etc significance with relevant examples. Methods to enhance shelf life protein based therapeutics. Packaging techniques and quality analysis of product.

UNIT-3

9hrs

APPLICATIONS OF BIOTHERAPEUTICS

Growth factors: IGF, EGF and Neurotrophic factors; Hormones: Production of human insulin by recombinant DNA technology, Formulation of insulin products, Engineered insulins; Therapeutic enzymes: asparaginase and thrombolytics (tPA, SK, UK);

Immunotherapeutics

9hrs

Cytokines as biopharmaceuticals: classification with examples, production and medical uses of interferons (α, β, γ). Overview of antibody based therapeutics, CAR-T cell therapy, biologics for autoimmunity and inflammation, vaccine- adjuvant technology, genetically engineered vaccines, cancer vaccines, m RNA vaccines , present and future biologics.



DEPARTMENT OF BIOTECHNOLOGY

UNIT-5

8hrs

Biopharmaceuticals Based Delivery Systems

Novel drug delivery systems for biopharmaceuticals (rate controlled and site specific), Nanotechnology based miniaturization of biopharmaceuticals and therapeutics, peptides for intracellular targeting, delivery of nucleic acids and therapeutic peptides, concept of responsive or smart drug delivery system.

Text Books:

1. Gary Walsh (2003) Biopharmaceuticals: Biochemistry and Biotechnology, 2nd Edition, John Wiley & Sons, Inc.
2. Daan J A Crommelin (2010), Pharmaceutical Biotechnology, 2nd Edition, Taylor & Francis Group.

Reference Books:

1. Rodney J. Y. Ho (2013) Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, 2nd Edition, John Wiley & Sons, Inc.
2. Gary Walsh (2007) Pharmaceutical Biotechnology: Concepts and Applications. John Wiley & Sons, Inc.
3. Oliver Kayser, Heribert Warzecha (2012) Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, 2nd Edition. John Wiley & Sons, Inc.

COURSE OUTCOMES

1. Outline the drug development process, and regulatory guidelines. (PO6, PO8)
2. Describe the concepts of formulation and modes of drug delivery (PO6)
3. Relate application of biopharmaceuticals for different therapeutic conditions. (PO1, PO6)
4. Relate application of suitable drug delivery systems for different therapeutic conditions. (PO1, PO6)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	ANIMAL BIOTECHNOLOGY										Credits	3		
Course Code	2	2	B	T	7	P	E	A	B	T	L-T-P	3	0	0

COURSE PRE-REQUISITES: Cell and Molecular Biology, Human Physiology, Basics of Biomolecules, Biochemistry and Bioenergetics, Bio analytical Techniques, Immunotechnology and Genetic Engg.

COURSE DESCRIPTION: This course includes the history of Animal biotechnology, development and maintenance of animal cell, tissue and organ cultures. It also includes the latest advances in tissue culture techniques and the regulatory guidelines for animal cell culture.

COURSE OBJECTIVES: To empower graduates to understand current technologies applied in Animal cell culture and its applications.

UNIT- 1

INTRODUCTION TO ANIMAL CELL CULTURE [5L]

History, scope, advantages & limitations. Planning, Construction, layout of laboratory.

UNIT-2

ESSENTIALS FOR ANIMAL CELL CULTURE [7 L]

Essential equipment and culture Vessels (types & designs): Media and reagents Physicochemical properties, Balanced salt solutions, complete media, Serum, serum free media, MEM, DMEM, RPMI and Ham's medium, role of antibiotics in media. Principles of sterile techniques.

UNIT -3

ANIMAL CELL CULTURE TECHNIQUES [7 L]

Establishment of primary cell cultures and cell lines, nomenclature, subculture, propagation and maintenance, suspension cultures & anchorage dependent cultures, Development and maintenance of Embryonic & adult stem cells, Organ and organotypic cultures, Contamination: Sources, types, Monitoring and Eradication, cryopreservation.

UNIT - 4

CHARACTERIZATION OF CELL LINES AND TISSUES [10 L]

Behavior, morphology, growth characteristics, chromosome analysis, DNA, RNA and Protein Content, Enzyme and Antigenic Markers, Transformation, Immortalization, Aberrant Growth Control, Tumorigenicity, Cell counting, Plating Efficiency, Labeling Index, Generation Time. Cytotoxicity assays: Viability and Survival assays, Micro-titration and Transformation assays.



DEPARTMENT OF BIOTECHNOLOGY

UNIT - 5

APPLICATIONS

[10 L]

Gene mapping, marker assisted selection and genetic improvement of desired characters of domestic animals, Commercial scale production of animal cells, Applications of animal cells: in-vitro testing of drugs and environmental pollutants, production of vaccines, growth factors and pharmaceutical proteins. Transgenic animals as bioreactors for production of proteins of pharmaceutical value. Ethical & legal issues

PRIMARY REFERENCES

3. Culture of Animal Cells by Freshney R I(2005), 5th Edn, Wiley-Liss.
4. Animal Cell Biotechnology by Spier RE and Griffiths JB (1988), Academic Press.6th edn.

SECONDARY REFERENCES

5. Molecular Biotechnology: Principles and Practices by Channarayappa (2006). University Press (India) Pvt.Ltd., Worldwide CRC Press,1st edn.
6. Molecular Biotechnology by Primrose; Blackwell scientific publication, 2nd edition
7. Animal Biotechnology by Murray Moo- Young (1989), Pergamon Press, Oxford, 1st edition
8. Introduction to cell & tissue culture by Jennie P. Mather & P.E.Robert, Springer-1st edition

e-BOOKS

3. Animal Cell Biotechnology Methods and Protocols, Editors: Nigel; ISBN: 978-0-89603-547-8(Print) 978-1-59259-486-3(Online), <http://link.springer.com/book/10.1385%2F0896035476>
4. Animal Biotechnology, 1st Edition Models in Discovery and Translation Editor(s):Verma & Singh eBook ISBN :9780123914347, <http://store.elsevier.com/Animal-Biotechnology/isbn9780124160026/>

MOOCs

1. <http://ocw.mit.edu> (<http://ocw.mit.edu/courses/biology/7-342-developmental-andmolecularbiology-of-regeneration-spring-2008/#>)

COURSE OUTCOMES (COs)

6. Draw sketches for layouts to design cell culture labs, (PO1, 3)
7. select and relate the usage of suitable equipment and media. (PO1, 3)
8. Differentiate the methods used for characterization of cultured cells. (PO1)
9. Relate the potential applications and merits & demerits of transgenic technologies in health and disease.(PO5,6, 12)
10. Select and describe the methodologies used for commercial scale production of animal cells and their products. (PO1,12)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	FOOD PROCESSING AND CONTROL QUALITY										Credit s	3		
Course Code	2	2	B	T	7	P	E	F	P	C	L-T-P	3	0	0

COURSE PRE-REQUISITES: Chemistry, biology, microbiology, nutritional science, Unit operations, biotechnology.

COURSE DESCRIPTION: Food processing and quality control is a multidisciplinary course that involves study of all the technical aspects of food. This course will enable the students to understand sourcing and acquiring of raw materials (fruits, vegetables etc.), food processing systems, processes, relevant equipments, dairy products, fruits and vegetable processing, packaging and marketing, storage and transportation techniques etc. This course emphasizes on the importance for good quality food products for consumption as health is now a major concerned point due to the possibility of engaging in various diseases on account of consuming degraded food items. Students will also be updated with scope of this course in developing skills required in Food industry by learning various techniques used in food processing to produce better quality products.

COURSE OBJECTIVES. Students will be able to develop a greater understanding of the outcome of agricultural raw materials, and how such materials are processed and formulated before being presented to the consumer. Additionally, they will be updated on management of production of food products; and usage of scientific knowledge to develop new products maintaining its hygiene and safety.

