BMS COLLEGE OF ENGINEERING, BANGALORE-19

DEPARTMENT OF BIOTECHNOLOGY

Scheme for

III to IV semester

Under 160 credits

A.Y. 2022-23 Batch onwards

Credit Distribution

Curricular Component/ Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Basic Science Course (BS)	8	8	3	3					22
Engineering Science Course (ES)	10	10		3					23
Professional Core Course (PC)	-	-	15	14	18	11	4	-	62
Professional Elective Course (PE)					3	3	3	3	12
Open Elective Course (OE)						3	3	3	9
Project/ Mini-Project (PW)					1	2	3	6	16
Seminar on Internship (SR)				1		1		2	
Humanities and Social Sciences, Management Course (HS)	1	1	2	1		2	2	2	11
Ability Enhancement Course / Mandatory Course (AEC)	1	1	2				1		5
Non-Credit Mandatory Course (NCMC)	_	_	NC	NC	NC	NC	NC	NC	6 Units
Total Credits	20	20	22	22	22	22	16	16	160

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 Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
BS	**23MA3BSTFN**	**Transform Calculus, Fourier Series and Numerical Techniques**	**2**	**1**	**0**	**3**	**4**
ES	**23BT3ESPPC**	**Process Principles and Calculations**	**2**	**1**	**0**	**3**	**4**
PC	**23BT3PCFME**	**Fluid Mechanics**	**3**	**0**	**0**	**3**	**3**
PC	**23BT3PCCMB**	**Cell and Molecular Biology**	**3**	**0**	**0**	**3**	**3**
PC	**23BT3PCMBG**	**Microbiology**	**3**	**0**	**0**	**3**	**3**
PC	**23BT3PCBBM**	**Basics of Biomolecules**	**2**	**1**	**0**	**3**	**4**
HS	**22MA3HSUHV**	**Universal Human Values**	**0**	**1**	**0**	**1**	**2**
AE	**23BT3AEFBL**	**Fundamentals of Biotechnology Lab**	**0**	**0**	**1**	**1**	**2**
PC	**23BT3PCMBL**	**Microbiology Lab**	**0**	**0**	**1**	**1**	**2**
PC	**23BT3PCFML**	**Fluid Mechanics Lab**	**0**	**0**	**1**	**1**	**2**
NCMC-1	22XX3NCPYA	Physical Activity *(or any other)*				PP/ NP	-
Total:-			**15**	**4**	**3**	**22**	**29**

IV Semester Scheme

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
BS	**23MA4BSBDE**	**Biostatistics and Design of Experiments**	**2**	**1**	**0**	**3**	**4**
ES	**23BT4ESPET**	**Process Engineering Thermodynamics**	**2**	**1**	**0**	**3**	**4**
PC	**23BT4PCBAB**	**Biochemistry and Bioenergetics**	**2**	**1**	**0**	**3**	**4**
PC	**23BT4PCGEN**	**Genetic Engineering**	**3**	**0**	**0**	**3**	**4**
PC	**23BT4PCBCA**	**Basics of Computer applications**	**3**	**0**	**0**	**3**	**3**
PC	**23BT4PCHMT**	**Heat and Mass Transfer**	**2**	**1**	**0**	**3**	**4**
PC	**23BT4PCBIE**	**Bioinspired Engineering**	**1**	**0**	**0**	**1**	**1**
AE	**23BT4AECBL**	**Computational Biology Lab**	**0**	**0**	**1**	**1**	**2**
PC	**23BT4PCBCL**	**Biochemistry Lab**	**0**	**0**	**1**	**1**	**2**
PC	**23BT4PCGEL**	**Genetic Engineering Lab**	**0**	**0**	**1**	**1**	**2**
NCMC- 2	22XX4NCCLA	Cultural Activity *(or any other)*				PP/NP	-
TOTAL:-			**15**	**4**	**3**	**22**	**30**

SYLLABUS (2023-2024)

Proposed syllabus for THIRD SEMESTER B. E.

(COMMON TO ALL BRANCHES EXCEPT CSSTREAM)

Course Title	**TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES**	**Course Code**	**23MA3BSTFN**
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; that 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 so that the delivered lessons develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and provide real-life examples.
3. Encourage the students for group learning to improve their creative and analytical skills.

UNIT-1

LAPLACE TRANSFORMS: **[08 hours]**

Definition and Laplace transforms of standard functions (statements only). Problems on Laplace transform of $e^{at} f(t)$, $t^n f(t)$, $\frac{f(t)}{t}$. 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 trigonometric polynomial, trigonometric series. 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 and Bendre-Schmidt explicit formulae. Solution of one-dimensional wave equation using finite difference method.

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. Inverse Z-transform and applications – Solution of difference equations.

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

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
23MA3BSTFN	**CO 1**	Apply the concepts of Series, Transform Techniques, Calculus of Variation and Finite Difference Methods to solve engineering problems.	1	3
	CO 2	Demonstrate the importance of Transform Techniques, Calculus of Variation and Finite Difference Methods in engineering using modern engineering and IT tools.	1 & 5	3

Assessment Details (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	
SEE	End Exam	100		50	

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 1 and Unit 5.

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, 6^{th} Edition.
5. Gupta C.B, Sing S. R. and Mukesh Kumar: "Engineering Mathematics 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)
2. http://academicearth.org/ 3. http://www.bookstreet.in.
4. VTU e-Shikshana Program
5. VTU EDUSAT Program

Course Title	PROCESS PRINCIPLES AND CALCULATIONS													
Course Code	2	3	B	T	3	E	S	P	P	C	Credits	03	L – T – P	2 – 1 – 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

[5L+2T]

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

[5L+2T]

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

[5L+3T]

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

UNIT – 4
STEADY STATE MATERIAL BALANCE WITH REACTION

[6L+3T]

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, Recycle and purge.

UNIT – 5
ENERGY BALANCE

[5L+3T]

General steady state energy balance equation, Heat capacity. Enthalpy, Heat of formation, Heat of reaction and Heat of combustion, Heat of solution and Heat of mixing, Stoichiometry of microbial growth and product formation-elemental balances, degree of reduction concepts and theoretical prediction of yield coefficients.

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
2. K. V. Narayanan, B. Lakshmikutty, "Stoichiometry and process calculations", https://books.google.co.in/books?id=52tqCFSC0ZgC&printsec

MOOCs:

1. http://www.nptel.ac.in/syllabus/103102017/
2. http://elearning.vtu.ac.in/10BT46.html

COURSE OUTCOMES (COs):

COs	Description
CO 1	Compute the compositions of various chemical and biological mixtures.
CO 2	Apply the concepts of material and energy balances in process calculations to steady-state unit operations including reactions and without reactions.
CO 3	Design the solutions to the problems related to humidification operations using psychrometric chart
CO 4	Analyze the stoichiometric equations for microbial growth & product formation for material balance calculations.
CO5	Deliver a seminar on the topic related to the course.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**													**1**	
CO2	**3**													**1**	
CO3			**2**											**2**	
CO4		**2**												**1**	
CO5									**2**	**2**		**1**		**1**	

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): SEE is 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 Title	FLUID MECHANICS													
Course Code	2	3	B	T	3	P	C	F	M	E	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 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, analyze and solve engineering problems involving fluid mechanics.

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, Reynolds experiment, Types of flow-laminar & turbulent, Flow in Boundary Layers, 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, Venturi meter, 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.

PRIMARY REFERENCES

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.

SECONDARY REFERENCE

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-books

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)

MOOCs

1. https://www.edx.org/course/basics-transport-phenomena-delftx-tp101x#!
2. http://www.nptel.ac.in/syllabus/102106027/

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 solid-liquid 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	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/report submission.

CO-PO-PSO mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1														**1**	
CO2	**3**													**1**	
CO3		**3**												**1**	
CO4									**2**	**2**		**1**		**1**	

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes mid-term tests 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 Title	CELL AND MOLECULAR BIOLOGY													
Course Code	2	3	B	T	3	P	C	C	M	B	Credits	03	L – T – P	3– 0 – 0

CIE	100 marks (50% weightage)	SEE	100 marks (50% weightage)

COURSE PREREQUISITES: 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.

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.

CO	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO 1	Understand the structure and function of bio molecules and their interactions															
CO 2	Compare & contrast basic molecular processes in prokaryotes & eukaryotes.	3												2		
CO 3	Interpret the outcomes of the knowledge of mutations and genetic recombinatio n.	2														
CO 4	Apply the knowledge of molecular mechanisms to disease states and treatment via antibiotics						2								1	

CO 5	Demonstrate cellular procedures using research based knowledge and communicate effectively.				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)

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 Science Pub. http://bit.ly/MolBioCell5thPDFFree
2. Molecular 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 Title	MICROBIOLOGY													
Course Code	2	3	B	T	3	P	C	M	B	G	Credits	03	L – T – P	3-0-0
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.

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 Archaebacteria, 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).