UNIT-1

FOOD PROCESSING AND PRESERVATION

[7L]

Development of Food Process and Technology, Basic concepts, Processing by chemical method- Methods of fruit and vegetable preservation - Processing using sugar – Preparation of jam, jelly, marmalade, squash, RTS, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt – Brining - Preparation of pickles, chutney and sauces, ketchup. Minimal processing and fermentation, canning, bottling, processing of dairy and animal foods.

UNIT-2

FOOD PROCESS EQUIPMENTS

[7L]

Metals and non-metals, pressure vessels – cylindrical shell –internal and external pressure - under continued loadings. Materials for fabrication, mechanical properties, storage vessels, Unit operations for food processing- heat exchangers, mechanical separators, evaporators, Drying principles-different types, Principles of refrigeration, refrigeration cycles, cold storage and cryogenic freezing.



DEPARTMENT OF BIOTECHNOLOGY

UNIT-3

FOOD SAFETY AND QUALITY CONTROL

[10 L]

Concept of Food safety, Characterization and risk analysis, Food hazards: Physical, Chemical and biological systems for food safety. Hazard Analysis Critical Control Point (HACCP) and its implementation. Quality Assurance-Theoretical and practical considerations, description of different systems: GAP, GMP, TQM, ISO. Indian food standards- Voluntary and Obligatory standards (PFA, FPO, MMPO, AGMARK etc.) Codex alimentarius, Worldwide food safety issues. Sensory Evaluation-Requirements and methods. Sensory parameters: Colour, flavour, texture, taste, aroma, general acceptability. Subjective and Objective test of sensory parameters, Different sanitizers and detergents- Sanitation and hygiene in quality assurance in different food industries (Fruits and vegetables, Meat, Milk, Cereal Based), Cost of Quality, Supplier development.

UNIT-4

FOOD PACKAGING AND STORAGE

[8L]

Introduction to packaging. Packaging operation, package functions and design. Principle in the development of protective packaging, Deteriorative changes in food stuff and packaging methods for prevention, Shelf life of packaged food, storage and transportation techniques, methods to extend shelf life. Flexible packaging materials, Trends in latest packaging- Modified atmospheric packing (MAP), Controlled atmospheric packaging (CAP), Oxygen Scavengers, Shrink packaging, Aseptic and retortable pouches etc. Packaging of different food materials- Fruit and vegetables, meat, milk and egg products, oils, RTE foods etc.

UNIT-5

FOOD LABELING

[7 L]

Need for labeling – Developing labeling standards at the world level – Limitations of labeling safety issues – Labeling regarding methods of processing – Irradiated products – Products derived from modern biotechnology– organic produce –Genetically modified foods – EU rules on nutritional labeling – US rules on nutritional labeling – Health claims – Approach of US and EU.

PRIMARY REFERENCES

1. Kees A. van der Heijden and Sanford Miller. International Food Safety Handbook Science, 1999.
2. Government of India. Guide to the Food Safety and Standards Act. Tax-mann Allied Services Pvt. Ltd. 2006.
3. Mehta R. and George J. Food Safety Regulation Concerns and Trade- The Developing Country Perspective. Published by Macmillan India Ltd., New Delhi, 2005

MOOCs

4. https://onlinecourses.swayam2.ac.in/cec20_ag06/preview
5. <https://nptel.ac.in/courses/126105015>



DEPARTMENT OF BIOTECHNOLOGY

Course Outcomes:

6. Comprehend the concepts of food processing and technology.
7. Apply biotechnological principles to understand the chemical reactions of biomolecules in processed and packaged foods(PO1,2).
8. Selection and application of appropriate design of unit operation for food processing (PO1,3).
9. Provide solutions by applying HACCP principles and sensory parameters to maintain food Quality (PO1, 2).
10. Analyze, compile and present individually the case studies or real world food related concepts (PO4,9,10).



DEPARTMENT OF BIOTECHNOLOGY

COURSE TITLE	TISSUE ENGINEERING										CREDITS	3			
COURSE CODE	2	2	B	T	7	P	E	T	E	N	L T P	3	0	0	0
CIE	100 marks (50% weightage)										SEE	100 marks (weightage) 50%			

PRE-REQUISITES: Knowledge of basic cell and molecular biology, Human physiology, Chemistry, Basics of Biomolecules. Biomaterials and their properties.

COURSE DESCRIPTION: This course deals with the concept's cells and tissues manipulation and engineering for various biomedical applications and principles of tissue engineering.

COURSE OBJECTIVES:

3. To Make Students Understand The potential applications of tissue engineering
4. To enable students to develop various strategies of cell and tissue manipulations for solving biomedical issues.

UNIT-1

[7 hrs]

Tissue engineering introduction. Growth Factors; Extracellular Matrix: Structure, Function Mechanical Forces On Cells; Cell Adhesion; Cell Migration. Stem cells, types and their applications in tissue engineering.

UNIT-2

[10 hrs]

Cell growth characteristics, Cell counting, culturing, propagation and storage. Organ culture techniques, Scaffold For Tissue Engineering Applications; Biomimetic Materials; Nanocomposite Scaffolds for Tissue Engineering; Bioreactors; Regulatory Issues In Tissue Engineering.

UNIT-3

[10hrs]

Tissue organization, tissue types, Tissue repair, homeostasis, angiogenesis and its importance. Cellular fate processes, Cell differentiation, Cell migration - underlying biochemical process.

UNIT-4

[6 hrs]

Applications of tissue engineering: Overview :Synthesis of human Skin Substitute; Nerve Tissue Engineering; Musculoskeletal Tissue Engineering; Bone Tissue Engineering; Cartilage Tissue Engineering; Smooth Muscle Tissue Engineering; Oesophagus Tissue Engineering.

UNIT-5

[6 hrs]

Tissue engineering for vasculature, Cardiac Tissue Engineering; Heart Valve Tissue Engineering; Urologic Organ Tissue Engineering; Hepatic Tissue Engineering; Renal Tissue Engineering; Dental Tissue Engineering.



DEPARTMENT OF BIOTECHNOLOGY

PRIMARY REFERENCES

1. PRINCIPLES OF TISSUE ENGINEERING, 5TH EDITION by Robert Lanza
2. Tissue Engineering" by Palsson and Bhatia, 2016, ISBN-10 9332571791

SECONDARY REFERENCES

3. Clemens van Blitterswijk (2008), Tissue Engineering, Academic Press
4. Tissue engineering by Anil K Sharma and Raj K Keservani

MOOCS

5. https://onlinecourses.nptel.ac.in/noc24_bt49/preview
6. https://archive.nptel.ac.in/content/syllabus_pdf/102106036.pdf

COURSE OUTCOMES:

7. Understand the current status and potential uses of tissue engineering (PO1,12)
8. Design experiments for culturing and growth of cells and tissues (PO3)
9. Identify different scaffolds and materials for usage in tissue engineering (PO1)
10. Apply tissue engineering solutions for various biomedical applications. (PO1 and PO3,12)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	Intellectual Property Rights for Engineers										Credits	3		
Course Code	2	2	B	T	7	O	E	I	P	R	L-T-P	3	0	0

Course Description

COURSE PRE-REQUISITES: Basic sciences, Mathematics, Engineering sciences, Engineering core and elective courses

COURSE DESCRIPTION: This course emphasizes on concept of intellectual property and its forms. The contents mainly focus on Industrial designs and innovative articles that could get protected from patent law under IP. It also emphasizes on softwares and Internet of things, Trademarks and trade secrets the knowledge of which gets protected by copyright and other IP laws. The course designed to effectively transfer the knowledge with real-life case studies from the filed of IPR.

COURSE OBJECTIVES: This course is designed to benefit the engineering students in protecting innovative and new products and processes that originate from their research domain. The course also provides the in-depth knowledge of operation of IP forms and protection from possible infringement.

UNIT 1

5Hr

Intellectual Property Rights, different forms and their usefulness for Engineers

Concept of property and types (similarities and differences), Intellectual Property and its different forms : Patents, Copyright, Trademarks, Industrial Designs, Registration of Plant Varieties, Registration of Semiconductor Integrated Circuit Layout Design (SICLD); Registration of Geographical Indications and Trade Secrets. Important International Treaties for Protection of Intellectual Property. Usefulness of IPRs for engineers-introduction to new career opportunities/consultancy opportunities

Unit 2

10Hr

Determination of patentability of inventions - the TRISHUL test of novelty, inventive step and industrial application; Making a patent search map and performing a prior art search; literature and non-literature sources of information for prior art assessment. Forms, Fee and time lines- Frequently asked questions- Double patenting, provisional patenting, patent of addition, divisional patents and convention patent applications. Precautions. Patents-some myths and misconceptions; Practical aspects of filing a patent outside India (International Patenting-PCT)

Patents- usefulness for engineers viz. preventing duplication of work; helping in identification of hot areas of research; preventing exploitation; promoting revenue generation; giving access to rare technical information; preventing infringements and helping to avoid litigation; stimulating creativity. Patents- Significance for engineering professionals/ technopreneurs/ business managers; Patents- to file or not to file? Practical aspects of filing a Patent in India and Abroad. Enforcement of Patent Rights at National and Global level. Case study- Bajaj vs TVS. Annexures-Patent filing forms.

UNIT 3

8Hr

Copyright and its usefulness in Engineering

Subject matter of copyright- Artistic, Literary, musical and cinematographic works; Definition, History, International Copyright Treaties; Internet treaties; Amendments in Indian Copyright Law and their significance; Protection of Software and digital innovations; Rights afforded by copyright law;



DEPARTMENT OF BIOTECHNOLOGY

Case; Case Studies - The Manipal Academy Case (Supreme Court of India, 2009); R.G. Anand v. Delux Films (Supreme Court of India, 1978); Adobe and Microsoft (Delhi High Court, 2009). Forms, Fee, Timeline- Ownership issues, transfer and duration. Model Agreements between author and publisher Royalty, Assignment Digital Innovations and Developments as Knowledge Assets Significance of IP in Content for the Internet and Tech Sector-Symbols and trademarks as Business Assets in the Information Age; Internet and the Worldwide Web; Applications of computer technology - advantages/disadvantages of computers; Cyber Technology- e commerce and e governance; Electronic records digital signatures; The Employment Relationship in the Internet and Tech Sector - role of CDAs and contracts; Trolls, landmines and other metaphors; Cyber etiquette.

UNIT 4

6Hr

Registration of Industrial Design and its usefulness in Engineering Illustrative story; Indian Law related to Registration of Industrial Designs; Essential Requirements for Registration of a Design in India- Limitations; American Law; International Agreements- The Hague System; Conflicts related to Registration of Design, Copyright or Trademark; Legal rights and advantages of Industrial Design Registration- The Tupperware Case. Practical aspects of Industrial Design Registration in India and Abroad. How to file application for registration of Industrial Design- a ten step guides.

UNIT 5

10Hr

Trade Secrets- Importance for Engineers

Trade Secrets- Importance for Engineers; FAQs related to trade secrets; Elements of Trade Secrets- what is a trade secret and what is not? Laws relating to protection of Trade Secrets; Spring Board Doctrine; Case Study- Diljeet Titus Case; Documentation related to trade secrets-confidentiality agreement (CDA); Non-disclosure Agreement or NDA; non-compete agreement or NCA and Trade Secret Bonds or TSBs; Practical aspects of maintaining trade secrets; Maintaining Lab Notebooks as Trade Secret Documents. Annexures- Format of NDA/CDA and a Trade Secret Bond Trademarks- Importance in Engineering industry; FAQs; National Trademark Filing- Practical aspects-forms, fee, timelines, procedural aspects. International Trademark Filing-Madrid System-Madrid Agreement and Madrid Protocol; Maintenance and Transfer; Dilution of ownership-likelihood of confusion; Case Study-Haldiram Bhujiawala (Supreme Court of India, 2000); Trade mark claims and Litigation; Enforcement - International trademark law. Case studies- Whirlpool (Supreme Court of India, 1996); Benz (Delhi High Court, 1993); Cadila (Delhi High Court, 2007); Distinction between Trademark and Domain name. Case Study- Satyam Infoway (Supreme Court of India, 2004). Annexures- Classification of goods and services; Format of form for Registration of Trademark (Form TM-1), Renewal of Trademark (TM-12)

Text Books:

1. Fundamentals of Intellectual Property for Engineers, Kompal Bansal and Parikshit Bansal, BS Publications, 2013.
2. Intellectual Property, Roopinder Tiwari and Mamta Bharadwaj, Publication Bureau of Punjab university, 2021

Reference Books:

1. Intellectual Property Rights for Engineers, Vivien Irish, 2nd Edition, 2005, IET Publishers
2. A Textbook of Intellectual Property Rights, [Ramakrishna Chintakunta](#), Blue Hill Publications, 2022.



DEPARTMENT OF BIOTECHNOLOGY

COURSE OUTCOMES

1. Understand the basic IP law pertain to filing for protection of products and processes. (PO1, PO6, PO12)
2. Assess and evaluate the possibility of technological developments for protection under patents, Industrial designs and trademarks (PO2, PO4, PO6)
3. Relate the implementation of IP guidelines into computer related applications (PO1, PO6).
4. Collect data, compile into report and present the controversial case studies relevant to IP protection (PO2, PO6, PO9, PO10, PO12)

https://onlinecourses.nptel.ac.in/noc22_hs49/preview

<https://www.asme.org/topics-resources/content/intellectual-property-and-engineers>

https://www.eit.edu.au/engineers-encourage-understanding-of-intellectual-property-in-engineering-industry/?_gl=1*yckmgn*_up*MQ..*_ga*MTA3MDI4MjI5MC4xNzIxNjI1MDE4*_ga_5JFFK72DLM

<https://www.wiley.com/en-us/Intellectual+Property+Law+for+Engineers%2C+Scientists%2C+and+Entrepreneurs%2C+2nd+Edition-p-9781119382010>

<https://shop.theiet.org/intellect-prop-rights-eng-2ed>



DEPARTMENT OF BIOTECHNOLOGY

COURSE TITLE	ECOLOGY & ENVIRONMENTAL MANAGEMENT										CREDITS	3		
COURSE CODE	2	2	B	T	7	O	E	E	E	M	L T P	3	0	0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

COURSE PRE-REQUISITES: Very basic knowledge about life forms, environment and ecology.

COURSE DESCRIPTION: The course covers various aspects of an ecosystem and its components, community characteristics and biogeochemical cycles. This course also includes general population attributes, their distribution and interaction of living components with each other and with environment. This course covers importance of the biodiversity, its protection and environmental issues, policies and regulations.

COURSE OBJECTIVES: To enable the students to gain knowledge on the various environmental issues and the application of biotechnological concepts in the management and sustainability of environment and the various policies and regulations involved.

UNIT – 1

[9hrs]

Introduction to Ecology, Community and Ecosystem: types of ecosystems. Interrelationship between the living world and environment: Ecological pyramids, trophic levels: Producers and consumers, Foodweb and food chain. Environmental concepts (theory of tolerance and limiting factors), Concepts of habitat and niche, Community characteristics, Primary and secondary ecological succession and biogeochemical cycles.

UNIT-2

Population and Community Ecology

[7hrs]

Population Attributes: Density, natality, mortality, age ratio, sex ratio, Dispersion of population, Exponential and logistic growth Simpsons index and examples and calculations.