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.)

e- books:

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:

1. https://www.mooc-list.com
2. https://www.mysliderule.com/topic/microbiology

Online courses: http://www.onlinecollegecourses.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): written examination for theory courses and practical/design examination with built-in oral part (Viva-Voce). 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):

PO	(CO) COURSE OUTCOMES	Descriptor
PO1 PO2	CO 1	Understand the working principle of microscopes, classification systems and metabolic diversity of microorganisms.
PO2	CO 2	Analyse and determine the growth, invitro culturing techniques, physicochemical properties and controlling of microorganisms.
PO2	CO 3	Select and apply appropriate microorganisms and their value-added products in various applications
PO5, PO7, PO9,PO10, PO12	CO4	Design a project, collect data, interpret results, make a report and communicate effectively.

	Mapping of COs with POs											
PO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	**2**	**2**										
CO2		**3**										
CO3		**3**										
CO4					**3**		**2**		**3**	**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): 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 Title	BASICS OF BIOMOLECULES													
Course Code	2	3	B	T	3	P	C	B	B	M	Credits	03	L – T – P	2 – 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

[6L+3T]

Structure and properties of water, pH and buffers. Derivation and numerical on Henderson Hasselbach equation Carbohydrates: Introduction, 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. Fischer and Haworth formula, pyranose and furanose structures, anomers and epimers. Structure and function of simple sugars: mono and disaccharides, homo and hetero polysaccharides, glycoconjugates (Proteoglycans , glycoproteins , glycolipids)

UNIT - 2
STRUCTURE OF LIPIDS

[4L+2T]

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

[6L+3T]

Introduction, classification, optical isomerism, polyionic nature, zwitterions, pKa and pI, peptide bond formation and properties, classification of proteins, levels of protein structure, determination of primary structure (sequencing strategies),

UNIT - 4
STRUCTURE AND CONFORMATION ANALYSIS OF PROTEINS

[8L+4T]

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, cooperative 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

[4L+1T]

General characteristics of nucleic acid structure, geometries, glycosidic bond, rotational isomers, ribose puckering, A, B and Z forms 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, 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

Mapping of COs with POs and PSOs

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1													3		
CO2	**3**												**3**		
CO3		**3**											3		
CO4	**3**								**3**	**3**		**2**	**3**		

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 Schrimer, Springer Verlag
4. An introduction to Practical Biochemistry by David T. Plummer, Tata Mc Graw Hill.(3rd Ed.) 5. Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande, I.K. International Pvt.Ltd.

e-books:

1. https://archive.org/details/LehningersPrinciples of Biochemistry

2.http://www.tok.ro/toksite/downloads/Bioinformatika/Konyvek/biokemia,%20sejtbiologia%20%20konyvek/Stryer%20Biochemistry.pdf

MOOCs:

1. https://www.mooc-list.com/initiative/saylororg?static=true

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

3. http://nptel.ac.in/courses/1021050

COURSE OUTCOMES (COs):

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

(CO) COURSE OUTCOMES	Descriptor
CO 1	Understand and explain the physiochemical properties and structural confirmations of biomolecules
CO 2	Apply the concept of solution chemistry to compute the numerical related to preparation of solutions and buffers
CO3	Analyse the structural and 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.

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 Code	Universal Human Values	Course Name	22MA3HSUHV/ 22MA4HSUHV
Credits	01	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!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of 'I' and harmony in 'I'
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
6. 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

1. 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
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals.
5. 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.

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

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.

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 – PanditSunderlal
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)

Course Title	FUNDAMENTALS OF BIOTECHNOLOGY LAB													
Course Code	2	3	B	T	3	A	E	F	B	L	Credits	01	L – T – P	0 –0– 1
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

Practical (2hrs/week)

1. Calculation, and preparation of normal, molar and percentage solutions.
2. Preparation of buffers (0.1M citrate buffer, 0.1M phosphate buffer, 0.1M tris buffer)
3. Determination of pH using pH meter.
4. Determination of pK_a value of amino acid using pH meter.
5. Qualitative analysis of Carbohydrate and Lipids. 6. Qualitative test for Amino acids and Proteins
7. Determination of iodine value of lipids.
8. Determination of saponification value of lipids
9. Study of stages of Mitosis using onion root tip
10. Study of stages of Meiosis in onion flower buds/grasshopper testes
11. Isolation of chloroplast pigments from spinach leaves.
12. Isolation of protoplast from plant tissue

PO4	CO 1	Design, conduct experiments related to solution chemistry, quantitative analysis of biomolecules, cell and its processes followed with analysis and interpretation of data

Mapping of COs with POs& PSOs

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO1				3									3		

REFERENCE BOOKS FOR LAB

Lab manual by Faculty.

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes continuous evaluation for each experiment for conduction, record and viva.

Semester End Examination (SEE): Includes laboratory examination that includes program/ code writing and conduction of given experiment and viva.

Course Title	MICROBIOLOGY LABORATORY													
Course Code	2	3	B	T	3	P	C	M	B	L	Credits	01	L – T – P	0 – 0 – 1

Experiments

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.

REFERENCE BOOKS FOR LAB

Lab manual by Faculty.
Experiments in Microbiology. K.R. Aneja, 3rd Edition.

COURSE OUTCOMES (COs)

CO1	Conduct experiments, analyse and interpret data related to gene microbiology

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			3											

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes continuous evaluation for each experiment for conduction, record and viva.

Semester End Examination (SEE): Includes laboratory examination that includes program/ code writing and conduction of given experiment and viva.

Course Title	FLUID MECHANICS LABORATORY													
Course Code	2	3	B	T	3	P	C	F	M	L	Credits	01	L – T – P	0 – 0 – 1

Experiments

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 FOR LAB

Lab manual by Faculty

COURSE OUTCOMES (COs)

CO 1	Conduct experiments on momentum transfer, and solid-liquid separation processes and interpret the data.

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				3										2	

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes continuous evaluation for each experiment for conduction, calculations & result analysis, record and viva.

Semester End Examination (SEE): Includes laboratory examination that includes procedure writing and conduction of given experiment, calculations & result analysis and viva.

4th Semester

FOURTH SEMESTER B.E. COURSE (BT)

Course Title	Biostatistics and Design of Experiments	Course Code	23MA4BSBDE
Credits	3	L – T – P	2-1-0
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

[08 hours]

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

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

UNIT-2

STATISTICAL INFERENCE – I

[08 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.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

UNIT-3

STATISTICAL INFERENCE – II [COMPARISON OF MEANS] **[08 hours]**

Parametric test - Test of significance for single mean & difference of two means [Small & large sample], paired t- test, Analysis of variance (one-way).

Non-parametric test - Kruskal Wallis One Way Analysis of Variance by Ranks, Wilcoxon Signed Rank Test, Wilcoxon Mann-Whitney Test.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

UNIT-4

DESCRIPTIVE STATISTICS: [08 hours]

Types of variables, measure of spread, logarithmic transformations, multivariate data. Basics of study design, cohort studies, model fitting.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

UNIT-5

DESIGN AND ANALYSIS OF EXPERIMENTS [08 hours]

Principles of experimental design, Randomized block design, Completely Randomized block design, Latin Square Design, Factorial Experiments with case studies.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

CO#	Course Outcomes	PO	Strength
CO1	Analyze and interpret the statistical data for bioscience and allied engineering.	1,2	3
CO2	Design and demonstrate the use of Statistical tools to analyze the real-world examples of bioscience and allied engineering as a team.	5,9,10	3

Assessment Details (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	
SEE	End Exam	100		50	

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 from Units 2, 4, 5 and two questions from Units 1 and 3.

Text Books:

- Alvin E. Lewis, Biostatistics, McGraw-Hill Professional Publishing 2013.
- T. P. Chapman, Statistical Analysis of Gene Expression Microarray Data CRC 2003.
- John F. Monahan, Numerical Methods of Statistics (Cambridge Series in Statistical and Probabilistic Mathematics), Cambridge University Press, 2011.
- Warren J. Ewens, Gregory Grant, Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology and Health), Springer. 2010. • P. S. S. Sundar Rao and J. Richard, An introduction to Biostatistics, 4th edition, 2006, Prentice Hall of India.

E-books and online course materials:

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

COURSE TITLE	PROCESS ENGINEERING THERMODYNAMICS													
COURSE CODE	2	3	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 PREREQUISITES: 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 and 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, Fugacity 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, Vapour-Liquid Equilibria (VLE) in ideal solutions, NonIdeal 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 and other factors affecting equilibrium conversion, Heterogeneous bioreaction equilibria, Phase rule for reacting systems. Heat evolution in aerobic cultures, thermodynamics of denaturation in proteins, coupled reactions, thermodynamic analysis of fermenters and bioreactors.

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. Stanley I Sandler, Chemical, Biochemical and Engineering Thermodynamics, 4th Ed., Wiley Publishers, 2006.

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 www.ocw.mit.edu-thermodynamics and kinetics.

COURSE OUTCOMES (COs):

COs	Description
CO 1	Apply the thermodynamic principles in physical, chemical and biological systems
CO 2	Interpret the condition of thermodynamic systems using ideal gas and real gas equations
CO 3	Analyze the problems related to phase and biochemical reaction equilibria.
CO 4	Design solution for issues related to thermodynamics for given chemical or bio-processes.
CO5	Review literature related to biochemical thermodynamics and analyze the problems individually.