UNIT-3

[6hrs]

Predation types, R and K selected species, Host parasite interactions, Social parasitism, Symbiosis with examples.,

UNIT-4

Biotechnology in environmental management:

[9hrs]

Biodiversity and conservation strategies, success stories conservation, Sustainable utilization, Red data book, rare, Endangered and threatened species, Germ plasm banks, Sustainable utilization of wastes, Biofertilizers, Ecofriendly biopesticides, Bioremediation, bio indicators.



DEPARTMENT OF BIOTECHNOLOGY

UNIT-5

Pollution, environmental impact and protection

[6 hrs]

Impact of urbanization and industrialization, Environmental impact assessment, Environmental Pollution, Global climatic changes, National and international guide lines, climate summits (Paris summit), Wild life act of India.

PRIMARY REFERENCES:

1. Environmental studies: Anubha kaushik, CP KAushik, New age international, 3rd edition.

SECONDARY REFERENCES:

1. Environmental studies selective and scientific books: Mishra A, New delhi, 2005
2. Basics of environmental science: Allaby. M , Routledge, 2002
3. Elements of Ecology: Smith, TM, Simth RC Istedn. Pearson publications, 2006
4. Environmental science: Miller GT, 11th edition Brooks/cole, 2006. E-Books:
1. Environmental studies: Erach Bharucha, Univeristy Grants Commission

MOOCs:

1. <http://nptel.ac.in/courses/122102006/>
2. Biodiversity and Global Change: Science & Action (Coursera):
<https://www.mooclist.com/course/biodiversity-and-global-change-science-action-coursera>
3. Environmental Challenges: Justice in Natural Resource Management (FutureLearn)
<https://www.mooc-list.com/course/environmental-challenges-justice-natural-resourcemanagementfuturelearn>
4. Environmental Studies: A Global Perspective (edX)
<https://www.mooclist.com/course/environmentalstudies-global-perspective-edx>

COURSE OUTCOMES:

1. Understand key ecological concepts and the ecological interactions which effect environment (PO1)
2. Analyse and predict the effects of ecological interactions amongst populations (PO3)
3. Understand the phytogeographical and zoogeographical distribution of the world (PO1)
4. Apply the knowledge of environmental management to solve industry related environmental issues (PO1, PO5 and PO12)

NOTE: Students of Biotechnology department are exempted from taking this course.



DEPARTMENT OF BIOTECHNOLOGY

Course Title	SUSTAINABILITY ENGINEERING												
Course Code	2	2	B	T	7	O	E	S	E	N	Credits		L – T – P
													3– 0 – 0

COURSE PRE-REQUISITES: Applied Chemistry, Introduction to civil engineering, Environment Science, Introduction to sustainable engineering

COURSE DESCRIPTION: This course offers an introduction to the idea of sustainability. Various models, such as those for population increase, global food production, and global water resources, are discussed throughout the course. In addition, the course emphasises current issues like urbanisation, resource depletion, and land usage. The course describes strategies in circular product design and design integration both in daily activities as well as in workplace. Additionally, the course covers a variety of industrial models and methods for sustainable engineering, including environmental sustainability design indicators, pollution control strategies, and the use of mass and energy balances in the development of sustainable systems.

COURSE OBJECTIVES: Objective of this course is to inculcate in students an awareness of environmental issues and the global initiatives towards attaining sustainability. The student should realize the potential of technology in bringing in sustainable practices.

UNIT 1

AN INTRODUCTION TO SUSTAINABILITY

[7 L]

Introduction, Sustainable development, concepts of sustainable development: three pillar model, egg of sustainability model, Atkisson's pyramid model, prism model, principles of sustainable development, sustainable engineering, threats for sustainability. Environmental Ethics and Legislations – Environmental ethics and education, multilateral environmental agreements and protocols, enforcement of environmental laws in India – The Water Act, The Air Act, The Environment Act

UNIT 2

RISK AND LIFE-CYCLE FRAMEWORKS FOR SUSTAINABILITY

[6 L]

Risk, Risk Assessment, Risk-Based Environmental Law, Life-Cycle Frameworks, Life-Cycle Assessment, Life-Cycle-Based Environmental Law, Life-Cycle Assessment Tools.

UNIT 3

GREEN SUSTAINABLE MATERIALS

[7L]

Environmental and Natural Resource Use Footprints of Material Extraction and Refining, Tracking Material Flows in Engineered Systems, Environmental Releases.



DEPARTMENT OF BIOTECHNOLOGY

UNIT 4

DESIGN FOR SUSTAINABILITY: ECONOMIC, ENVIRONMENTAL, AND SOCIAL INDICATORS [10L]

Sustainable Engineering Design Principles, Economic Performance Indicators, Estimates of Environmental Costs, A Framework for Evaluating Environmental Costs, Environmental Performance Indicators.

UNIT 5

SUSTAINABILITY PRACTICES [9L]

Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport, Case studies

TEXT BOOKS

1. R. L. Rag and Lekshmi Dinachandran Remesh. Introduction to Sustainable Engineering. 2nd Edition, PHI Learning Pvt. Ltd., 2016.
2. Introduction to Sustainability for Engineers, Toolseeram Ramjeawon, CRC Press, 1st Edition., 2020

REFERENCE BOOKS

3. D. T. Allen and D. R. Shonnard. Sustainability Engineering: Concepts, Design and Case Studies, 1 st Edition, Prentice Hall, 2011.
4. A.S. Bradley, A. O. Adebayo, P.Maria. Engineering applications in sustainable design and development, 1st Edition, Cengage learning, 2016.

e-books

5. <https://dokumen.pub/sustainable-engineering-concepts-design-and-case-studies-1nbsped0132756544-2011041250-9780132756549.html>

MOOCs

6. <https://nptel.ac.in/courses/127105018>
7. <https://nptel.ac.in/courses/107103081/www.macfound.org>
8. <https://www.my-mooc.com/en/mooc/technology-innovation-for-sustainable-development/>
9. <https://www.edx.org/course/engineering-design-for-a-circular-economy>

COURSE OUTCOMES (COs)

CO1	Comprehend the concepts of sustainable development and different environmental agreements and protocols.
CO2	Apply life cycle assessment tools and sustainable materials
CO3	Analyze sustainability through various indicators and sustainability practices.
CO4	Work individually or in groups to identify real life sustainability practices and communicate the findings of the literature study and solution proposed, as oral presentations and report submission.



DEPARTMENT OF BIOTECHNOLOGY

CO-PO-PSO mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	
CO 1														1		CO 1
CO 2	3						3							2		CO 2
CO 3		3					3							2		CO 3

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes mid-term tests, weekly/fortnightly class tests, homework, assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): Includes written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE.



DEPARTMENT OF BIOTECHNOLOGY

8TH SEMESTER

Course Title	BIOLOGICAL DATA ANALYTICS										Credits	3			
Course Code	2	2	B	T	8	P	E	B	D	A	L-T-P-S	3	0	0	0

COURSE PRE-REQUISITES: Basics of computer applications, Bioinformatics, Genome informatics, Statistics, Genomics and proteomics.

COURSE DESCRIPTION: This course emphasizes on basics of R programming and interfacing with statistics to analyze the data. It also portrays the fundamentals of Bioconductor an open source software tool for bioinformatics to analyze and interpret the Biological data.

COURSE OBJECTIVES: This course is designed to impart good operational knowledge on basics of R programming and interfacing with statistics for the computational analysis of data. This course also highlights the fundamentals and applications of Bioconductor an open source software tool for bioinformatics. Further students will inculcate these tools to critically analyze the data and derive valid conclusions.

Unit- I

[07hours]

R PROGRAMMING BASICS

Overview of R programming, Environment setup with R Studio, R Commands, Variables and Data Types, Control Structures, Vectors, Factors, Functions, Matrices, Arrays and Lists.

Unit- 2

[07hours]

INTERFACING

Interfacing R to other languages, Parallel R, Basic Statistics: Linear Model, Generalized Linear models, Non-linear models, Time Series, Autocorrelation and Clustering.

Unit- 3

[07hours]

INTRODUCTION TO BIOCONDUCTOR FOR SEQUENCE DATA

Sequencing Resources, Ranges Infrastructure, DNA /amino acid sequence from FASTA files, Reads from FASTQ files, Aligned Reads from BAM files, Called Variants from VCF files, Genome Annotations from BED, WIG, GTF files



DEPARTMENT OF BIOTECHNOLOGY

Unit- 4

[09hours]

BIOLOGICAL DATA ANALYSIS

Preparing count matrices, The DESeqDataSet, sample information, and formula design, exploratory analysis and visualization, Differential expression analysis, Plotting results, Annotating and exporting results

UNIT-5

MASS SPECTROMETRY AND PROTEOMICS DATA ANALYSIS

[09hours]

Exploring available infrastructure, Mass spectrometry data, Getting data from proteomics repositories, Handling raw MS data, Handling identification data, MS/MS database search, Analyzing search results, Analysis of peptide sequences, Trimming the data, Parent ion mass error, Filtering criteria, Filter optimization, High-level data interface, Quantitative proteomics, Importing third-party quantitation data, Data processing and analysis, Raw data processing, Processing and normalization, Statistical analysis, Machine learning: Classification, Clustering: k-means, Annotation.

PRIDE Database, Raw Data Acquisition, Quality Control, Data Preprocessing (Convert Raw Files, Peak Detection and Alignment), Peak Detection and Alignment (Search Database, Validate Results), Protein Quantification (Quantify Proteins, Normalization), Differential Expression Analysis (Statistical Analysis, Multiple Testing Correction (e.g., Benjamini Hochberg), Functional Annotation (Gene Ontology (GO) Enrichment, Pathway Analysis), Data Visualization (Volcano Plot, Heatmap), Data Annotation and Export.

PRIMARY REFERENCES

1. An Introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics. W. N. Venables, D.M. Smith and the R Development Core Team. Version 3.3.3.
2. Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison- Wesley Data & Analytics Series, 2013.

SECONDARY REFERENCES

3. Norman Matloff, "The Art of R Programming: A Tour of Statistical Software Design", No Starch Press, 2011.
4. Avril Coghlan, "A Little Book of R For Bioinformatics", Release 0.1

E-BOOKS:

5. <https://cran.r-project.org/doc/manuals/r-release/R-intro.pdf>
6. <https://www.bioconductor.org/>

MOOCs

1. <https://www.class-central.com/tag/r%20programming>
2. <https://www.edx.org/course/introduction-r-data-science-microsoft-dat204x-3>



DEPARTMENT OF BIOTECHNOLOGY

Course Title	DRUG DISCOVERY										Credits	3			
Course Code	2	2	B	T	8	P	E	D	R	D	L-T-P-S	3	0	0	0

Unit 1

[07hours]

QUANTITATIVE STRUCTURE-ACTIVITY RELATIONSHIP (QSAR):

Database search methods: Chemical indexing, Proximity searching, 2D and 3D Structure and Substructure searching. Pharmacophores, Computational Models: Introduction, Historical Overview and Quantitative Structure-Activity Relationship Analysis: Model building, Model evaluation, Topological analysis 3DQSAR, 4D-QSAR.

Unit 2

[07hours]

CHEMOINFORMATICS:

Introduction to Chemoinformatics: - Small molecule database, molecular descriptors and chemical spaces, chemical spaces and molecular similarity, modification and simplification of chemical spaces. Compound classification and selection – cluster analysis, partitioning, support vector machines. Chemical structure drawing, 3-D chemical molecular conversion. (Data analysis problems).

Unit 3

[09hours]

COMPUTER - ASSISTED DRUG DISCOVERY AND MOLECULAR DYNAMICS SIMULATION

Introduction to the concept of receptors and drug receptor interactions Drug discovery and development process, Contributions and achievements of CADD groups, Introduction to Molecular Dynamics Simulation, Molecular dynamics simulation - simple modes, at constant temperature, pressure and solvent effects. Applications of MD Simulation

Unit 4

[09hours]

NETWORK BIOLOGY AND PATHWAY ANALYSIS

Biological Networks - Types of Biological Networks: Protein-Protein Interaction Networks, Gene Regulatory Networks, Metabolic Networks, Network Construction and Representation, Network Topology and Properties

Pathway Analysis - Signaling Pathways, Metabolic Pathways, Pathway Databases and Tools , AI in Network and Pathway Analysis - Network-based Machine Learning, Predictive Modeling of Biological Pathways, Case Studies



DEPARTMENT OF BIOTECHNOLOGY

Unit 5

[07hours]

PERSONALIZED MEDICINE

Personalized Medicine - Genomics and Personalized Treatment, AI for Personalized Treatment Plans, Ethical and Practical Considerations. Ethical and Practical Considerations - Data Privacy and Security, Regulatory Issues, Case Studies.

PRIMARY REFERENCES

1. Young D. C. Computational Drug Design: A Guide for Computational and Medicinal Chemists, WileyInterscience, 2009.
2. Andrew R. Leach, An Introduction to Chemoinformatics, Publisher : SPRINGER (SIE) 2009
3. N. Claude Cohen, Guidebook on Molecular Modelling in Drug Design, Elsevier India; First Edition, 2008
4. "AI for Drug Development and Biomarker Discovery" by Ulrich Nielsch, Ulf Baginski, and Michael E. Beckmann

SECONDARY REFERENCES

1. Barry A. Bunin, Brian Siesel, Guillermo Morales, Jürgen Bajorath, Chemoinformatics: Theory, Practice, & Products, 2007.
2. Alexander Hillisch, Rolf Hilgenfeld, Birkhäuser. Modern Methods of Drug Discovery, 2003.
3. Hugo Kubinyi, Gerd Folkers, Yvonne C. Martin. 3D QSAR in Drug Design: Ligand-protein interactions and molecular similarity, Springer, 1998.
4. Personalized and Precision Medicine Informatics by Terrence Adam and Ryan A. Radev

COURSE OUTCOMES

1. Understand the guidelines for drug design, and fundamentals of QSAR and its
1. parameters [L1]
2. Utilize in silico approaches to critically evaluate the pharmacophore for ligand-
1. protein binding and its application to drug design. (PO3) [L3]
3. Analyze and interpret computer aided biopharmaceutical characterization using computer simulations during clinical development. (PO5) [L3]
4. To apprehend the importance of artificial intelligence in pharmaceutical applications (PO5 and PO12) [L3]



DEPARTMENT OF BIOTECHNOLOGY

Course Title	ADVANCED BT PROCESSES & PRODUCTS									Credits	3		
Course Code	2	2	B	T	8	P	E	A	B	L-T-P	3	0	0

COURSE PRE-REQUISITES: Knowledge of Microbiology, Unit Operations, Biochemistry, Molecular Biology, Genetic Engineering and Bioprocess Technology

COURSE DESCRIPTION: This course offers an introduction to commercial potential of biotechnology. The course will give an insight into the advanced process technologies for primary and secondary products and other modern biotechnological products. It covers the current uses of bioprocessing, including the production of alcohol, organic acids, antibiotics, vaccines, and other products.

COURSE OBJECTIVES: The objective of the course is to impart basic knowledge on how to use microorganisms and enzymes to produce goods with enormous industrial value. It combines science, engineering, and other biochemical processes in a novel way to produce products from a variety of industries, including food, chemicals, and bioenergy. Instead of just covering theory, the course primarily focusses on applications, giving students the opportunity to learn about bioprocess in a real-world setting.

UNIT 1 INTRODUCTION

[4 L]

Biotechnology: Scope and importance, Commercial potential of Biotechnology in India. Historical overview of industrial fermentation process -traditional and modern Biotechnology. Characteristic and comparison of bioprocessing with chemical processing.