		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	**3**													**1**	
CO 2		**3**												**1**	
CO 3		**3**												**2**	
CO 4			**1**											**1**	
CO 5									**2**	**2**		**1**		**1**	

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 Title	BIOCHEMISTRY & BIOENERGETICS													
Course Code	2	3	B	T	4	P	C	B	A	B	Credits	03	L – T – P	2 –1– 0
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 and Bioinformatics.

UNIT – 1
PRINCIPLES OF BIOENERGETICS

[6L+3T]

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

UNIT – 2
CARBOHYDRATE METABOLISM

[8L+4T]

Introduction, Glycolysis: pathway, regulation and bioenergetics, Gluconeogenesis: pathway regulation and bioenergetics, Glycogen metabolism: degradation, synthesis, regulation and bioenergetics, Hexose interconversions, TCA cycle: pathway, regulation and bioenergetics, Amphibolic and Anaplerotic reactions, HMP pathway, Glyoxylate pathway, Structure and functions of electron carriers of ETC, Respiration and ATP formation in mitochondria, Electron transport chain, Oxidative phosphorylation, Energetics of Electron transport chain, Ion-electrochemical potential difference calculations, Malate-Aspartate shuttle system.

UNIT – 3
PHOTOSYNTHESIS

[4L+1T]

Introduction, Chloroplast/thylakoid structure, Photosynthetic apparatus, Photosynthetic reaction centre, Hill reaction, Light reaction, Cyclic and non-cyclic photophosphorylation, CO2 assimilation reaction, C4and CAM pathways, Photorespiration.

UNIT – 4
LIPID METABOLISM

[6L+3T]

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

[4L+2T]

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 Biosynthesis of amino acids, Biosynthesis of amino acids of oxaloacetate family.

Biosynthesis of nucleotides: de novo purine nucleotide synthesis (AMP and GMP), de novo pyrimidine nucleotide synthesis (UTP, CTP 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)
3.Lab manual by Faculty

REFERENCE BOOKS:

1. Biochemistry by Voet and Voet, Wiley New York
2. Biochemistry by Garett and Grisham, Thompson Learning
3. Bioenergetics by David.G.Nicolls and Styart J. Ferquson, Academic Press, Elsevier
4. An introduction to Practical Biochemistry by David T. Plummer, Tata Mc Graw Hill (3rd Ed.)
5. Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande, I.K. International Pvt. Ltd.

e-books

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

COURSE OUTCOMES (COs):

(CO) COURSE OUTCOMES	Descriptor
CO 1	Understand the basic aspects of metabolic pathways of proteins, nucleic acids, lipids, and carbohydrates
CO 2	Apply the principles of thermodynamics to compute the bioenergetics of metabolic pathways in living systems
CO 3	Analyze the role of bioenergetics for identifying the directionality of a pathway
CO 4	Analyse metabolism of carbohydrates, lipids, proteins and nucleic acids through various anabolic and catabolic pathways
CO5	Evaluate the role of key metabolic reactions and intermediates in the regulation of pathways and their mode of regulation

Mapping of COs with POs &PSOs

PO CO	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1													3		
CO2	**3**												3		
CO3		**3**											3		
CO4		**3**											3		
CO5		**3**											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): 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 Title	GENETIC ENGINEERING													
Course Code	2	3	B	T	4	P	C	G	E	N	Credits	0 3	L – T – P	3 – 0 – 0

COURSE PREREQUISITES: 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.

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: CpGMethylase, Dam Methylase, DcmMethylase, 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.

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
GENETIC ENGINEERING 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

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, etal.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

COURSE OUTCOMES (COs)

1. Understand, Relate, compare and contrast application of various tools in gene manipulation.
2. Differentiate various gene transfer methods and factors influencing its expression.
3. Compare approaches for isolation, purification, amplification and detection of nucleic acids .
4. Design vectors, construct and screen genomic and cDNA library.
5. Apply the concepts and tools for gene manipulation in development of GMOs.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3												3		
CO 2					3								3		
CO 3					2								1		
CO 4			2										1		
CO 5						2	2					2		2	

Course Title	BASICS OF COMPUTER APPLICATIONS													
Course Code	2	3	B	T	4	P	C	B	C	A	Credits	03	L – T – P	3 – 0 – 0

COURSE PRE-REQUISITES: 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.

UNIT – 1
OPERATING SYSTEM CONCEPTS

[7L]

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
DATABASE MANAGEMENT SYSTEMS

[9L]

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

[9L]

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

.[7L]

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

[7L]

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

PRIMARY REFERENCES

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.

SECONDARY REFERENCE

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.getfreeebooks.com

MOOCs

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

COURSE OUTCOMES (COs)

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.

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															
CO 2	**3**														**3**
CO 3		**3**													**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): 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 Title	HEAT AND MASS TRANSFER													
Course Code	2	3	B	T	4	P	C	H	M	T	Credits	03	L – T – P	2 – 1 – 0

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.

UNIT – 1
CONDUCTIVE & CONVECTIVE HEAT TRANSFER

[6L+3T]

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

[5L+2T]

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

[5L+3T]

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

[7L+3T]

Distillation - Methods of distillation, Distillation of binary mixtures – Raoults 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

[3L+2T]

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.

PRIMARY REFERENCES

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.

SECONDARY REFERENCES

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-books

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)

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/

COURSE OUTCOMES (COs)

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 analyze and solve problems based on steady state heat and mass transfer phenomena.
CO4	Work individually to identify real life problems associated with heat and mass transfer operations in biotechnology or bioprocess, search for solutions, and communicate the findings of the literature study and solution proposed, as oral presentations/report submission.

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

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes mid-term tests 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 Title	BIOINSPIRED ENGINEERING													
Course Code	2	3	B	T	4	P	C	B	I	E	Credits	01	L – T – P	1– 0 – 0

COURSE PRE-REQUISITES: Cell & molecular biology, Biochemistry, Basics of Biomolecules, Microbiology, Chemistry, Physic, Elements of mechanical engineering

COURSE DESCRIPTION: The course emphasizes the role of biological systems in engineering aspects. It imparts knowledge on relation between various biological structures and their functions to that of engineering the structures and their designs in the present scenario. The concepts in the course inspire students to engage in interdisciplinary research aspects.

COURSE OBJECTIVES: To make students understand and assess the role of biological systems in development of artificial goods.

UNIT – 1

Introduction to Bio-inspired Engineering

[2L]

Innovation through imitation, Natural selection and evolution of adaptations in nature; Sustainable engineering in nature

UNIT - 2

Nature's Surfaces: Surface Engineering

[4L]

Surface structures of plant leaves, insects and birds and their evolutionary significance. Surface textural characterisation and their properties, Surface heterogeneity, surface chemistry, surface tension and surface energy; Superhydrophobicity. Engineering applications.

UNIT – 3

Biomechanics

[4L]

Concepts and seed and fruit dispersal in plants, dispersal of spores in fungi and mushrooms, Abiotic and Biotic vectors for pollination, Adaptation for maximising flotation in air and water, Aerodynamics and buoyancy in nature

UNIT - 4

Bioadhesives

[3L]

Natural adhesives in plants and animals, Chemical nature and adhesive forces, Muscle adhesive proteins; Wound healing in biological system, Self-healing materials, Biomedical and other applications of adhesives.

PRIMARY REFERENCES

1. **Bio-inspired Engineering, C. H. Jenkins Momentum Press, 2011.**

SECONDARY REFERENCES 1. **Bioinspired Materials Science And Engineering, Yang, Wiley publisher, 2019**

COURSE OUTCOMES (COs)

1. Understand the architecture, functional mechanism and the importance of various natural biosystems . (PO1)
2. Assess and infer the role of Biological systems in developments of products through sustainable engineering. (PO2, PO5)

Assessment pattern

CIE:

- Three Tests shall be conducted, for a maximum of 25 marks each.
- The Faculty handling the course shall conduct Three CIE during the class hours only. The method of assessments for CIE can be decided by the faculty with prior notification to the students.

SEE:

- The SEE will be conducted for a maximum of 50 Marks and reduced to 25 for grade calculation.
- The question paper shall have Part-A and Part-B.
- Part-A can be of MCQ/Fill in the blanks for a maximum of 20 marks.
- Part-B shall cover descriptive questions with maximum of 50 marks-five questions with sub-divisions out of which the student needs to answer any three questions for 30 marks. In descriptive portion of the paper, questions can't be for less than 5 marks.
- Examination shall be conducted for a duration of 1 hour.

Course Title	COMPUTATIONAL BIOLOGY LABORATORY													
Course Code	2	3	B	T	4	P	C	C	B	L	Credits	01	L – T – P	0 – 0 – 1

List of Experiments

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 on fundamentals.
5. Perl programs for Bioinformatics applications.
6. Python programs on fundamentals.
7. Python programs on machine learning.
8. Python programs on Modeling and simulation
9. MATLAB programming on fundamentals.
10. MATLAB programming on Bioinformatics Toolbox and Simbiology.

REFERENCE BOOKS FOR LAB

Lab manual by Faculty

COURSE OUTCOMES (COs)

CO1	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.