UNIT 2

PROCESS TECHNOLOGIES FOR PRIMARY METABOLITES

[8 L]

Process technology for the production of cell biomass and some primary metabolites: alcohols (ethanol, acetone-butanol), organic acids (citric acid, lactic acid, acetic acid), dextran and amino acids (glutamic acid and tryptophan). Production of secondary metabolites-penicillin and tetracycline

UNIT 3

PROCESS TECHNOLOGIES FOR SECONDARY METABOLITES

[8L]

Process technology for the production of some secondary metabolites: penicillin, streptomycin, erythromycin and tetracycline, vitamins (Vitamin B12, Vitamin B2, Vitamin A)



DEPARTMENT OF BIOTECHNOLOGY

UNIT 4

PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS

[10 L]

Production of industrial enzymes (glucose isomerase, amylases, proteolytic enzymes, pectinases, invertase), Production of biopesticides, Biofertilizers, biopreservative (Nisin), biopolymers (xanthan gum & PHB), cheese, SCP.

UNIT 5

PRODUCTION OF MODERN BIOTECHNOLOGY PRODUCTS

[8 L]

Production of recombinant proteins having therapeutic and diagnostic applications (insulin, human growth hormone), Production of recombinant vaccines (Covid vaccine, Hepatitis B vaccine, cholera vaccine), production of monoclonal antibodies.

Note: Emphasis on Process Flow Diagram (PFD), block diagram to be given for process description wherever applicable.

TEXT BOOKS

1. Advanced Biotechnology by R C Dubey, S Chand publishers, 2022
2. Advances in Biotechnology by Indu Ravi, Mamta Baunthiyal, Jyoti Saxena, Springer, 2014
3. Industrial Microbiology by Prescott & Dunn, CBS Publishers, 1987.
4. Industrial Microbiology by Casida LE, Willey Eastern Ltd, 1989.

REFERENCE BOOKS

1. Bioprocess Technology-fundamentals and applications by Enfors SO and Hagstrom LRIT, Stockholm, 1992.
2. Biotechnology, Economic & social Aspects by Dasilva EJ, Ratledge C & Sasson. A Cambridge Univ. Press, Cambridge, 1992
3. Environmental Biotechnology by Foster CF and John ware DA. Ellis Horwood Limited. 1987.
4. Encyclopedia, Kirk and othmer, 2007
5. Fuels from waste by Larry Anderson and David A, TillmanAcademic Press, 1977.
6. Comprehensive Biotechnology by Young MY, Pergamon Press, 1985.
7. Biotechnology: A Text Book of Industrial Microbiology by Brock TD (1990), Smaeur Associates.

e-books

1. <https://pdfcoffee.com/industrial-microbiology-free-version-pdf-free.html>
2. https://biosafetysociety.ir/files/site1/files/Advances_in_Biotechnology_1081041355.pdf
3. https://www.researchgate.net/publication/264311523_Advanced_Biotechnology

MOOCs

4. https://onlinecourses.nptel.ac.in/noc19_bt20/preview

COURSE OUTCOMES (COs)

CO1	Understand the biotechnological concepts and process techniques required for production
------------	---



DEPARTMENT OF BIOTECHNOLOGY

CO2	Apply the concepts and techniques used for production of bioprocess and modern biotechnological products.
CO3	Identify and analyze the process technologies for different types of biotechnological products.
CO4	Work individually or in groups to identify research papers on advanced biotechnological processes or products and communicate the findings of the literature study as oral presentations and report submission.

CO-PO-PSO mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	O1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1														1	
CO 2	3													2	
CO 3		3												2	
CO 4									2	2		1		2	

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes mid-term tests, weekly/fortnightly class tests, homework, assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): Includes written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE.



DEPARTMENT OF BIOTECHNOLOGY

Course Title	Food Waste Management										Credits	3		
Course Code	2	2	B	T	7	P	E	F	W	M	L-T-P	3	0	0

Course Description

COURSE PRE-REQUISITES: Basic sciences, Microbiology, Food Microbiology, Advances in food chemistry, Biochemistry

COURSE DESCRIPTION: This course introduces the characteristics and impact of wastes generated in a food industry. The course content mainly emphasize on sustainable utilisation of food waste for production of value-added products. The course also deals with wastes generated across the dairy industry, its characteristics and management. The convenient and advanced technologies used in the treatment of food waste are also well explored in the course content.

COURSE OBJECTIVES: The course imparts complete knowledge on wastes generated in a typical food industry and its management. It makes the students to learn the various ways positively utilise the food wastes to the beneficial aspects.

UNIT 1

05 hr

Food Industry Waste: Introduction, Characteristics of waste, Environmental Standards and Regulations

UNIT 2

10 hr

Utilization of Waste from Food Processing Industries: Part 1

Fruits and Vegetable By-Product Utilization as a Novel Approach for Value Addition, Phytochemicals from the Fruits and Vegetable Waste: Holistic and Sustainable Approach, Fruit Peels: A Sustainable Agro Waste Utilization Approach, Potential Value Addition from Cereal and Pulse Processed By-Products, Waste from Oil-Seed Industry: A Sustainable Approach.

UNIT 3

07 hr

Utilization of Waste from Food Processing Industries: Part 2

Wealth from Meat Industry By-Products and Waste, Post-Harvest Management of Climacteric Fruits in India, Agricultural Waste Produce: Utilization and Management, Biobased Packaging from Food Industry Waste, Advances in Sugarcane Industry: By-Product Valorization,

UNIT 4

07 hr

Sustainable Food Waste Management Technologies

Mushroom: A Potential Tool for Food Industry Waste, Bioremediation: A Sustainable Biological Tool for Food Waste Management, Recovery of Bioactive Components from Food Processing Waste, Food Processing Waste to Biofuel: A Sustainable Approach, Digital Knowledge Ecosystem: A New Weapon to Achieve Sustainable Food Waste Management



DEPARTMENT OF BIOTECHNOLOGY

UNIT 5

10 hr

Dairy waste management Introduction, Sources of Waste from Dairy Industries, Characteristics of dairy wastes, Prevention of wastes, Disposal of Spoiled Products, Utilisation of By-Products : Ski milk and butter milk, Cheese and Casein Whey, Spillage and Overflow of Milk, Rinsings and Washings, Standard Maximum Load. Treatment of Milk Waste: Land irrigation, Aeration, Biological filtration and Activated sludge

Text books

1. Sustainable Food Waste Management, Concepts and Innovations. MonikaThakur et.al. Springer Publishers, 2020
2. Integrated Waste Management Approaches for Food and Agricultural Byproducts, Tawheed Amin et.al. Apple Academic Press, 2023.

Reference books

1. Food Waste Management: Solving the Wicked Problem, Narvanen and Elina, Palgrave MacMillan Publishers, 2019.
2. Food Waste To Valuable Resources : Applications And Management, 1St Edition, Rajesh Banu et.al., Elseviers Publishers, 2020

COURSE OUTCOMES

1. Understand the characteristics, impact and beneficial properties of food wastes generated in an industry (PO1, PO12)
2. Assess the sustainable utilisation and derivation of value-added products from the wastes of food and dairy industries. (PO2, PO4,)
3. Adopt and implement various conventional and advanced treatment methods for the wastes generated from food and dairy industries (PO1, PO5,).
4. Collect data, analyse, compile into report and present the case studies relevant to eco-friendly products from food and dairy wastes. (PO2, PO4, PO9, PO10, PO12)



DEPARTMENT OF BIOTECHNOLOGY

COURSE TITLE	NANOTECHNOLOGY										CREDITS			3		
COURSE CODE	2	2	B	T	8	P	E	N	A	T	L	T	P	3	0	0
CIE	100 marks (50% weightage)										SEE			100 MARKS (50% Weightage)		

COURSE PRE-REQUISITES: Chemistry, Physics, Bioanalytical techniques, Biosensors and Bioinstrumentation, Molecular Biology, Basics of Biomolecules

COURSE DESCRIPTION: This course aims at teaching the fundamentals of nanotechnology and its applications in biomedical and biological research.

COURSE OBJECTIVES: This course will increase the student's competence in using technology applications for control of macromolecules processes.

UNIT - 1

INTRODUCTION

[7hrs]

A Brief History; Definition of a nano system; Dimensionality and size dependent phenomena: Surface to volume ratio, Fraction of surface atoms, Surface energy and surface stress-, surface defects; Properties at nanoscale (optical, mechanical, electronic and magnetic). Biomolecule-surface interactions.

UNIT - 2

NANOSTRUCTURES

[9 hrs]

Types of nano structures: Buckyballs, Nanotubes, Fullerenes, Carriers, Dendrimers, Nanoparticles, Membranes / Matrices, Nano shells, Quantum Dot, Nano crystals, hybrid biological/inorganic devices. Tools for nano structuring and characterization of nanostructures-Scanning tunneling microscopy, atomic force microscopy, X-ray spectroscopy, Surface enhanced Raman spectroscopy, Lithography. Biocompatibility of nanostructures. Interaction of nanoparticles with cells. Assessment of the toxic effectsvarious tests.

UNIT - 3

NANODIAGNOSTICS

[7 hrs]

Function and application of DNA based nanostructures- DNA microarrays, Nanofabricated devices to separate and interrogate DNA-Nanopore sequencing. Protein arrays, Virus and bacterial Nano technology.

UNIT - 4

NANO THERAPEUTICS

[9 hrs]

Drug Discovery Using Nano crystals, Resonance Light Scattering (RLS) and Nano sensors. Benefits of Nano-Imaging Agents, Applications in Drug Delivery - Bioavailability, Sustained and targeted release, Benefits of Nano-Drug Delivery. Antibodies and conjugates, delivery of drugs through antibodies Nano robots. Health risks and challenges.



DEPARTMENT OF BIOTECHNOLOGY

UNIT - 5

BIOMEMS

[6 hrs]

Introduction and Overview, Biosignal Transduction Mechanisms: Electromagnetic Transducers Mechanical Transducers, Chemical Transducers, Optical Transducers – Sensing and actuating mechanisms

PRIMARY REFERENCES

1. A Textbook of Nanoscience and Nanotechnology, by Pradeep T, Tata McGraw Hill Education Pvt. Ltd., 2012.
2. Nanostructured Materials and Nanotechnology by Hari Singh Nalwa, Academic Press, 2002.
3. Nanotechnology – Basic Science & Emerging Technologies: Chapman & Hall/CRC 2002.

SECONDARY REFERENCES

1. Nanobiotechnology Protocols: Rosenthal, Sandra J and Wright, David W., Humana Press, 2005.
2. Nanotechnology: Richard Booker and Earl Boysen (Eds), Wiley dreamtech 2005 edition
3. Nanobiotechnology: Concepts, Applications and Perspectives (2004), Christof M.Niemeyer (Editor), ChadA. Mirkin (Editor), Wiley VCH.
4. Nanotechnology – A gentle Introduction to the Next Big Idea: Mark Ratner and Daniel Ratner, Pearson Education, 2005.

E-BOOKS

1. <https://link.springer.com/book/10.1007%2F978-3-642-02525-9>
2. <https://link.springer.com/book/10.1007%2F978-1-59745-218-2>
3. <http://as.wiley.com/WileyCDA/WileyTitle/productCd-3527306587.html>

MOOCs

1. <https://www.mooc-list.com/tags/nanotechnology>
2. <https://www.mooc-list.com/course/nanotechnology-and-nanosensors-part-1-coursera>
3. <https://archive.nptel.ac.in/courses/118/107/118107015/>

COURSE OUTCOMES

1. Identify the Nano biomaterials and understand their properties. (PO1 and PO2)
2. Apply the concepts of nanotechnology for Nano analytics and characterize nanomaterial. (PO3 and PO12)
3. Comprehend the concept of nanotechnology and their role in a wide range of diagnostic and therapeutic applications (PO1 and PO3)

**DEPARTMENT OF BIOTECHNOLOGY**

Course Title	BIOETHICS & BIOSAFETY										Credits	2		
Course Code	2	2	B	T	8	H	S	B	E	B	L-T-P	2	0	0

COURSE PRE-REQUISITES: Knowledge of Constitution of India and Professional Ethics, Microbiology, Genetic engineering, Pharmaceutical BT, Animal BT, Plant BT

COURSE DESCRIPTION: The course deals with impact of biotechnology on society, ELSI of biotechnology solutions, biosafety levels and regulations.

COURSE OBJECTIVES: On completion of the course, students will have fundamental knowledge on concepts of ELSI and safety issues governing a technology.

UNIT 1**BIOTECHNOLOGY AND SOCIETY****[3L]**

Introduction to science, technology and society; biotechnology and social responsibility - public acceptance issues in biotechnology - issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, globalization and development divide. Case studies/experiences from developing (Bt cotton and Bt brinjal) and developed countries; Biotechnology and hunger: Challenges for the Indian Biotechnological research and industries.

UNIT 2**BIOETHICS AND CONFLICTS IN BIOTECHNOLOGY****[3L]**

Introduction; Ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, bioethics vs. business ethics, Issue of technology transfers across the globe.

UNIT 3**BIOETHICS IN HEALTH CARE & RESEARCH****[7L]**

Medical ethics - Basic principles of medical ethics; Bioethics in health-care - Patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation; Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Synthetic or artificial cell, HGP and its issues, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.

UNIT 4**BIOSAFETY CONCEPTS AND ISSUES****[8L]**

Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels - GRAS organisms, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools; Bio-safety issues in clinical trials; Biological weapons -



types and possible role of RDT in production of novel bioweapons; social, economic and ethical implications of bioterrorism.

UNIT 5

BIOSAFETY REGULATIONS AND GUIDELINES

[5L]

International

regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

COURSE OUTCOMES

1. Understand the basic structure of ethical principles of modern BT and biosafety practices.
2. Apply the concepts and guidelines of bioethics and biosafety practices in execution of research and projects. (PO1, PO6)
3. Analyze and interpret the case studies associated with inventiveness, ethics and biosafety in real world scenario. (PO2)
4. Reason, anticipate and evaluate appropriately the ethical, legal and social issues associated with biotechnological processes and products. (PO8)
5. Investigate the case study, conduct surveys, collect data associated with bioethics and biosafety practices, individually work and compile in a report the interpretations from the methods and results. (PO9, PO10)

PRIMARY REFERENCES

1. **Bioethics & Biosafety** by Sateesh MK (2008), IK Publishers.
2. **Biotechnology and Safety Assessment** by Thomas by J.A., Fuch, R.L. (2002), Academic Press.

SECONDARY REFERENCES

1. **Biotechnologies in developing countries** by Sasson A, UNESCO Publishers, 1993.
2. **Biological safety Principles and practices** by Fleming, D.A., Hunt, D.L., (2000), ASM Press.

E-BOOKS

https://vufind.carli.illinois.edu/vf-tiu/Record/tiu_576971

MOOCs

<https://www.mooc-list.com/course/bioethics-law-medicine-and-ethics-reproductive-technologies-and-geneticsedx>



DEPARTMENT OF BIOTECHNOLOGY

Course Title	FORENSIC SCIENCE										Credits	3		
Course Code	2	2	B	T	8	O	E	F	R	S	L-T-P	3	0	0

PRE-REQUISITES: Knowledge of Human Physiology, Engineering Chemistry and Physics, Biology for Engineers.