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				3											2

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes continuous evaluation for each experiment for conduction, record and viva.

Semester End Examination (SEE): Includes laboratory examination that includes program/ code writing and conduction of given experiment and viva.

Course Title	BIOCHEMISTRY LAB													
Course Code	2	3	B	T	4	P	C	B	C	L	Credits	01	L – T – P	0 –0– 1
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

practical (2hrs/week):

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

PO4	CO 1	Design, conduct experiments related to quantitative analysis of biomolecules and interpret data
PO4, PO9, PO10	CO2 (open ended expts.)	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.

	Mapping of COs with POs														
PO CO	**PO1**	**PO 2**	**PO3**	**PO 4**	**PO 5**	**PO6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1				**3**									3		
CO2				**3**					**2**	**2**			3		

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes continuous evaluation for each experiment for conduction, record and viva.

Semester End Examination (SEE): Includes laboratory examination that includes program/ code writing and conduction of given experiment and viva.

Course Title	GENETIC ENGINEERING LAB													
Course Code	**2**	**3**	**B**	**T**	**4**	**P**	**C**	**G**	**E**	**L**	**Credits**	**0 1**	**L – T – P**	**0– 0 – 1**

EXPERIMENTS:-

1. DNA quantification (Plant/Animal/Bacteria)
2. Plasmid isolation
3. Genomic DNA isolation from Prokaryotes
4. Genomic DNA isolation from Plant/Animal sources
5. Total protein isolation from Prokaryotes/Eukaryotic
6. Restriction digestion, agarose gel electrophoresis and size determination.
7. Competent cell preparation
8. Blue-white colony selection –Transformation
9. Ouchterlony Double Diffusion (ODD)
10. PCR: gene /DNA amplification
11. Western blot (demo)
12. Agrobacterium mediated transformation (demo)

REFERENCE

Lab manual by Faculty

Course Outcome:

Conduct experiments, analyze and interpret data related to gene manipulation.

CO/PO	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1				3									2		

DEPARTMENT OF BIOTECHNOLOGY

DEPARTMENT OF BIOTECHNOLOGY

Scheme and syllabus for V and VI semester under 160 credits

For the Academic Year 2022-23 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.

DEPARTMENT 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 f or 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.
PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society t large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning**: Recognize the need f or, and have the preparation and ability to engage in independent and life -long learning in the broadest context of technological change.

DEPARTMENT OF BIOTECHNOLOGY

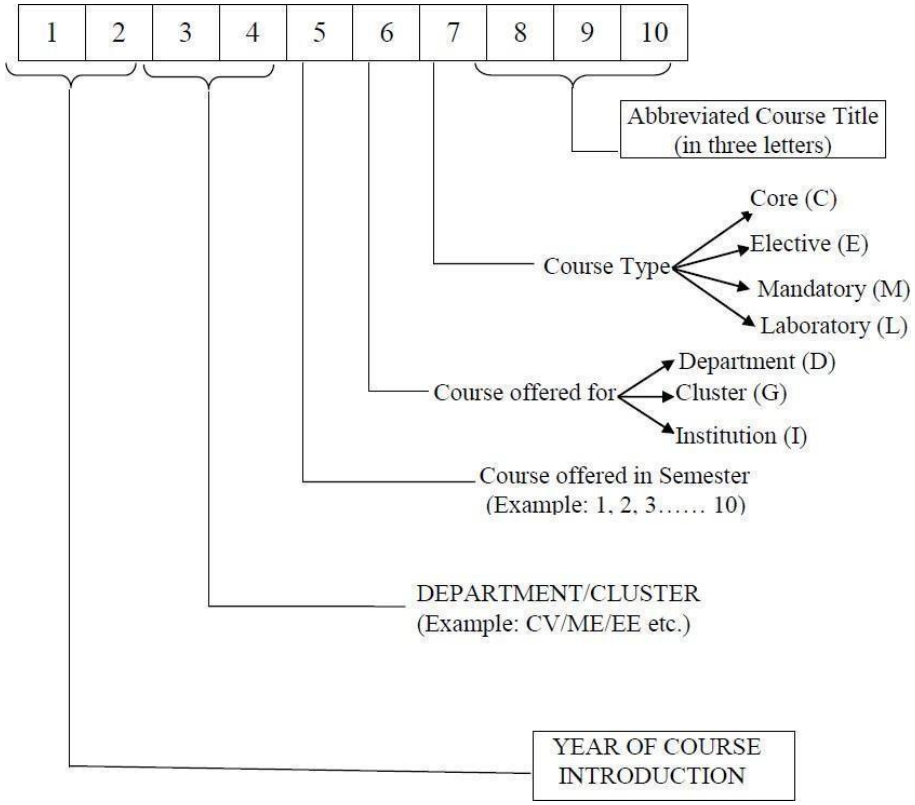
PROGRAM SPECIFIC OBJECTIVES

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.

DEPARTMENT OF BIOTECHNOLOGY

B.M



DEPARTMENT OF BIOTECHNOLOGY

Credit Distribution

Curricular Component/ Semester	I	II	III	IV	V	VI	VII	VIII	Total
Basic Science Course (BS)	8	8	3	3					22
Engineering Science Course (ES)	10	10		3					23
Professional Core Course (PC)	-	-	15	14	18	11	4	-	62
Professional Elective Course (PE)					3	3	3	3	12
Open Elective Course (OE)						3	3	3	9
Project/ Mini-Project (PW)					1	2	3	6	16
Seminar on Internship (SR)				1		1		2	
Humanities and Social Sciences, Management Course (HS)	1	1	2	1		2	2	2	11
Ability Enhancement Course / Mandatory Course(AEC)	1	1	2				1		5
Non-Credit Mandatory Course (NCMC)	_	_	NC	NC	NC	NC	NC	NC	6 Units
Total Credits	20	20	22	22	22	22	16	16	160

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).

V Semester

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PC-9	23BT5PCREN	Reaction Engineering	2	1	0	3	4
PC-10	23BT5PCBIN	Bioinformatics	3	0	0	3	3
PC-11	23BT5PCBAT	Bioanalytical Techniques	2	1	0	3	4
PC-12	23BT5PCIMM	Immunotechnology	3	0	0	3	3
HS	23BT5HSEVS	Environmental Studies	1	0	0	1	1
PE-1	23BT5PEPE-1	Professional Elective -1	3	0	0	3	3
PW-1	23BT5PCPW-1	Project -1	0	0	2	2	4
PC	23BT5PCBIL	Bioinformatics Lab	0	0	1	1	1
PC	23BT5PCBTL	Bioanalytical Techniques Lab	0	0	1	1	1
AE	23BTA5ERMI	Research Methodology and IPR	2	0	0	2	2
		Details of 40 AICTE Activity Points					
TOTAL:-			**16**	**2**	**4**	**22**	**26**

Professional Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-1	23BT5PEMTE	Metabolic Engineering	3	0	0	3	3
PE-1	23BT5PESTN	Signal Transduction	3	0	0	3	3
PE-1	23BT5PEMBT	Microbial BT	3	0	0	3	3
PE-1	23BT5PEFMB	Food Microbiology	3	0	0	3	3
PE-1	23BT5PEVCI	Vaccines and cancer immunotherapy	3	0	0	3	3

DEPARTMENT OF BIOTECHNOLOGY

VI Semester

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PC	23BT6PCGAP	Genomics and Proteomics	**3**	**0**	**0**	**3**	**3**
PC	23BT6PCETK	Enzyme Technology and Kinetic s	**2**	**1**	**0**	**3**	**4**
HS	23BT6HSPMF	Project Management and Finance	**2**	**0**	**0**	**2**	**2**
PC	23BT6PCBPT	Bioprocess Technology	**3**	**0**	**0**	**3**	**3**
PE	23BT6PEXXX	Professional Elective -2	**3**	**0**	**0**	**3**	**3**
OE	23BT6OEXX	Open Elective -1	**3**	**0**	**0**	**3**	**3**
PC	23BT6PCETL	Enzyme Technology and Kinetic s Lab	**0**	**0**	**1**	**1**	**2**
PC	23BT6PCBPL	Bioprocess Technology Lab	**0**	**0**	**1**	**1**	**2**
PW-2	23BT6PCPW-1	**Project work -1**	**0**	**0**	**2**	**2**	**4**
AE	23BT6AEISD	Industry skill development	**0**	**0**	**1**	**1**	**2**
NCMC		*NSS, YOGA, Physical Edu. s and (Sport Athletics)*	0	0	0	P/ NP	-
		Details of 20 AICTE Activity Poi nts	-	-	-	-	-
		TOTAL:-	**16**	**1**	**5**	**22**	**28**

Professional Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-2	23BT6PESYB	Systems Biology	3	0	0	3	3
PE-2	23BT6PETAP	Toxicology & Pharmacology	3	0	0	3	3
PE-2	23BT6PEPBT	Plant Biotechnology	3	0	0	3	3
PE-2	23BT6PEAFC	Advances in Food chemistry				3	3
PE-2	23BT6PEBIM	Biomaterials				3	3

Open Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
OE-1	23BT6OEIMA	Instrumental Methods of Analysis	3	0	0	3	3
OE-1	23BT6OEBBI	Biosensors & Bioinstrumentation	3	0	0	3	3
OE-1	23BT6OEBTE	Battery Technology	3	0	0	3	3

Course Title	REACTION ENGINEERING													
Course Code	2	3	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.

UNIT 1

REACTION KINETICS **[5L+3T]**

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+3T]**

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

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 **[6L+3T]**

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, Humprey & 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)

Course Title	BIOINFORMATICS										Credits	3		
Course Code	2	3	B	T	5	P	C	B	I	N	L-T-P	3	0	0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

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 portraits 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.

UNIT – 1
BIOINFORMATIC RESOURCES AND SEARCH TOOLS

[6L]

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

[10L]

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

[10L]

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.

UNIT - 4

NALYTICAL TOOLS FOR GENOMIC AND PROTEOMIC STUDIES [7L]

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 [6L]

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

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. (PO 2 & 5)
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)

COURSE TITLE	BIOANALYTICAL TECHNIQUES													
COURSE CODE	2	3	B	T	5	P	C	B	A	T	Credits	03	L-T-P	2-1-0
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 thesebiomolecules. 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 bimolecules.

UNIT – 1
CHROMATOGRAPHIC TECHNIQUES

[6L+3T]

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

[6+3TL]

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.

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 biochemDiEsPtrAyRbTyMOENkoTtOorFeBRIO.OTE.NCHeNwOALOgGeIYnternational. 1998.
8. Physical Chemistry: Principles and Applications in Biological Sciences by Tinoco and others (Prentice Hall, 4th Ed).

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 Schrimer (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.BiophysicalTechniques by by Iain Campbell https://0b9411cb7057497b22db0cd9f69e827bce11ede8.googledrive.com/host/0B5XjjBGDoIrhNlFVcVhQWjA2a1k/Biophysical-Techniques-Iain-Campbell-ebook-51iBvNTIHhL.pdf

MOOCs

1. http://nptel.ac.in/courses/102106022/ 2. http://nptel.ac.in/courses/102103044/

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)

Course Title	IMMUNOTECHNOLOGY										Credits	3		
Course Code	2	3	B	T	5	P	C	I	M	M	L-T-P	3	0	0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

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.

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)

Course Title	Environmental Studies										Credits	01		
Course Code	2	3	B	T	5	H	S	E	V	S	L-T-P	1	0	0
CIE	50 marks										SEE	50 marks		

COURSE OBJECTIVES:

1. To acquire the knowledge of environmental studies, it's need & importance
2. To understand the concept, structure and function of different ecosystems
3. To know about pollution problems and green technology
4. To develop a sense of responsibility about the role of students in fostering the idea of learning to live in harmony with nature.
5. To aware the studies about current conditions of environment
6. To give an opportunity to the student to experience the interdisciplinary nature of the environmental studies
7. To create interest in students about the environment through a project work
8. To encourage student to prevent the environmental degradation

COURSE OUTCOME:
CO1: Understand 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, economical and ethical values from environmental perspectives.

Unit – I :
Introduction to Environment:

[4L]

Definition about Earth, atmosphere, hydrosphere, lithosphere and biosphere. Structure of Atmosphere : Troposphere, Stratosphere, Mesosphere, Ionosphere, Exosphere. Internal structure of the Earth: Crust, Mantle, Core. Ecosystem, types of Ecosystem: Land, Forest, Water, Desert, Marine. Effects of Human activities on Environment: Agriculture, Housing, Industries, Mining and Transportation.

Unit-II:
Natural Resources:

[2L]

Introduction, Classification, Types and Uses of Natural Resources, Challenges Facing Natural Resources, conservation Strategies

Unit-III:
Environmental pollution

[3L]

Introduction, causes, effects and control measures. Water pollution, land pollution, noise pollution, air pollution and marine pollution-case studies. Environmental management: Solid waste, hazardous waste, e-waste, bio medical waste.

Unit-IV:
Social issues and Environment

[4L]

Climatic changes: G lobal warming, acid rain, ozone layer depletion. Water conversation: rain water harvesting and ground water recharging. Environmental Protection Acts: Air, Water, land and Noise (Prevention and Control of pollution), Forest conservation, Wildlife protection.

TEXT BOOKS:

1. Environmental studies by - Dr. Geethabalakrishanan (Revised Edition)
2. Ecology by – Subramanyam (Tata McGraw Hill Publication)
3. Environmental studies by – Dr. J.P.Sharma (Third edition)
4. Environmental studies by – SmritiSrivastav

REFERENCES:

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

LEARNING RESOURCES:

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

MOOC's:

MOOCS – https://www.coursera.org / course / sustain

SEE PAPER PATTERN:

Sub: Environmental Studies (23BT5HSEVS), Total SEE marks:50. Duration:2 hours
SEE Question paper consist of two parts, Part –A consists of 20 MCQ'S, one mark each. Whereas Part –B consist of 5 questions with maximum two subsections of 10 marks each.

Student should answer Part – A compulsory and any three full questions from Part-B, covering all units.

Professional Elective Courses

COURSE TITLE	METABOLIC ENGINEERING (Stream: Computational Biology)														
COURSE CODE	2	3	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.

UNIT - 4
METABOLIC CONTROL ANLAYSIS

[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, NewYork, 1999.
2. R.Heinrich and S. Schuster, The Regulation of Cellular Systems, Chapman &Hall, 1996. **3.** E.O. Voit, Computational Analysis of Biochemical Systems. CambridgeUniversity Press, 2000.

e- BOOKS

1. https://books.google.co.in/books/about/Metabolic_Engineering.html?id=9mGzkso4NV QC
2. 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).

Course Title	SIGNAL TRANSDUCTION (Stream: Pharma BT)										Credits	3		
Course Code	2	3	B	T	5	P	E	S	T	N	L-T-P	3	0	0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

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.

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/ -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: 0-8153-3218-1ISBN-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 EditionAuthor(s): Gerhard KraussFirst published:17 July 2001Print ISBN:9783527303786 |Online SBN:9783527600052 |DOI:10.1002/3527600051Copyright © 2001 Wiley VCH Verlag GmbH
2. Biochemistry, 5th editionJeremy 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 heath and disease (PO1)
2. Identify the different types of Extracellular/intracellular Signals And Receptors and correlate to their functional significance in heath and disease (PO 2)
3. Design the mechanisms by which different receptors may be regulated by ligands (PO 3.PO 5 &PO 12)

Course Title	MICROBIAL BIOTECHNOLOGY (Stream: Advanced BT)										Credits	3		
Course Code	2	3	B	T	5	P	E	M	B	T	L-T-P	3	0	0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

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

[6L]

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 e

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 Thermophilic Microbes of Coal Particles, 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	3	B	T	5	P	E	F	M	B	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, 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.

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).

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 aDsEfPoAoRdTsM, EDNaTirOyF BfoIOoTdECpHrNoOduLOctGsY, Fermented foods with major bio- chemical 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 Malo-lactic 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- part3-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).

Course Title	VACCINES AND CANCER IMMUNOTHERAPHY (Vaccines & Regenerative Biology/Medicines)										Credits	3		
Course Code	2	3	B	T	5	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 OOKS:

1. Pinkbook Course Book: Epidemiology of Vaccine ... – CDC
2. THE VACCINATION BOOKLET FOR EVERYONEhttps://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 Sisodiya1https://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)

COURSE TITLE	**BIOINFORMATICS LAB**													
COURSE CODE	**2**	**3**	**B**	**T**	**5**	**P**	**C**	**B**	**I**	**L**	**Credits**	**01**	**L-T-P**	**0-01**
CIE	**100 marks (50% weightage)**										**SEE**	**100 marks (50% weightage)**		

BIOINFORMATICS LABORATORY

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

REFERENCE BOOKS FOR LAB

Lab manual by Faculty

COURSE OUTCOMES (COs)

CO1	Conduct experiments to perform sequence analysis, phylogenetic analysis, restriction site mapping, primer designing, visualization of protein structures, Insilico drug discovery.(PO4)

CO-PO-PSO mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1				**3**											**2**

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes continuous evaluation for each experiment for conduction, record and viva.

Semester End Examination (SEE): Includes laboratory examination that includes program/ code writing and conduction of given experiment and viva

DEPARTMENT OF BIOTECHNOLOGY

COURSE TITLE	**BIOANALYTICAL TECHNIQUES LAB**													
COURSE CODE	**2**	**3**	**B**	**T**	**5**	**P**	**C**	**B**	**T**	**L**	**CREDITS**	**01**	**L-T-P**	**0-01**
CIE	**100 marks (50% weightage)**										**SEE**	**100 marks (50% weightage)**		

BIOANALYTICAL TECHNIQUES LABORATORY

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)

REFERENCE BOOKS FOR LAB
Lab manual by Faculty

COURSE OUTCOMES (COs)

1

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

1. CO1 Design, conduct experiments related to quantitative analysis of biomolecules and interpret data
2. CO2 Engage in independent learning & work effectively as an individual to carry out literature search effectively, design, conduct experiments & interpret data & write a technical report (PO 4,9,10)

ASSESSMENT
Continuous Internal Evaluation (CIE): Includes continuous evaluation for each experiment for conduction, record and viva.
Semester End Examination (SEE): Includes laboratory examination that includes procedure writing and conduction of given experiment and viva.

COURSE TITLE	REASEARCH METHODOLOGY & IPR													
COURSE CODE	2	3	B	T	5	A	E	R	M	I	CREDITS	01	L-T-P	2-0-0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

Unit 1

6hrs

Meaning and sources of research problem, Objectives and Characteristics of research; Errors in selecting research problem; Research methods versus; Methodology; Types of research; Criteria of good research; Developing a research plan.

Unit 2

5hrs

Investigations of a research problem; Selecting the problem - Necessity of defining the problem; Data collections-analysis; Importance of literature review in defining a problem;
Survey of literature; Necessary instrumentations.

Unit 3

5hrs

How to write paper: Conference articles; poster preparation; thesis report writing, inclusion of references; journal reviewing; process, journal selection process, filling. Journal template, developing effective research proposal-plagiarism-research ethics.

UNIT 4

5hrs

Introduction to IPR, Patents criteria and case studies from Biotechnology

Basic principles of Patent laws: Basis for IP protection. Criteria for patentability: Novelty, Utility, and Inventive step, Non obviousness, Non patentable inventions in Biotechnology. Patents: Definition and objectives, Criteria of patenting (How it's different in Biotechnology). Claims: Definition, broad vs narrow claims, verification of claims, Case studies from BT. Assignment of Patent rights, compulsory license (Specific to Biotechnology). Patent Infringement: definition, laws and case studies from BT.

UNIT 5

5hrs

Patentable innovations, other forms of IP in Biotechnology

Commercial potential of BT invention, R & D investments, Rationale and applications. Microorganisms and BT inventions, Early patents granted in BT, Patenting of GMOs or GM products.Moral issues in patenting BT invention. Traditional knowledge(TK) as IP: Introduction to TK, plant variety protection(UPOV 1991), Plant variety protection in India. Justification for geographical indications.

TEXTBOOKS

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, An introduction to Research Methodology, RBSA Publishers, U.K., 2002.
2. Subbarau N R, Handbook of Intellectual property law and practice, S Viswanathan Printers and Publishing Private Limited, 1998.
3. IP in Biotechnology, Ramakrishna, NLS Bengaluru. 2002

REFERENCE BOOKS

1. Kothari, C.R., Research Methodology: Methods and Techniques. New Age International. 418p, 1990.
2. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi.
3. Sinha, S.C. & Dhiman, A.K., Research Methodology, ESS Publications. Vol. 1 and Vol. 2, 2002.

E- BOOKS

1. Ioannis K. Kookos, "Practical Chemical Process Optimization with MATLAB® and GAMS®", Springer, 2022, https://link.springer.com/book/10.1007/978-3-031-11298-0.
2. Frank (Xin X.) Zhu, "Energy and Process Optimization for the Process Industries", Wiley, 2013, https://onlinelibrary.wiley.com/doi/book/10.1002/9781118782507.

MOOC and ONLINE COURSES:

1. Optimization in Chemical Engineering, NPTEL Swayam Course, By Prof. Debasis Sarkar, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc23_ch22/preview.

COURSE OUTCOMES

CO1: Write and present a substantial technical report/document
CO2: Demonstrate a degree of mastery over the area of specialization
CO3: learn and Apply the knowledge of IP in protection of advanced products and processes
CO4: Analyse technological innovations in the field of biotechnology that have potential to fetch IP rights.

VI SEMESTER

DEPARTMENT OF BIOTECHNOLOGY

Course Title	GENOMICS AND PROTEOMICS										Credits	3		
Course Code	2	3	B	T	6	P	C	G	A	P	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 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
QUANTITIVE 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.

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. HÃ¶pker, 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**	**3**	**B**	**T**	**6**	**P**	**C**	**E**	**T**	**K**	**Credits**	**03**	**L-T-P**	**2-1-0**
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 applicationsof enzymes in medicine and industry.

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 Km,Vmax , Kcat,Kcat/Km 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), Covalent catalysis (chymotrypsin), Metal ion catalysis (Carbonic anhydrase), catalysis through proximity and

orientation effects, Substratestrain (lysozyme) & entropy effects. Mechanism of coenzymes (NAD+/NADP+, FAD/FADH , PLP, Coenzyme A, TPP, Biotin).

UNIT - 4
Immobilization of enzymes

[4L+3T]

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 ofnovel enzymes.

PRIMARY REFERENCES

1. Fundaments 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, IKInternational, 2004 3. Proteins and Proteomics by Richard JSimpson, IK International, 2003
4. Enzymes by Dixon and Webb. IRL Press.
5. Principles of Enzymology for technological Applications byButterworth Heinemann Ltd.Oxford (1993).
6. Biocatalyst for Industry by J.S. Dordrick (1991), Plenum press, Newyork.

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/fundamentalsof-enzymology-

MOOCs

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

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 therelated 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).

DEPARTMENT OF BIOTECHNOLOGY

Course Title	PROJECT MANAGEMENT AND FINANCE										Credits	2		
Course Code	2	3	B	T	6	H	S	P	M	F	L-T-P	2	0	0

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 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

[4L]

PROJECT IDENTIFICATION & FORMULATION

Characterization of project, Functional management, Project Life cycle & its phases, defining the project scope, establishing project, project feasibility, Roles and responsibility of project manager,

UNIT 2
PROJECT PLANNING, SCHEDULING & FINANCING

[7L]

Work breakdown structure, Gantt chart, Developing project schedule: scheduling techniques, terminologies in networking and networking convention: PERT, CPM, procurement schedule, Sources of finance, role of financial institution in project financing, financial analysis of projects.

UNIT 3
PROJECT EXECUTION, CO-ORDINATION & CONTROL

[7 L]

Communication in a project, Management Information system (MIS), project co-ordination, cost control, Controlling project costs: Project cost Vs project completion time, normal time and crash time, time and cost tradeoffs, balance sheet, budget, Introduction to block chain.

UNIT 4
CONTRACT AND HUMAN RESOURCE MANAGEMET

[4 L]

Types of contracts, sub-contract, tendering procedures, types of payments to contractors, project organization structure project teams, project leadership, project risk management.

UNIT 5
PROJECT PERFORMANCE MEASUREMENT & EVALUATION

[4 L]

Termination & closeout responsibilities, performance indicators, project evaluatio objectives, evaluation methods, post audit: phases & types, audits and audit reports, agencies for post audit.

COURSE OUTCOMES

1. Check the feasibility of project and categorize its life cycle
2. Apply scheduling and financing techniques for given project
3. Develop cost control strategies for project
4. Prepare project charter for research work and communicate the same by report submission

	Mapping of COs with POs											
PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					X						X	
CO2					X						X	
CO3											X	
CO4											X	

PRIMARY REFERENCES

1. **Project Management**: S.Chodhary, Tata McGraw Hill Publication.
2. **Project Management:** K.Nagarajan, Sixth edition, New Age International Publishers.

SECONDARY REFERENCES

1. **Project Management:** Rosy Burke, Fourth Edition, Weily India edition.
2. **Project Management:** Clifford F Crray and Erile W Harson, Third Edition, McGraw Hill publication.
3. **Project Management:** John.M.Nichola and Herman Stey, Third edition, Elsevier publication. **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)

DEPARTMENT OF BIOTECHNOLOGY

Course Title	BIOPROCESS TECHNOLOGY										Credits	3			
Course Code	2	3	B	T	6	P	C	B	P	T	L-T-P	3	0	0	0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)			

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.

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

[7L]

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

[10L]

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

[8L]

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

[7L]

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.

UNIT - 5
SECONDARY PRODUCT SEPARATION TECHNIQUES AND PRODUCT RECOVERY

[7L]

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 Engineeringby Bailey and Ollis, McGraw Hill Publisher.
2. Fermentation advancesby Perlman. D (Ed), Aca press, New York.
3. Bioprocess Engineeringby 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)
   Analyse the data collected from the recent research paper make a report & deliver a Presentation in team (PO5,PO9,PO 10,PO 12)

5. Analyse the data collected from the recent research papers make a report & deliver a presentation in team 9 PO5, PO9, PO10,PO12)

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

PROFESSIONAL ELECTIVES

Course Title	SYSTEMS BIOLOGY ((Stream: Computational Biology)													
Course Code	2	3	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-kB 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.

Kineties modelling og biological networks using mathab.

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.

Modeling metabolism; pathway model, metabolic control analysic

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.

The cell cycle ; steps in the cell cycle , Minimal cascode model of a mitotic oscillator , models of budding yeast cycle the aging Process.

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)

COURSE TITLE	TOXICOLOGY & PHARMACOLOGY (Stream: Pharma BT)													
COURSE CODE	2	3	B	T	6	P	E	T	A	P	Credits	3	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 (Pediatries & 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.

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 eDdEitPioAnR,TKM.EEN.TSOtiFnBeIOanTdECTH.NMO.LBOGroYwn; 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)
4. Illustrate toxicity risk assessment and fate of toxicants in humans. (PO5,PO12)

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

CIE	100 marks (50% weightage)	SEE	100 marks (50% weightage)

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 - phosphoinothricin, glyphosate, atrazine; insect resistance. Biosafety regulations and evaluation of transgenics contained conditions. Implications of gene

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;4Q3TLs analysis in crop plants, Gene pyramidinDgE.PMARaTrMkeErNaTsOsiFstBeIdOTsEeClcHcNtiOoLnOaGnYd molecular breeding; Genomics and geoinformatics for crop improvement; Integrating functional genomics information on gronomically/ gronomically/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 mannual 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).

Course Title	ADVANCES IN FOOD CHEMISTRY (Stream: Food Technology)										Credits	3		
Course Code	2	3	B	T	6	P	E	A	F	C	L-T-P	3	0	0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

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.

UNIT-4

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).

COURSE TITLE	BIOMATERIALS (Stream: Vaccines & Regenerative Biology/Medicines)													
COURSE CODE	2	3	B	T	6	P	E	B	I	M	Credits	3	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, Springers 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)

OPEN ELECTIVES

COURSE TITLE	INSTRUMENTAL METHODS OF ANALYSIS													
COURSE CODE	2	3	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 MICROSCOPITECHNIQUES

[9 L]

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

UNITII

COLORIMETRY AND SPECTROPHOTOMETY

[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. .

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

[7 L]

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 andCompany)
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.googledrive.com/host/0B5XjjBG DoIrhNlFVcVhQWjA2a1k/Biophysical- TechniquesIainCampbell-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	3	B	T	6	O	E	B	B	I	L-T-P	3	0	0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

COURSE PRE-REQUISITES: Knowledge of Human Physiology, Engineering Physics, Basics of Electrical and Electronics.

COURSE DESCRIPTION: This course deals with the fundamentals of measurement science 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 bioinstrumentation 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

FUNDAMENTALS OF MEDICAL INSTRUMENTATION [9 L]

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

MEDICAL IMAGING SYSTEMS AND BIOINSTRUMENTATION FOR CARDIOVASCULAR CONDITIONS [8 L]

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 pCO_2, pO_2 ; Plethysmography; Pacemakers(Need for Cardiac pacemaker, External pacemaker, Implantable pacemaker, Programmable pacemakers); Defibrillators(DC defibrillator, AC defibrillator and Implantable Defibrillator) , Conceptual numericals.

UNIT - 3

BIOMEDICAL DEVICES FOR RESPIRATORY SYSTEM [7 L]

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 equipment; Anesthesia machines: related instrumentation of equipment involved and sensors, Conceptual numericals.

UNIT - 4

BIOSENSORS & BIOCHIPS **[6 L]**

Introduction to biosensors - History and overview of Biosensors, definition and concept, components of a biosensor, consideration, commercial requirement and obstacles in biosensor development; Types of biosensors;
Biochip-Introduction and structure of DNA Chips, design and operating principles, related instruments; BIA core- an optical biosensor.

UNIT - 5

APPLICATIONS OF BIOSENSORS **[9 L]**

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 fibro 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

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

COURSE OUTCOMES (COs)

1. Understand the components and applications of biomedical devices and biosensors.
2. Apply the characteristics of bio-signals, transducers, amplifiers and biosensors for comparing different devices used in cardio-vascular systems, respiratory systems and environment monitoring. (PO1)
3. Identify, interpret and analyze the physical quantity measurements in electrical form using various biomedical devices and solve related problems. (PO2)
4. Work individually or in a team and design solutions for the limitations associated with existing biomedical devices or biosensors and validate the solution by applying reasoning to assess societal, health and safety issues and communicate the findings of the literature study and solution in the form of modified design, as oral presentations and report submission. (PO3, PO6, PO9, PO10, PO1

5. Analyse the output of various biomedical devices to diagnose the diseases (PO2)

Course Title	BATTERY TECHNOLOGY													
Course Code	2	3	B	T	6	O	E	B	T	E	Credits	03	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 charge-discharge 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 MnO_2 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, Redox flow batteries

Lithium ion batteries: Construction, working, and applications. Types of cathode materials

UNIT 4

Fuel cells **[9**L**]**

Chemistry, Working principle, Classifications, Construction, working and applications: Direct methanol fuel cell, Polymer electrolyte fuel cell, Phosphoric acid 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

4. Handbook of Batteries by David Linden and Thomas B Reddy, McGraw-Hill Handbooks, 2001
5. Understanding Batteries, by Dell R M and Rand D A J, Royal Society of Chemistry, 2001
6. Battery Technology Crash Course: A Concise Introduction by Slobodan Petrovic, Springer, 2020

REFERENCE BOOKS

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

COURSE OUTCOMES (COs)

1. Choose suitable primary batteries for the given power requirement.(PO2, 6, 7)
2. Analyze the performance characteristics of secondary batteries and fuel cells. (PO2, 6, 7)
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)

COURSE TITLE	ENZYME TECHNOLOGY AND KINETICS LAB													
COURSE CODE	2	3	B	T	6	P	C	E	T	L	Credits	0 1	L-T-P	0-01
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

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 Km and Vmax
2. Effect of temperature.
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.

REFERENCE BOOKS FOR LAB

Lab manual by Faculty

COURSE OUTCOMES (COs)

CO1 Design, conduct experiments, analyse and interpret results related to enzyme reaction kinetics (PO1, PO3, PO4 & PO12).

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		3	3								3	3		

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes continuous evaluation for each experiment for conduction, record and viva.

Semester End Examination (SEE): Includes laboratory examination that includes procedure writing and conduction of given experiment and viva.

Course Title	BIOPROCESS TECHNOLOGY LABORATORY													
Course Code	2	3	B	T	6	P	C	B	P	L	Credits	01	L – T – P	0 – 0 – 1
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

EXPERIMENTS

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 – Burman design for media.
   b) Response surface methodology for media design
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)

REFERENCE BOOKS FOR LAB

Lab manual by Faculty

COURSE OUTCOMES (COs)

CO1	Conduct experiments for production, isolation and recovery of bio - products.
CO2	Conduct an experiment related to Bioprocess technology by implementing a research paper, make a report & present in team

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	PSO1	PSO2	PSO3
CO1				3										2	

ASSESSMENT

Continuous Internal Evaluation (CIE): Includes continuous evaluation for each experiment for conduction, record and viva.

Semester End Examination (SEE): Includes laboratory examination that includes procedure writing and conduction of given experiment and viva.

DEPARTMENT OF BIOTECHNOLOGY

VII Semester

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PC-17	23BT7PCEQD	Bioprocess Equipment Design and CAED	2	1	0	3	4
PC	23BT7PCEQL	Bioprocess Equipment Design and CAED Lab	0	0	1	1	2
PE-3	23BT7PEPE-3	Professional Elective -3	3	0	0	3	3
PW-3	23BT7PCPW-3	Project -3	0	0	5	5	10
OE-2	23BT7OEOE-2	Open Elective -2	3	0	0	3	3
HS	25MA7HSIKL	Indian Knowledge Systems	1	0	0	1	1
		Details of 80 AICTE Activity Points					
TOTAL:-			8	**1**	**7**	**16**	**23**

Professional Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-3	23BT7PEGIN	Genome Informatics	3	0	0	3	3
PE-3	23BT7PEBNB	Biologics & Biopharmaceuticals	3	0	0	3	3
PE-3	23BT7PEABT	Animal BT	3	0	0	3	3
PE-3	23BT7PEFPC	Food processing and quality control	3	0	0	3	3
PE-3	23BT7PETEN	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	23BT7OEIPR	IPR in Engineering	3	0	0	3	3
OE-2	23BT7OEEEM	Ecology and Environmental Management	3	0	0	3	3
OE-2	23BT7OESEN	Sustainability Engineering	3	0	0	3	3

VIII Semester

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-5	23BT8PEPE-4	Professional Elective -4	3	0	0	3	3
PW-4	23BT80E	Open Elective-3	3	0	0	3	3
INT-3	23BT8SRIN	Internship-Based Seminar	0	0	10	10	20
		Details of 100 AICTE Activity Points					
TOTAL:-			**6**	**0**	**10**	**16**	**26**

Professional Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-4	23BT8PEBDA	Biological data analytics	3	0	0	3	3
PE-4	23BT8PEDRD	Drug discovery	3	0	0	3	3
PE-4	23BT8PEABP	Advanced BT processes and Products	3	0	0	3	3
PE-4	23BT8PEFWM	Food waste management	3	0	0	3	3
PE-4	23BT8PENAT	Nanotechnology	3	0	0	3	3

Open Electives List

Course Type	Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
OE-3	23BT8OEFRS	Forensic Science	3	0	0	3	3
OE-3	23BT8OEHAN	Health and Nutrition	3	0	0	3	3

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

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.

UNIT 1

INTRODUCTION TO BIOPROCESS DESIGN **[7L]**

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, DiapLagm 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

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

1. Flanged pipe joint
2. Gland & Stuffing box expansion joint
3. Ball valve
4. Gate valve
5. Non- return valve
6. DiapLagm 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	PO 10	PO 11	PO 12	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.

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 Tapobrata 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 tLee 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

Course Title	GENOME INFORMATICS										Credits	3			
Course Code	2	3	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

[7L]

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 [7 L]

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.

UNIT – 4

NEXT GENERATION SEQUENCING IN CANCER RESEARCH [8 L]

Applications of NGS in RNA biomarker discovery in cancer research;; NGS for high-tLoughput 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, ZaLa 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, ChoudLy, 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-SequencingforBiomedicalResearch/isbn-9780123942876/
3. http://vufind.carli.illinois.edu/vf-rou/Record/rou_279168/TOC

MOOCs

1. https://www.mooc-list.com/course/clinical-bioinformatics-unlockinggenomicshealthcarefuturelearn?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)

Course Title	Biologics & Biopharmaceuticals										Credits	3		
Course Code	2	3	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 Immunotherapeutic .

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 portraits knowledge of bio therapeutic applications

UNIT-1

Introduction to Biopharmaceuticals and Biogenerics [7L]

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

UNIT-2

Formulation of Biopharmaceuticals [7L]

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

APPLICATIONS OF BIOTHERAPEUTICS [8L]

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

UNIT-4

Immunotherapeutics [8L]

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.

UNIT-5

Biopharmaceuticals Based Delivery Systems [8L]

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, 2ndEdition, 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)

Course Title	ANIMAL BIOTECHNOLOGY										Credits	3		
Course Code	2	3	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

[7L]

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

[8 L]

Behavior, morphology, growth characteristics, cLomosome 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.

UNIT - 5
APPLICATIONS

[8L]

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/7-342developmentalandmolecularbiology-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)

Course Title	FOOD PROCESSING AND CONTROL QUALITY										Credit s	3		
Course Code	2	3	B	T	7	P	E	F	P	C	L-T-P	3	0	0

COURSE PRE-REQUISITE

S: 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.

UNIT-3
FOOD SAFETYAND QUALITY CONTROL

[8L]

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, SLink 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

[7L]

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

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**	**3**	**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

[7L]

Tisue 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

[8 L]

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

[8 L]

Tissue organization, tissue types, Tissue repair, homeostasis, angiogenesis and its importance. Cellular fate processes, Cell differentiation, Cell migration - underlying biochemical process.

UNIT-4

[7 L]

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

[7 L]

Tissue engineering for vasculature, Cardiac Tissue Engineering; Heart Valve Tissue Engineering; Urologic Organ Tissue Engineering; Hepatic Tissue Engineering; Renal Tissue Engineering; Dental Tissue Engineering.

PRIMARY REFERENCES

1. PRINCIPLES OF TISSUE ENGINEERING, 5TH EDITION by Robert Lanja
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 in Engineering										**Credits**	**3**		
Course Code	**2**	**3**	**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

[7L]

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

[8L]

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

[8L]

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 publisherRoyalty, 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

[7L]

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

[8L]

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.

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 *MTcyMTYyNTAxNy4xLjAuMTcyMTYyNTAxNy4wLjAuMA..
https://www.wiley.com/en-us/Intellectual+Property+Law+for+Engineers%2C+Scientists%2C+and+Entrepreneurs%2C+2nd+Editio n-p-9781119382010
https://shop.theiet.org/intellect-prop-rights-eng-2ed

COURSE TITLE	ECOLOGY & ENVIRONMENTAL MANAGEMENT										CREDITS	3		
COURSE CODE	2	3	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

[8L]

Introduction to Ecology, Community and Ecosystem: types of ecosystems.Interrelationship between the living world and environment: Ecological pyramids, trophic levels: Producesrs 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 **[7L]**

Population Attributes: Density, nasality, mortality, age ratio, sex ratio, Dispersion of population, Exponential and logistic growth Simpson's index and examples and calculations.

UNIT-3

[7L]

Predation types, R and K selected species, Host parasite interactions, Social parasitism, Symbiosis with examples.,

UNIT-4

Biotechnology in environmental management:

[7 L]

Biodiversity and conservation strategies, success stories conservation, Sustainable utilization, Red data book, rare, Endangered and tLeatened species, Germ plasm banks, Sustainable utilization of wastes, Biofertilizers, Ecofriendly biopesticides, Bioremediation, bio indicators.

UNIT-5

Pollution, environmental impact and protection

[7 L]

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: MisLa 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 & ActionCoursera): 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 resource management future learn
4. EnvironmentalStudies: A Global Perspective (edX) https://www.mooclist.com/course/environmentalstudiesglobal-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.

COURSE TITLE	**SUSTAINABILITY ENGINEERING**										**CREDITS**	**3**				
COURSE CODE	**2**	**3**	**B**	**T**	**7**	**O**	**E**	**S**	**E**	**N**	**L T P**	**3**	**0**	**0**		
CIE	**100 marks (50% weightage)**										**SEE**	**100 marks (50% weightage)**				

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 tLoughout 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: tLee pillar model, egg of sustainability model, Atkisson's pyramid model, prism model, principles of sustainable development, sustainable engineering, tLeats 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 [8L]

Sustainable Engineering Design Principles, Economic Performance Indicators, Estimates of Environmental Costs, A Framework for Evaluating Environmental Costs, Environmental Performance Indicators.

UNIT 5

SUSTAINABILITY PRACTICES [8L]

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-1nbsped-0132756544-2011041250-9780132756549.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 tLough 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.

CO-PO-PSO mapping

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

8TH SEMESTER

Course Title	BIOLOGICAL DATA ANALYTICS										Credits	3			
Course Code	2	3	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 portraits 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- 1 **[08hours]**

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 **[08hours]**

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 **[08hours]**

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 **[08hours]**

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 **[08hours]**

MASS SPECTROMETRY AND PROTEOMICS DATA ANALYSIS

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.

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

COURSE OUTCOMES

1. Comprehend the basics of R programming and Bioconductor (PO1)
2. Apply statistical techniques using R Programming for analysis of data. (PO5)
3. Analyze and interpret the Biological data using Bioconductor tools. (PO)

DEPARTMENT OF BIOTECHNOLOGY

Course Title	DRUG DISCOVERY										Credits	3			
Course Code	2	3	B	T	8	P	E	D	R	D	L-T-P-S	3	0	0	0

UNIT 1

[07L]

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

[07L]

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

[08L]

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

[08hours]

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 etwork and Pathway Analysis - Network-based Machine Learning, Predictive Modeling of Biological Pathways, Case Studies

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]

Course Title	ADVANCED BT PROCESSES & PRODUCTS										Credits	3		
Course Code	2	3	B	T	8	P	E	A	B	P	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 **[4L]**

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, erytLomycin and tetracycline, vitamins (Vitamin B12, Vitamin B2, Vitamin A)

UNIT 4
PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS

[8 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. Bioprosess 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.

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	
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.

Course Title	Food Waste Management										Credits	3		
Course Code	2	3	B	T	8	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 L]

Food Industry Waste: Introduction, Characteristics of waste, Environmental Standards and Regulations

UNIT 2

[8 L]

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 L]

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 L]

Sustainable Food Waste Management Technologies

MusLoom: 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

UNIT 5

[8 L]

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)

COURSE TITLE	NANOTECHNOLOGY			CREDITS	3	
COURSE CODE	23BT8PENAT	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 [7L]

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

NANOSTRUCURES [8 L]

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 L]

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 [8 L]

Drug Discovery Using Nano crystals, Resonance Light Scattering (RLS) and Nano sensors. Benefits of NanoImaging Agents, Applications in Drug Delivery - Bioavailability, Sustained and targeted release, Benefits of Nano-Drug Delivery.

Antibodies and conjugates, delivery of drugs tLough antibodies Nano robots. Health risks and challenges.

UNIT - 5

BIOMEMS **[7 L]**

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), CListof 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	FORENSIC SCIENCE										Credits	3		
Course Code	2	3	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 **[07 L]**

Introduction to Forensics, Definition and scopes of forensics, History and cLonology 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 **[8 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 **[8 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 CLomatography, High Performance Liquid CLomatography, Thin Layer CLomatography, Electrophoresis)

UNIT 4

FORENSIC **BIOLOGY** **[08 L]**

Forensic Pathology (Rigor mortis, Lovor mortis, Algor mortis); Forensic AntLopology, 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.
4. 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)

Course Title	HEALTH AND NUTRITION										Credits	3		
Course Code	2	3	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 [8 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 [8 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 [7 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 guidelinesfor children, WHO guide lines, Dietarygoals 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, Oxforduniversity press, 2002

REFERENCE BOOKS

1. Principles of Human Nutrition by Martin Eastwood Edinburgh, second edition, BlackwellScience Ltd, 2003.

e-books

1. http://faculty.sdmiramar.edu/faculty/sdccd/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)

1. Understand the components of basic food nutrients and their uses.
2. Apply appropriate diet as a therapy to manage metabolic diseases.(PO1)
3. Analyze the nature of food habits and intake, societal behavior towards food and artificialfood substitutes. (PO2,PO6)
4. Work individually or in a team to identify and assess the case studies relevant to foodhabits and challenges across the globe and communicate the findings as oral presentations and report submission. (PO9,PO10)

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.