UNIT 1

INTRODUCTION

[06 L]

Introduction to Forensics, Definition and scopes of forensics, History and chronology of the events in forensics, (Contribution of various scientists and forensic experts in forensic sciences), and important milestones in the forensics, importance and significance of court in forensics (procedure and protocol:- Inquest and different types, medical examiners systems, powers of courts, different documentary evidences and witness, Doctors guide to court), application of the forensics in various fields.

UNIT 2

CRIME LAB & THE CRIME SCENE

[10 L]

Crime lab: Organization of crime lab at various levels in India (Center and State), Basic services provided by full service crime laboratories (physical, biological unit, firearms unit, Document Examination unit, photograph unit, - functions and duties), optional services provided by full service crime laboratories (lie detector, toxicology, voice print analysis unit). The Crime Scene: Processing the crime scene (Crime scene, Preservation and record, methodic search for evidence, Collection and package of the evidences, maintain chain of custody, crime scene safety). Physical evidences: common types & sources of physical evidences, Handling, packing and labeling of evidence, Individual and class characteristics, significance of physical evidences.

UNIT 3

FORENSIC ANALYSIS

[10 L]

Glass (nature of information obtained, properties, glass fractures, collection and preservation of glass evidence); Soil (forensic characteristics, collection and preservation); Hairs (Morphology, Identification and comparison, collection), Fibers (Types, Identification), semen, paint (collection, nature & examination), Blood (stain patterns, preservation, characterization). Selecting an analytical technique to identify a organic substance (Gas Chromatography, High Performance Liquid Chromatography, Thin Layer Chromatography, Electrophoresis)

UNIT 4

FORENSIC BIOLOGY

[08 L]

Forensic Pathology (Rigor mortis, Lovor mortis, Algor mortis); Forensic Anthropology, Forensic Entomology, Forensic Psychiatry, Forensic odontology, Forensic Engineering, DNA Analysis, Finger prints (Classification and patterns, ridge characteristics, Methods of detecting fingerprints).



UNIT 5

COMPUTER CRIME & ETHICS IN FORENSICS

[05 L]

Computer crime: Introduction and definition, classification (Physical, Data & software related), computer crime prevention measures, overview of cyber forensics.

Ethics in forensic science: Introduction, The importance of professional ethics to science practitioners, Various models of codes of ethics (broad model and Detailed model), How ethical requirement, impact the daily work of a forensic scientist, ethical dilemmas and their resolution.

PRIMARY REFERENCE BOOKS

1. Criminalistics: An Introduction to Forensic Science by Richard Saperstein, Prentice Hall, 2001.
2. Forensic Science in Crime Investigation by B.S.Nabar, Asia Law House, 3rd edition, 2007

SECONDARY REFERENCE BOOKS

3. Principles of Forensic Medicine by Apurba Nandy, New central book agency (p) Ltd.
3. M.K.R.Krisnas's Handbook of Forensic Medicine including Toxicology by V. P. Patnaik, Pras Medical Books, 11th edition, 1999.

COURSE OUTCOMES

By the end of the course, students should be able to:

4. Comprehend the basic concepts of forensic sciences viz., legal procedure and protocols required to solve cases and ethics involved in forensic sciences.
5. Apply the concepts of forensic sciences to solve criminal cases. (PO1)
6. Analyze the crime scenes and physical evidences based on the nature of evidences. (PO2)
7. Identify a suitable case study, prepare a report and communicate effectively. (PO2, PO10)



DEPARTMENT OF BIOTECHNOLOGY

Course Title	HEALTH AND NUTRITION										Credits	3		
Course Code	2	2	B	T	8	O	E	H	A	N	L-T-P	3	0	0

PRE-REQUISITES: Knowledge of Engineering Chemistry, Scientific foundation of health and Biology for Engineers.

COURSE DESCRIPTION: This course deals with the basics of health and nutrition of humans. The course emphasizes on importance of basic food nutrients in one's sustainable life. The course provides in depth knowledge about nutritional intake, dietary standards and food substitutes.

COURSE OBJECTIVES: The objective of the course is to enable the students to gain knowledge on the various aspects of food nutrients, their intake and deficiency disorders.

UNIT 1

INTRODUCTION TO HUMAN NUTRITION

[7 L]

Concept and definition of terms -Nutrition, Malnutrition and Health, Scope of Nutrition, Basic classification of nutrients, Digestion, Absorption and Utilization of Nutrients, The Recommended Dietary Allowances, BMI, BMR, Calorie intake.

UNIT 2

FOOD PLANNING, PREPARATION AND ANALYSIS

[9 L]

Planning and preparation of adequate meal for different age groups with special reference to different physiological conditions: infants, preschooler, school children, adolescents, adults, pregnancy, lactation and old age, analytical techniques to evaluate food nutrients and food adulterants.

UNIT 3

DIET THERAPY

[9 L]

Adaptation of Normal Diet for Changing Needs, Principles of Diet Therapy, Role of Nutrition in Infections, Fever, Lung Diseases, Diabetes, Gastrointestinal diseases, cancer, stress and mental health. Involvement of nutrition in Addictive Behaviors in Anorexia Nervosa, Bulimia and Alcoholism, Nutrient Drug Interaction.

UNIT 4

FOOD SUBSTITUTES: NATURAL VS ARTIFICIAL

[6 L]

Nutritive and Non-Nutritive Sweeteners: Classification, uses, and impact; Food flavors: Classification, uses, and impact; Food colors: Classification, uses, and impact.



UNIT 5

SOCIETAL FOOD HABITS

[8 L]

Studying food habits, Social and cultural influences on food choice, Changing food habits in the modern world; Nutritional recommendations for the general population : Recommended nutrient intakes, A lower diagnostic level for assessing adequacy of nutrient intake, An upper level (UL) to control high dosage of supplements, Estimated average requirement (EAR), Optimal intake range for some essential nutrients, Dietary goals and guidelines (DGGs), Dietary guidelines for children, WHO guide lines, Dietary goals and guidelines in developing countries, Integrating RNIs and DGGs in nutrition promotion, Reference numbers for nutrition labelling and food standards.

TEXT BOOKS

3. Introduction to human nutrition by Michael J Gibney, Susan A Lanham-New, Aedin Cassidy, Hester H Vorster, Second edition, Wiley Blackwell, 2009.
4. Essentials of Human Nutrition, by Jim Mann, A. Stewart Truswell, second edition, Oxford university press, 2002

REFERENCE BOOKS

2. Principles of Human Nutrition by Martin Eastwood Edinburgh, second edition, Blackwell Science Ltd, 2003. e-books
4. <http://faculty.sdmiramar.edu/faculty/sdccc/mmcmahon/nutrition/>
5. http://www.freebookcentre.net/medical_books_download/Nutrition-in-Health-andDiseases.html
6. http://www.freebookcentre.net/medical_books_download/The-Chemistry-of-Food- andNutrition.html

MOOCs

5. <https://www.mooc-list.com/categories/food-nutrition>
6. <https://www.mooc-list.com/tags/nutrition>
7. <https://www.my-mooc.com/en/mooc/nutrition-health-part-1-macronutrients-wageningenxnutr101x-0/>
8. <https://www.edx.org/course/subject/food-nutrition>

COURSE OUTCOMES (COs)

CO1	Understand the components of basic food nutrients and their uses.
CO2	Apply appropriate diet as a therapy to manage metabolic diseases.
CO3	Analyze the nature of food habits and intake, societal behavior towards food and artificial food substitutes.
CO4	Work individually or in a team to identify and assess the case studies relevant to food habits and challenges across the globe and communicate the findings as oral presentations and report submission.

CO-PO-PSO mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1														1	
CO 2	3													2	
CO 3		3				2								2	
CO 4									2	2		1		2	



DEPARTMENT OF BIOTECHNOLOGY

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes mid-term tests, weekly/fortnightly class tests, homework, assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE): Includes written examination for theory. Both CIE and SEE are given equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE.