SCHEME OF INSTRUCTION AND SYLLABI
OF
B. TECH I to VIII SEMESTERS

FOR

BIOTECHNOLOGY

(In line with AICTE Model Curriculum with effect from AY 2022-23)

(R–22 Regulation)

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Affiliated to OU, Approved by AICTE, Accredited by NBA, NAAC (A++)

Kokapet Village, Gandipet Mandal, Hyderabad– 500 075. Telangana

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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)
DEPARTMENT OF BIOTECHNOLOGY

INSTITUTE VISION AND MISSION

VISION

To be centre of excellence in technical education and research

MISSION

To address the emerging needs through quality technical education and advanced research

DEPARTMENT VISION AND MISSION

VISION

To excel in education, research and entrepreneurship in various fields of Biotechnology for contribution to the evolving needs of the society

MISSION

1. To provide an excellent educational experience to the undergraduate students of Biotechnology through quality teaching and advanced curriculum with roots into the fundamentals, that enables students to become leaders in their chosen field of Biotechnology
2. To provide vibrant learning and research environment that enables students to focus on lifelong learning to transform into entrepreneurs, and renowned researchers
3. To instil the spirit of innovation and creativity in young minds through participation in International and National level conferences/hackathons combined with a deep awareness of ethical responsibilities to profession and society

PROGRAM EDUCATIONAL OBJECTIVES (PEOS):

The Biotechnology department is dedicated to graduating engineers who,

1. Will demonstrate successful careers in industry through scientific thinking, interpreting, analysing experimental results and pursue higher education and research in reputed national and international institutes.
2. Will demonstrate leadership and initiative to advance professional and organizational goals with a commitment to ethical standards of profession, teamwork, and respect for diverse cultural background
3. Will be involved in lifelong /self-learning to keep abreast with the constantly evolving technologies for establishing start-ups and becoming successful entrepreneurs.
4. Will be committed to creative practice of engineering and other professions in a responsible manner contributing to the socio-economic development of the society.

PROGRAM SPECIFIC OUTCOMES (PSOS):

Students should be able to

1. Apply the concepts of Biotechnology in the fields of health care, agriculture, biofuels, food industry and other relevant areas
2. Demonstrate adequate proficiency of good lab practices by adopting standard operating protocols and illustrate independent, safe and accurate handling of the biotechnology lab equipment

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

(In line with AICTE Model Curriculum with effect from AY 2022-23)

SEMESTER–I

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MTC03/ 22BTC01	Mathematics-I / Basics of Biology-I	3	1	0	3	40	60	4
2	22CYC01	Chemistry	3	0	0	3	40	60	3
3	22EEC01	Basic Electrical Engineering	2	1	0	3	40	60	3
4	22CSC01	Problem Solving and Programming	2	1	0	3	40	60	3
PRACTICAL									
5	22CYC02	Chemistry Lab	0	0	3	3	50	50	1.5
6	22MBC02	Community Engagement	0	0	3	-	50	Nil	1.5
7	22CSC02	Problem Solving and Programming Lab	0	0	3	3	50	50	1.5
8	22MEC37	Robotics & Drones Lab	0	2	2	-	100	Nil	3
9	22EEC02	Basic Electrical Engineering Lab	0	0	2	3	50	50	1
TOTAL			**10**	**5**	**13**	**21**	**460**	**390**	**21.5**

L: Lecture T: Tutorial D: Drawing
P: Practical CIE-Continuous Internal Evaluation SEE-Semester End Examination

22MTC03

MATHEMATICS-I
(BioTech- BiPC Stream)

Instruction:	3 L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

COURSE OBJECTIVES:

1. To discuss elementary transformations of trigonometric functions.
2. To explain basics of limit and continuity of the functions.
3. To explain differentiation of the basic functions
4. To discuss matrix methods to solve system of linear equations.
5. To discuss the exact roots of Cubic and Bi-quadratic equations.

COURSE OUTCOMES:

Upon completing this course, students will be able to:

1. Calculate the elementary transformations of trigonometric functions.
2. Evaluate the limit and Continuity of the functions
3. Calculate the differentiation of functions.
4. Apply the matrix methods to solve the system of linear equations.
5. Solve the Cubic and Bi-quadratic equations.

CO-PO Articulation Matrix

PO/PSO CO	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
CO1	2	2	2	2								1	1	
CO2	3	3	3	3								2	1	
CO3	3	3	3	3								2	1	
CO4	3	3	3	3								2	1	
CO5	2	2	2	2								1	1	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Trigonometry: Review of basics of Trigonometry, Compound angles and multiple and sub multiple angles, Transformations-sum and product rules, Hyperbolic and Inverse Hyperbolic functions.

UNIT-II

Function, Limits and Continuity: Function $sinx, cosx, e^x, logx$ intervals and neighbourhoods, limits and concept of limit, standard limits and related problems

UNIT-III

Differentiation: Derivatives of a function, Elementary properties. Derivatives of Trigonometric, Inverse Trigonometric, Hyperbolic and inverse Hyperbolic functions, Methods of differentiation, second and higher order derivatives.

UNIT-IV

Matrices: Types of matrices, multiplication of matrices, scalar multiplication, Inverse of a matrix-determinant, singular, non-singular, minor, cofactors, adjoint, Rank-Echelon form, consistency and inconsistency, Solutions of simultaneous linear equations.

UNIT-V:

Theory of Equations: Relation between roots and the co-efficients in an equation, solution of the equation when two or more of its roots are connected by certain relations.

TEXT BOOKS:

1. Shanti Narayan and Mittal P.K. ," Differential Calculus" , 30th edition, S Chand Publishers, 2005.
2. A.R.Vasistha, "Matrices", 43rd edition, Krishna's Educational Publishers, 2014.
3. Hall and Knight, "Higher Algebra", Arihant Publications, 2016.

SUGGESTED READING:

1. N P Bali and Manish Goyal, "A Text Book of Engineering Mathematics", 9th Edition, Laxmi Publishers, 2017.
2. Joseph Edwards, "Differential Calculus For Beginners", Arihant Publishers, 2016.
3. Kanti B.Datta, "Mathematical Methods of Science and Engineering", Cengage Learning India Publishers, 2012.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/109104124
   (Week- 1 to 3)
2. https://nptel.ac.in/courses/111107112
   (Week -1)
3. https://www.youtube.com/watch?v=pvbCzCKKQ0E&list=PLjJXHoFO4cj4c7_GWtmtpkyhspWmxObFX&index=28

22BTC01

BASICS OF BIOLOGY - I
(FOR MPC STREAM OF BIOTECH)

Instruction:	3 L+1T Hours per week
Duration of SEE:	3 Hours
SEE:	60 Marks
CIE:	40 Marks
Credits:	4

COURSE OBJECTIVES: This course aims to

1. To give understanding of fundamentals of origin of life and various theories of evolution.
2. To give an insight of plant cell and its organelles
3. To provide a knowledge on classification of plants and their propagation mode.
4. To impart theoretical knowledge on various physiological aspects of plants
5. To give the students an understanding of knowledge on microbes and their economic importance.

COURSE OUTCOMES: After completion of this course, student will be able to

1. Outline the theories behind the origin of life and evolution studies.
2. Describe the structure and functions of plant cell and its organelles.
3. Relate the plants based on the habit and habitat and mechanism of seed development in plants.
4. Infer the basic physiological processes in plants and various methods of crop improvement.
5. Demonstrates characteristics of bacteria, fungi, virus and explains virus related diseases and economic importance of microbes.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2							2	2	2		2	2	
CO2	2							2	2	2		3	2	1
CO3	2							2	2	2		3	3	
CO4	2							2	2	2		3	3	1
CO5	2							2	2	2		3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

History of Life and Evolution: History of earth, Evolutionary theories of origin of life. Experimental verification of chemical origin of life. Darwinism, Natural selection, Sexual selection, Artificial selection, Mendelism, Hugo De Vries mutation theory, Neo-Darwinism. Introduction and importance of classification-five kingdoms (Monera, Protista, Fungi, Plantae and Animalia).

UNIT-II

Cell Structure and Internal Organization of Plants: Cell as basic UNIT-of life, overview of the plant cell, cell cycle, cell division, mitosis and meiosis. Concept of growth, meristems (apical, intercalary and lateral) their functions. Simple tissues (parenchyma, collenchyma and sclerenchyma), complex tissues (xylem and phloem). Tissue systems (epidermal, ground and vascular)

UNIT-III

Plant Systematic and Reproduction: Plant kingdom, salient features of classification. Alternation of generation of the plants. Type studies of Algae (Spirogyra), Bryophytes (Moss), Pteridophyta (Pteris), Gymnosperms (Cycas) and general characteristics and life cycle of Angiosperms. Overview of modes of reproduction-Asexual: vegetative propagation, budding, sporulation, binary fission; Sexual reproduction:

pollination, fertilization, development of embryo, endosperm, fruit and seed formation. Apomixes, parthenocarpy, polyembryony type of reproduction.

UNIT-IV

Plant Physiology and Concepts in Plant Biotechnology: Absorption of water soil water, water potential, diffusion, imbibitions, osmosis, plasmolysis, absorption of water, ascent of sap, transportation. Crop improvement - Heterosis and mutation breeding. Plant tissue culture techniques and their applications. Plant growth regulators.

UNIT-V

Introduction to Microbial World: General account of prokaryotes: structure & function of bacterial cell. Concept of species and strains. Salient properties of Fungi and type study of Rhizopus. General characteristics of Virus. Study of Bacterial viruses - T4, plant viruses TMV, animal viruses HIV. Structure Reproduction in bacteria (asexual- binary fission and sexual - conjugation) and viruses (lytic and lysogenic). Economic importance of beneficial bacteria (agriculture, industry, medicine and biotechnology).

TEXT BOOKS:

1. Ray F. Evert, Susan E. Eichhorn Biology of Plants W. H. Freeman 2012. Tata McGraw Hill Publishing Co. Pvt. Ltd 9th edition, (2010).
2. Campbell, N.A., Reece, J.B., Urry, Lisa, Cain, ML., Wasserman, S.A., Minorsky, P.V., Jackson, R.B. Biology: A Global 11th edition, Pearson Education Ltd. (2017)

SUGGESTED READING:

1. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M New York: McGraw-Hill. 6th Edition (2011).

22CYC01

CHEMISTRY
(BIOTECH)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credit	3

COURSE OBJECTIVES: This course aims to

1. This syllabus helps at providing the concepts of chemical bonding and chemical kinetics to the students aspiring to become practicing engineers
2. Thermodynamic and Electrochemistry units give conceptual knowledge about processes and how they can be producing electrical energy and efficiency of systems.
3. To teach students the value of chemistry and to improve the research opportunities knowledge of stereochemistry and organic reactions is essential.
4. Water chemistry UNIT-impart the knowledge and understand the role of chemistry in the daily life.
5. New materials lead to discovering of technologies in strategic areas for which an insight into Polymers, nanomaterials and basic drugs of modern chemistry is essential.

COURSE OUTCOMES: At the end of the course student will be able to:

1. Identify the microscopic chemistry in terms of molecular orbitals, intermolecular forces and rate of chemical reactions.
2. Discuss the properties and processes using thermodynamic functions, electrochemical cells and their role in batteries and fuel cells.
3. Illustrate the major chemical reactions that are used in the synthesis of organic molecules.
4. Classify the various methods used in treatment of water for domestic and industrial use.
5. Outline the synthesis of various Engineering materials & Drugs.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	3	2	2			2	2					2	1	1
CO2	3	2	2			2	2					2	2	2
CO3	3	2	3			2	2					2	3	2
CO4	3	2	3			2	2					2	3	2
CO5	3	2	2			2	2					2	3	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Atomic and molecular structure and Chemical Kinetics:

Atomic and molecular structure: Molecular Orbital theory - atomic and molecular orbitals. Linear combination of atomic orbitals (LCAO) method. Molecular orbitals of diatomic molecules. Molecular Orbital Energy level diagrams (MOED) of diatomic molecules & molecular ions (H_2, He_2^+, N_2 , O_2 , O_2^- , CO, NO). Pi- molecular orbitals of benzene and its aromaticity.

Chemical Kinetics: Introduction, Terms involved in kinetics: rate of reaction, order & molecularity; First order reaction-Characteristics: units of first order rate constant & its half-life period, second order reaction-Characteristics: units of second order rate constant & its half- life period. Numericals.

UNIT-II

Use of free energy in chemical equilibria Use of free energy in chemical equilibria: Thermodynamic functions: Internal energy, entropy and free energy. Significance of entropy and free energy (criteria of spontaneity). Free energy and emf (Gibbs Helmholtz equations and its applications). Cell potentials,

electrode potentials, and – Reference electrodes (NHE, SCE) electrochemical series. Nernst equation and its applications. Determination of pH using combined Glass & Calomel electrode. Potentiometric Acid base & Redox Titrations. Numericals.

Battery technology: Rechargeable batteries & Fuel cells.
Lithium batteries: Introduction, construction, working and applications of Li-MnO_2 and Li-ion batteries.
Fuel Cells: Introduction, difference between conventional cell and fuel cell, limitations & advantages. Construction, working & applications of methanol-oxygen fuel cell.

UNIT-III
Stereochemistry and Organic reactions
Stereochemistry: Representations of 3 dimensional structures, Types of stereoisomerism- Conformational isomerism confirmations of n-butane (Newman and sawhorse representations), Configurational isomerism Geometrical (cistrans) isomerism & Optical isomerism- optical activity, Symmetry and chirality: Enantiomers (lactic acid) & Diastereomers (Tartaric acid), Absolute configurations, Sequence rules for R&S notation.
Types of Organic reactions: Substitution Reactions- Electrophilic substitution (Nitration of Benzene); Nucleophilic Substitution (S_N1& S_N2); Free Radical Substitution (Halogenation of Alkanes)
Addition Reactions: Electrophilic Addition – Markonikoff's rule, Free radical Addition Anti Markonikoff's rule (Peroxide effect), Nucleophilic Addition (Addition of HCN to carbonyl compounds)
Eliminations-E1 and E2 (dehydrohalogenation of alkyl halides), Cyclization (Diels - Alder reaction)

UNIT-IV Water Chemistry:
Hardness of water – Types, units of hardness, Disadvantages of hard water, Alkalinity and Estimation of Alkalinity of water, Boiler troubles - scales & sludge formation, causes and effects, Softening of water by lime soda process (Cold lime soda process), ion exchange method and Reverse Osmosis. Specifications of potable water & industrial water. Disinfection of water by Chlorination; break point chlorination, BOD and COD definition, Estimation (only brief procedure) and significance, Numericals.

UNIT-V Engineering Materials and Drugs:
Introduction, Terms used in polymer science; Thermoplastic polymers (PVC) & Thermosetting polymers (Bakelite); Elastomers (Natural rubber). Conducting polymers- Definition, classification and applications.
Polymers for Electronics: Polymer resists for integrated circuit fabrication, lithography and photolithography
Nano materials-Introduction to nanomaterials and general applications, basic chemical methods of preparation- Solgel method. Carbon nanotubes and their applications. Characterisation of nanomaterials by SEM and TEM (only Principle). Drugs-Introduction, Synthesis and uses of Aspirin (analgesic), Paracetamol (Antipyretic), Atenolol (antihypertensive).

TEXT BOOKS:

1. P.C. Jain and M. Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company Ltd., New Delhi,16th edition (2015).
2. W.U. Malik, G.D.Tuli and R.D.Madan, "Selected topics in Inorganic Chemistry", S Chand & Company Ltd, New Delhi, reprint (2009).
3. R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, "Organic Chemistry", Pearson, Delhi, 7th edition (2019).
4. A Textbook of Polymer Science and Technology , Shashi Chawla ,Dhanpat Rai & Co. (2014)
5. T. Pradeep, Nano: The Essentials, Tata McGraw-Hill Education, Delhi, 2012
6. G.L. David Krupadanam, D. Vijaya Prasad, K. Varaprasad Rao, K.L.N. Reddy and C.Sudhakar, "Drugs", Universities Press (India) Limited, Hyderabad (2007).

SUGGESTED READINGS:

1. B. H. Mahan, "University Chemistry", Narosa Publishing house, New Delhi, 3rd edition (2013).
2. B.R. Puri, L.R. Sharma and M.S. Pathania, "Principles of Physical Chemistry", S. Nagin Chand & Company Ltd., 46th edition (2013).
3. T.W. Graham Solomons, C.B. Fryhle and S.A. Snyder, "Organic Chemistry", Wiley, 12th edition (2017).
4. P.W. Atkins, J.D. Paula, "Physical Chemistry", Oxford, 8th edition (2006).

22EEC01

BASIC ELECTRICAL ENGINEERING

Instruction	2L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. To understand the behaviour of different circuit elements R, L & C, and the basic concepts of electrical AC circuit analysis
2. To comprehend the basic principle of operation of AC and DC machines
3. To infer about different types of electrical wires and cables, domestic and industrial wiring, safety rules and methods of earthing.

COURSE OUTCOMES: After the completion of this course, the student will be able to

1. Understand the concepts of Kirchhoff's laws and their application various theorems to get solution of simple dc circuits.
2. Predict the steady state response of RLC circuits with AC single phase/three phase supply.
3. Infer the basics of single phase transformer
4. Describe the construction, working principle of DC machine and 3-phase Induction motor.
5. Acquire the knowledge of electrical wires, cables, earthing, Electrical safety precautions to be followed in electrical installations and electric shock and its safety and energy calculations.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	3	3	2						1	2		3		
CO2	3	3	2						1	2		3		
CO3	3	3	2	1					1	2		3		
CO4	2	1							1	2		3		
CO5	2		2						1	2		3		

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

DC Circuits: Electrical circuit elements (R,L and C), voltage and current sources, Kirchhoff current and voltage laws, analysis of simple circuits with dc excitation, Superposition, Thevenin's and Norton's Theorems.

UNIT-II

AC Circuits: Representation of sinusoidal waveforms, peak and RMS values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of R, L, C, series RL and RC. Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT-III

Single Phase Transformer: Construction, Working principle, EMF Equation, Ideal and Practical transformer, Equivalent circuit of Transformer, OC and SC tests on a transformer, Efficiency and Regulation

UNIT-IV

DC and AC Machines: DC Generators: Construction, Principle of operation, EMF equation, Classification, Characteristics of shunt generators. DC Motors: Classification, Torque Equation, Characteristics and Speed control of DC Shunt and Series Motors, Losses and efficiency Three - Phase Induction Motors: Principle of operation, Applications

UNIT-V

Electrical Installations: Electrical Wiring: Types of wires and cables, Electrical Safety precautions in handling electrical appliances, electric shock, and first aid for electric shock, safety rules. Components of LT Switchgear: Switch Fuse UNIT-(SFU), MCB, ELCB, Earthing (Elementary Treatment only), Elementary calculations for energy consumption

TEXT BOOKS:

1. L. S. Bobrow, Fundamentals of Electrical Engineering, Oxford University Press, 2011.
2. E. Hughes, Electrical and Electronics Technology, Pearson, 2010.

SUGGESTED READING:

1. D. P. Kothari & I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989
3. D.C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009
4. P.V. Prasad, S. Sivanagaraju, R. Prasad, "Basic Electrical and Electronics Engineering" Cengage Learning, 1st Edition, 2013

22CSC01

PROBLEM SOLVING AND PROGRAMMING

Instruction	2L + 1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to:

1. Develop logical skills and basic technical skills so that students should be able to solve basic computational problems.
2. Learn any basic programming language.

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

1. Understand real world problems and develop computer solutions for those problems.
2. Understand the basics of Python.
3. Apply Python for solving basic programming solutions.
4. Create algorithms/flowcharts for solving real-time problems.
5. Build and manage dictionaries to manage data.
6. Handle data using files.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	3	1	1		1							1	2	2
CO2	3	1	1		1							1	2	2
CO3	3	1	1		1							1	2	2
CO4	3	1	1		1							1	2	2
CO5	3	1	1		1							1	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Programming - Evolution of languages: Machine, Assembly and High-level languages. Software requirements for programming: OS, compiler, linker, loader, editor. Design specification: Algorithms and Flowcharts.

UNIT-II

Data Types and Operators, Variable, Sequences and Iteration - Data types, Expressions, Precedence Rules, Operators: arithmetic, relational, logical, bit-wise and miscellaneous operators; local variable, global variables, List, String, Tuples, Sequence mutation and accumulating patterns.

UNIT-III

Conditional Statement, Loops, Arrays and Strings, user-defined Data Types – if, else, for, while, nested iteration, Concept and use of arrays, declaration and usage of arrays, 2-dimensional arrays, different types of user defined data types.

UNIT-IV

Dictionaries and Dictionary Accumulation, Functions/Methods - Dictionary basics, operations, methods, accumulation, advantages of modularizing program into functions, function definition and function invocation. Positional parameters passing arrays to functions, recursion, library functions.

UNIT-V

File Handling and Memory Management - Concepts of files and basic file operations, writing/reading data to/from a .csv file, Memory Management Operations.

TEXT BOOKS:

1. R.S. Salaria, "Programming for Problem Solving", First Edition, Khanna Book Publishing Co., Delhi.
2. Jeeva Jose, "Taming Python by Programming", Revised Edition, Khanna Book Publishing Co., Delhi.
3. Mark Lutz, "Learning Python", 5th Edition, O'Reilly Media, Inc.
4. Python Crash Course: A Hands-On, Project-Based Introduction to Programming by Eric Matthes, No Starch Press.
5. "Programming in Python", R.S. Salaria, Khanna Book Publishing Co., Delhi.

REFERENCES:

NPTEL/SWAYAM COURSES

1. Introduction to Problem Solving and Programming, Video Lectures, Prof. D Gupta, IIT Delhi.
2. Problem Solving Aspects and Python Programming, Dr. S Malinga, Dr Thangarajan, Dr. S V Kogilavani, Kongu Engineering College.
3. https://www.coursera.org/specializations/python-3-programming

22CYC02

CHEMISTRY LAB
(BIOTECH)

Instruction:	3P Hours per Week
Duration of SEE:	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits:	1.5

COURSE OBJECTIVES: This course aims to

1. To impart fundamental knowledge in handling the equipment / glassware and chemicals in chemistry laboratory.
2. To provide the knowledge in both qualitative and quantitative chemical analysis
3. The student should be conversant with the principles of volumetric analysis
4. To apply various instrumental methods to analyse the chemical compounds and to improve understanding of theoretical concepts.
5. To interpret the theoretical concepts in the preparation of new materials like drugs and polymers.

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

1. Identify the basic chemical methods to analyse the substances quantitatively & qualitatively.
2. Estimate the amount of chemical substances by volumetric analysis.
3. Determine the rate constants of reactions from concentration of reactants/ products as a function of time.
4. Calculate the concentration and amount of various substances using instrumental techniques.
5. Develop the basic drug molecules and polymeric compounds.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	3	2	2			2	2					2	2	2
CO2	3	2	1			2	2					2	2	2
CO3	3	2	3			2	2					2	2	2
CO4	3	2	2			2	2					2	2	2
CO5	3	2	3			2	2					2	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

1. Introduction: Preparation of standard solution of oxalic acid and standardisation of NaOH.
2. Estimation of metal ions (Co^{+2} & Ni^{+2}) by EDTA method.
3. Estimation of temporary and permanent hardness of water using EDTA solution
4. Determination of Alkalinity of water
5. Determination of rate constant for the reaction of hydrolysis of methyl acetate. (first order)
6. Determination of rate constant for the reaction between potassium per sulphate and potassium Iodide. (second order)
7. Estimation of amount of HCl Conductometrically using NaOH solution.
8. Estimation of amount of HCl and CH_3COOH present in the given mixture of acids Conductometrically using NaOH solution.
9. Estimation of amount of HCl Potentiometrically using NaOH solution.
10. Estimation of amount of Fe^{+2} Potentiometrically using $KMnO_4$ solution
11. Preparation of Nitrobenzene from Benzene.
12. Synthesis of Aspirin drug and Paracetamol drug.
13. Synthesis of phenol formaldehyde resin.

TEXT BOOKS:

1. J. Mendham and Thomas, "Vogel's text book of quantitative chemical analysis", Pearson education Pvt.Ltd. New Delhi , 6th ed. 2002.
2. Senior practical physical chemistry by B.D.Khosla, V.C.Garg & A.Gulati; R. Chand & Co. : New Delhi (2011).

SUGGESTED READINGS:

1. Dr. Subdharani , "Laboratory Manual on Engineering Chemistry", Dhanpat Rai Publishing, 2012.
2. S.S. Dara , "A Textbook on experiment and calculation in engineering chemistry", S.Chand and Company, 9th revised edition, 2015.
3. Kogilavani, Kongu Engineering College.

22MBC02

COMMUNITY ENGAGEMENT

Instruction	3P Hours per week
SEE	Nil
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES: This course aims to:

1. Develop an appreciation of rural culture, life-style and wisdom among the Students.
2. Learn about the various livelihood activities that contribute to rural economy.
3. Familiarize the Rural Institutions and the Rural Development Programmes in India.

COURSE OUTCOMES: After completion of this course, student will be able to after the completion of this Course, Student will be able to:

1. Gain an understanding of rural life, Culture and Social realities.
2. Develop a sense of empathy and bonds of mutuality with Local Communities.
3. Appreciate significant contributions of Local communities to Indian Society and Economy.
4. Exhibit the knowledge of Rural Institutions and contributing to Community's Socio-Economic improvements.
5. Utilise the opportunities provided by Rural Development Programmes.

CO-PO Articulation Matrix

PO/PSO CO	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
CO1	1	2	2	2		3	3	1	2			2	2	
CO2		1	2	2		2	2		2	1		1	1	
CO3		1	1	2		3	3	1	3	1	2	1	1	
CO4	2	2	3	2		2	2	1	2	2	1			
CO5	1	2	2	1		2	2		1		1	1	1	

1 - Slightly, 2 - Moderately, 3 - Substantially

MODULE- I APPRECIATION OF RURAL SOCIETY

Rural life style, rural society, Caste and Gender relations, Rural values with respect to Community, Nature and Resources, elaboration of 'soul of India lies in villages' (Gandhi), Rural Infrastructure.

MODULE-II UNDERSTANDING RURAL ECONOMY AND LIVELIHOOD

Agriculture, Farming, Landownership, Water management, Animal Husbandry, Non-farm Livelihood and Artisans, Rural Entrepreneurs, Rural markets, Rural Credit Societies, Farmer Production Organization/Company.

MODULE-III RURAL INSTITUTIONS

Traditional Rural organizations, Self-Help Groups, Panchayati Raj Institutions (Gram Sabha), Gram Panchayat, Standing Committees, Local Civil Society, Local Administration.

MODULE-IV RURAL DEVELOPMENT PROGRAMMES

History of Rural Development in India, Current National Programmes: SarvaShikshaAbhiyan, BetiBhachao, BetiPadhao, Ayushman, Bharat, Swachh Bharat, PM AwasYojana, Skill India, Gram Panchayat Decentralised Planning, NRLM, MNREGA etc.

TEXT BOOKS:

1. Singh, Katar, Rural Development: Principles, Policies and Management, Sage Publications, New Delhi, 2015.
2. A Hand book on Village Panchayat Administration, Rajiv Gandhi Chair for Panchayati Raj Studies, 2002.
3. United Nations, Sustainable Development Goals, 2015, un.org/sdgs
4. M.P Boraia, Best Practices in Rural Development, Shanlax Publishers, 2016.

JOURNALS:

1. Journal of Rural development (published by NIRD & PR, Hyderabad).
2. Indian Journal of Social Work, (by TISS, Bombay).
3. Indian Journal of Extension Educations (by Indian Society of Extension Education).
4. Journal of Extension Education (by Extension Education Society).
5. Kurukshetra (Ministry of Rural Development, GOI).
6. Yojana (Ministry of Information & Broadcasting, GOI).

22CSC02

PROBLEM SOLVING AND PROGRAMMING LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES: This course aims to

1. Master the fundamentals of writing Python scrips.
2. Learn Python elements such as variables, flow controls structures, and functions.
3. Discover how to work with lists and sequence data, and files.

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

1. Understand various Python program development Environments.
2. Demonstrate the concepts of Python.
3. Implement algorithms/flowcharts using Python to solve real-world problems.
4. Build and manage dictionaries to manage data.
5. Write Python functions to facilitate code reuse.
6. Use Python to handle files and memory.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	3	2	1									1	2	
CO2	3	3	2	2	3							1	2	
CO3	2	3	3	2	3							1	2	
CO4	2	3	3	2	2							1	2	
CO5	2	3	3	3	3							1	2	

1 - Slightly, 2 - Moderately, 3 - Substantially

LABORATORY / PRACTICAL EXPERIMENTS:

1. Explore various Python Program Development Environments.
2. Demonstration of input/output operations.
3. Demonstration of operators.
4. Demonstration of selective control structures.
5. Demonstration of looping control structures.
6. Demonstration of List, Tuple and Set
7. Demonstration of Python Dictionaries.
8. Implementation of searching and sorting techniques.
9. Implementation of string manipulation operations.
10. File handling and memory management operations.

TEXT BOOKS:

1. R.S. Salaria, “Programming for Problem Solving”, First Edition, Khanna Book Publishing Co., Delhi.
2. Jeeva Jose, “Taming Python by Programming”, Revised Edition, Khanna Book Publishing Co., Delhi.
3. Mark Lutz, “Learning Python”, 5th Edition, , O'Reilly Media, Inc.,
4. Python Crash Course: A Hands-On, Project-Based Introduction to Programming by Eric Matthes, No Starch Press.
5. “Programming in Python”, R.S. Salaria, Khanna Book Publishing Co., Delhi.

REFERENCES:

NPTEL/SWAYAM COURSE

1. Introduction to Problem Solving and Programming, Video Lectures, Prof. D Gupta, IIT Delhi.
2. Problem Solving Aspects and Python Programming, Dr. S Malinga, Dr Thangarajan, Dr. S V Kogilavani, Kongu Engineering College.
3. https://www.coursera.org/specializations/python-3-programming.

22MEC37

ROBOTICS AND DRONES LAB
(Common to All Branches)

Instruction	2T + 2P Hours per week
CIE	100 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. To develop the students' knowledge in various robot and drone structures and their workspace.
2. To develop multidisciplinary robotics that have practical importance by participating in robotics competitions
3. To develop students' skills in performing spatial transformations associated with rigid body motions, kinematic and dynamitic analysis of robot systems.
4. Through projects done in lab, increase the true hands-on student learning experience and enhance their conceptual understanding, increase students' ability, competence and teamwork skills on dealing with real-life engineering problems

COURSE OUTCOMES: After completion of course, students would be able to

1. Demonstrate knowledge of the relationship between mechanical structures of robotics and their operational workspace characteristics
2. Understand mechanical components, motors, sensors and electronic circuits of robots and build robots.
3. Demonstrate knowledge of robot controllers.
4. Use Linux environment for robotic programming.
5. Write Python scripts to control robots using Python and Open CV.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2	1	1			1	3	3	1	2	2	1
CO2	1	2	2	1	1			1	3	3	1	2	2	1
CO3	1	2	2	1	1			1	3	3	1	2	3	1
CO4	2	2	2	1	1			1	3	3	1	2	2	1
CO5	2	2	2	1	1			1	3	3	1	2	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

LAB EXPERIMENTS:

1. Assembling of robot mechanical components, mounting of motors, sensors, electronic circuits to the chassis.
2. Connecting to electronic circuitry: motor drivers, incremental encoders proximity sensors, micro controller,
3. Different types of batteries, selection of suitable battery for application, safety precaution.
4. Introduction to Linux Command Line Interface: basic file and directory management and other useful commands
5. Controlling robot using Python: i) Move robot using Python code, ii) Make robot move in patterns using Python
6. Robot programming with Sensor inputs: i) Read sensor data using Python, ii) Visualize sensor data using Python, iii) Code robot to avoid obstacles by using sensor data
7. Open CV: i) Create an Image and display an image; ii) Read and change pixel values; iii) Create colored shapes and save image; iv) Extract the RGB values of a pixel; v) Reading and Writing Videos
8. Open CV: i) Extraction of Regions of Interest; ii) Extraction of RGB values of a pixel
9. Coding robot to work with colors, follow colored objects, identifying shape of the object-oriented
10. Projects: i)Making a line follower robot using a Camera; ii) Writing code for a complex function Assembly of a drone

SUGGESTED READINGS:

1. https://www.geeksforgeeks.org/robotics-introduction/
2. https://www.ohio.edu/mechanical-faculty/williams/html/PDF/IntroRob.pdf
3. https://www.idtechex.com/en/research-report/new-robotics-and-drones-2018-2038-technologies-forecasts-players/584
4. https://dronebotworkshop.com/

22EEC02

BASIC ELECTRICAL ENGINEERING LAB

Instruction	2P Hours per week
Duration of SEE	3 Hours
Semester End Examination	50 Marks
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course aims to

1. To acquire the knowledge on different types of electrical elements and to verify the basic electrical circuit laws and theorems.
2. To determine the parameters and power factor of a coil, calculate the time and frequency responses of RLC circuits and to familiarize with measurement of electric power & energy.
3. To determine the characteristics of Transformers, dc, ac machines and switch gear components

COURSE OUTCOMES: After completion of this course, student will be able to

1. Comprehend the circuit analysis techniques using various circuital laws and theorems.
2. Analyse the parameters of the given coil and measurement of power and energy in AC circuits
3. Determine the turns ration/performance parameters of single-phase transformer
4. Infer the characteristics of DC shunt motor different tests.
5. Illustrate different parts and their function of electrical components, equipment and machines.

CO-PO Articulation Matrix

PO/PSO CO	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
CO1	3	2	2			2	2					2		
CO2	3	2	1			2	2					2		
CO3	3	2	3			2	2					2		
CO4	3	2	2			2	2					2		
CO5	3	2	3			2	2					2		

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF LABORATORY EXPERIMENTS/DEMONSTRATIONS:

1. Verification of KCL and KVL.
2. Verification of Thevenin's theorem.
3. Verification of Norton's theorem.
4. Charging and discharging of Capacitor.
5. Determination of parameters of a choke or coil by Wattmeter Method.
6. Power factor improvement of single-phase AC System.
7. Active and Reactive Power measurement of a single-phase system using
   (i) 3-Ammeter method (ii) 3-Voltmeter method
8. Measurement of 3-Phase Power in a balanced system
9. Calibration of single-phase energy meter.
10. Verification of Turns/voltage ratio of single-phase Transformer.
11. Open Circuit and Short Circuit tests on a given single phase Transformer
12. Brake test on DC Shunt Motor
13. Speed control of DC Shunt Motor
14. Demonstration of Measuring Instruments and Electrical Lab components.
15. Demonstration of Low-Tension Switchgear Equipment/Components
16. Demonstration of cut - out section of Machines like DC Machine, Induction Machine etc.

Note: TEN experiments to be conducted to cover all five Course Outcomes.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)
(In line with AICTE Model Curriculum with effect from AY 2022-23)

B.TECH. BIOTECHNOLOGY

SEMESTER –II

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MTC06/ 22BTC02	Mathematics-II/ Basics of Biology-II	3	1	0	3	40	60	4
2	22PYC07	Physics	3	0	0	3	40	60	3
3	22CEC01	Engineering Mechanics	3	1	0	3	40	60	4
4	22EGC01	English	2	0	0	3	40	60	2
PRACTICAL									
5	22PYC10	Physics Lab	0	0	3	3	50	50	1.5
6	22EGC02	English lab	0	0	2	3	50	50	1
7	22MEC01	CAD and Drafting	0	1	3	3	50	50	2.5
8	22MEC38	Digital Fabrication Lab	0	0	3	3	50	50	1.5
TOTAL			**11**	**3**	**11**	**24**	**360**	**440**	**19.5**

L: Lecture **T: Tutorial** **D: Drawing**

P: Practical **CIE-Continuous Internal Evaluation** **SEE-Semester End Examination**

22MTC06

MATHEMATICS-II
(Bio-Tech BiPC Stream)

Instruction:	3 L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

COURSE OBJECTIVES:

1. To discuss the basic operations in Vector Algebra.
2. To discuss Physical interpretations on Scalars and vector functions.
3. To explain various methods of partial fractions.
4. To explain various techniques of integration.
5. To discuss the solutions of first order differential equations.

COURSE OUTCOMES: Upon completing this course, students will be able to:

1. Apply the basic operations on Scalar and Vectors.
2. Apply the vector differential operators to Scalars and Vector functions.
3. Solve partial fractions by various methods.
4. Evaluate definite and indefinite Integral.
5. Solve the first order ordinary differential equations.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2	2								1	1	
CO2	2	2	2	2								2	1	
CO3	2	2	2	2								2	1	
CO4	3	3	3	3								2	1	
CO5	3	3	3	3								1	1	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Vector Algebra: Addition of vectors, scalar multiplication, angle between two non-zero vectors, linear combination of vectors, component of vectors in three dimensions, scalar product geometrical interpretations, orthogonal projections, properties of dot product, angle between two vectors, vector product of two vectors and properties, scalar triple product, vector triple product.

UNIT-II

Vector Differential Calculus: Definitions, scalar and vector point functions, vector differential operator, Gradient, Divergence and Curl, Solenoidal and Irrotational vectors, properties of gradient, divergence and curl (vector identities)

UNIT-III

Partial Fractions: Resolving f(x)/g(x) into partial fractions, g(x) contains non repeated linear factors, g(x) contains repeated and non-repeated linear factors, g(x) contains non repeated irreducible factors, g(x) contains repeated and non repeated irreducible factors.

UNIT-IV

Integration: Simple integrations of algebraic, trigonometric and exponential functions. Methods of integration, integration by parts, integration of rational, irrational and Trigonometric functions, definite integrals.

UNIT-V

Differential Equations: Formation of Differential equations, Solutions of first order and first degree differential Equations, Variable Separable, Homogeneous, Linear, Bernoulli and Exact differential Equations.

TEXT BOOKS:

1. Shanti Narayan, "Vector Calculus", S.Chand Publishers, 2003.
2. B.S.Grewal, "Higher Engineering Mathematics", 43rd edition, Khanna Publishers, 2014.

SUGGESTED READING:

1. William E. Boyce, Richard C. Diprima, "Elementary differential equations", 9th Edition, Wiley Publishers, 2008.
2. Joseph Edwards, "Differential Calculus For Beginners", Arihant publishers, 2016.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/111105122 (Week- 8)
2. https://nptel.ac.in/courses/111106100 (Week1 &2)

22BTC02

BASICS OF BIOLOGY -II
(For MPC Stream of Bio-Tech)

Instruction	3 L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

COURSE OBJECTIVES: This course aims to

1. To impart theoretical knowledge on animal cell, tissues their types and level organization
2. To provide knowledge on basic concepts of Biology and basis of animal kingdom classification.
3. To provide knowledge on various parasites, lifecycle and diseases caused by them.
4. To impart knowledge on ecology, environment and biotic interactions in nature
5. To give an insight on genes, chromosome, blood grouping system, and gene expression

COURSE OUTCOMES: After completion of this course, student will be able to

1. Identify the basic structure, function of various animal cell organelles, level of organization and types of tissues in animals.
2. Explains nomenclature and the animal kingdom classification with its characteristic features.
3. Explain and identify the lifecycles, diseases, treatment and preventive measures of human pathogens.
4. Outline population ecology, various biotic and abiotic environmental factors of ecosystem.
5. To give an insight on genes, chromosome, blood grouping system and gene expression.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2					2	2	2	2	2		2	2	1
CO2	2					2	2	2	2	2		2	2	
CO3	2					2	2	2	2	2		2	2	1
CO4	2					2	2	2	2	2		2	2	
CO5	2					2	2	2	2	2		2	2	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Animal Cell, Tissues and Level of Organization: Structure of animal cell and its organelles. Differences between plant and animal cell. Level of organization, multicellularity, diploblastic and triploblastic conditions. Asymmetry, symmetry: radial symmetry and bilateral symmetry. Acoelomates, pseudo coelomates and coelomates in brief. Animal tissues structure and functions. Different types of animal tissues and their functions. Epithelial, Connective, Muscular and Nervous tissues in brief

UNIT-II

Animal Kingdom Classification: Classification of animal kingdom. Phylogeny of invertebrate and vertebrate phyla. Salient features of non-chordates up to phyla, and chordates up to class level. Binomial and trinomial nomenclature. Concept of species and genus.

UNIT-III

Parasitology: Parasitism and Parasitic Adaptation: Health and disease: introduction, life cycle, pathogenicity, treatment and prevention; *Entamoeba histolytica*, *Plasmodium vivax*, *Ascaris lumbricoides* and *Wuchereria bancrofti*. Brief account of pathogenicity, treatment and prevention of typhoid, pneumonia, common cold and ring worm.

UNIT-IV

Ecology and Environment: Levels of biological hierarchy, Organism and environment, habitat and niche. Abiotic environmental factors light, temperature, water and soil. Population and ecological adaptations, population attributes: growth, birth and death rate, sex ratio, age distributions, Population density. Population growth models, Biotic & environmental factors interactions: competition, mutualism, commensalism, parasitism, predation & ammensalism.

UNIT-V

Genetics: Structure and functions of DNA, Chromosome; Concept of gene and alleles, multiple alleles, ABO blood groups. Sex chromosomes, Sex linked inheritance. Central Dogma, Characteristics of genetic code, Gene expression and regulation: transcription, translation and regulation in prokaryotes (lac operon) and eukaryotes.

TEXT BOOKS:

1. Campbell, N.A., Reece, J.B., Urry, Lisa, Cain, ML., Wasserman, S.A., Minorsky, P.V., Jackson, R.B. Biology: A Global 11th edition, Pearson Education Ltd. (2017)
2. Beginning Science: Biology. B.S. Beckett. Oxford University Press.1st edition, 1983.

SUGGESTED READING:

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer Invertebrates: A New Edition, Blackwell Science (2002)
2. K Vaidhyanath, K Pratap Reddy and K Sathya Prasad, to Applied Biology and BS Publications, India, 2004.

22PYC07

PHYSICS
(BIOTECH & CHEMICAL)

Instruction	3L Hours per week
Duration of SEE	3Hours
SEE	60Marks
CIE	40Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. Learn the basic concepts of wave nature of light
2. Know about the properties of magnetic and dielectric materials
3. Understand the basics of nanomaterials
4. Familiarize with fundamental ideas of quantum mechanics

COURSE OUTCOMES:

At the end of the course, the student will be able to

1. Analyse the wave nature of the light by correlating theoretical concepts with experimental results.
2. Categorize lasers and optical fibres for real time applications..
3. Identify magnetic and dielectric materials for engineering applications.
4. Make use of properties of nanomaterials for technological applications.
5. Interpret the dual nature of light and its quantum effects.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	3	1	1	1	1	2	2	1	1	2	1	2		
CO2	3	1	2	1	2	2	2	1	2	2	2	2	2	1
CO3	2	2	1	1	1	1	1	1	1	2	1	2	2	2
CO4	3	2	2	2	2	2	2	1	1	2	1	2	2	2
CO5	3	2	2	2	2	1	1	2	1	2	1	2		

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Wave Optics: Huygen's principle–Superposition of waves –Interference of light by splitting of wave front and amplitude–Fresnel's biprism–Interference in thin films (reflected light) – Newton's rings – Fraunhofer diffraction from a single slit – Double slit diffraction–Concept of N-slits–Diffraction grating and its resolving power. Polarization: Introduction–Malus's law–Double refraction –Nicol's prism– Quarter-wave plate and half-wave plate–Optical activity– Laurent's half shade polarimeter.

UNIT-II

Lasers: Characteristics of lasers– Einstein's coefficients–Amplification of light by population inversion– Ruby laser– He-Ne laser– Semiconductor laser–Applications of lasers in engineering and medicine.

Fiber Optics: Introduction–Construction–Principle–Propagation of light through an optical fiber – Numerical aperture and acceptance angle – Step-index and graded-index fibers –Pulse dispersion –Fiber losses –Fiber optic communication system –Applications.

UNIT-III

Dielectric Materials: Introduction: Dielectric polarization Types of dielectric polarization: electronic & ionic polarizations (quantitative); orientation & space-charge polarizations (qualitative) Frequency and temperature dependence of dielectric polarization–Determination of dielectric constant (Schering bridge method) Ferroelectricity Barium titanate Applications of ferroelectrics.

Magnetic Materials: Origin of magnetism Magnetic moment - Bohr magneton Classification of magnetic materials: dia, para, ferro, anti-ferro and ferrimagnetic materials Weiss molecular field theory Domain theory Hysteresis curve Soft and hard magnetic materials–Applications.

UNIT-IV

Nanomaterials: Properties of materials at reduced size–Surface to volume ratio–Quantum confinement–Preparation of nanomaterials: bottom-up approach (sol-gel method) and top-down approach (ball-milling method)–Elementary ideas of carbon nanotubes–Applications of nanomaterials.

UNIT-V

Quantum Mechanics: Introduction–Planck's' law of black body radiation – Wien's law and Rayleigh-Jean's law from Planck's law – Photoelectric effect – Compton effect –de-Broglie hypothesis –Wave-particle duality –Physical significance of ψ –Born's interpretation of the wave function –Verification of matter waves by Davisson-Germer's experiment –Uncertainty principle – Schrodinger wave equation (time-dependent and time-independent) –Particle in infinite square well potential.

TEXT BOOKS:

1. B. K. Pandey and S. Chaturvedi, *Engineering Physics*, Cengage Publications, 2012.
2. M. N. Avadhanulu and P. G. Kshirsagar, *A Text Book of Engineering Physics*, S. Chand Publications, 2014.
3. M. Arumugam, *Materials Science*, Anuradha Publications, 2015.
4. S. L. Gupta and Sanjeev Gupta, *Modern Engineering Physics*, Dhanpat Rai Publications, 2011.

SUGGESTD READING:

1. R. Murugeshan and Kiruthiga Sivaprasath, *Modern Physics* S. Chand Publications, 2014.
2. V. Rajendran, *Engineering Physics*, McGraw-Hill Education Publications, 2013.
3. P.K. Palanisamy, *Engineering Physics*, Scitech Publications, 2012.
4. V. Raghavan, *Materials Science and Engineering*, Prentice Hall India Learning Private Limited; 6th Revised edition, 2015.

22CEC01

ENGINEERING MECHANICS

Instruction	3L+1T Periods per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

COURSE OBJECTIVES: This course aims to

1. Understand the resolution of forces and to obtain resultant of all force systems,
2. Understand equilibrium conditions of static loads for smooth and frictional surface
3. Analyse simple trusses for forces in various members of a truss
4. Obtain centroid, centre of gravity for various regular and composite areas and bodies
5. Obtain Moment of inertia for various regular and composite areas and bodies and also to obtain Mass moments of inertia of elementary bodies

COURSE OUTCOMES: After completion of this course, student will be able to

1. Calculate the components and resultant of coplanar forces system and Draw free body diagrams to analyze the forces in the given structure
2. Understand the mechanism of friction and can solve friction problems
3. Analyse simple trusses for forces in various members of a truss.
4. Determine the centroid of plane areas, composite areas and centres of gravity of bodies.
5. Determine moments of inertia, product of inertia of plane and composite areas and mass moments of inertia of elementary bodies,

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	3	1	1	1	1	2	2	1	1	2	1	2		
CO2	3	1	2	1	2	2	2	1	2	2	2	2	2	1
CO3	2	2	1	1	1	1	1	1	1	2	1	2	2	2
CO4	3	2	2	2	2	2	2	1	1	2	1	2	2	2
CO5	3	2	2	2	2	1	1	2	1	2	1	2		

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Resolution and Resultant of Force System: Basic concepts of a force system. Components of forces in a plane. Resultant of coplanar concurrent force system. Moment of a force, couple and their applications. Resultant of coplanar non-concurrent force system

Equilibrium of force system: Free body diagrams, equations of equilibrium of planar force systems and its applications. Problems on general case of coplanar force systems.

UNIT-II

Theory of friction: Introduction, types of friction, laws of friction, application of friction to a single body & connecting systems. Wedge and belt friction

UNIT-III

Analysis of Simple Trusses: Introduction to trusses, Assumptions, analysis of simple trusses using method of joints and method of sections.

UNIT-IV

Centroid: Significance of centroid, moment of area, centroid of line elements, plane areas, composite areas, theorems of Pappus & its applications. Center of gravity of elementary and composite bodies

UNIT-V

Moment of Inertia: Definition of MI, Area MI. Polar Moment of Inertia, radius of gyration, transfer theorem, Moment of Inertia of elementary & composite areas, and Product of inertia. Mass moments of inertia of elementary bodies.

TEXT BOOKS:

1. K. Vijay Kumar Reddy and J. Suresh Kumar, Singer's Engineering Mechanics, BS Publications, Hyderabad, 2011.
2. Ferdinand L Singer, Engineering Mechanics, Harper and Collins, Singapore, 1904.

SUGGESTED READING:

1. A. Nelson, Engineering Mechanics, Tata McGraw Hill, New Delhi, 2010.
2. S. Rajashekaran & G. Sankarasubramanyam, Engineering Mechanics, Vikas publications, Hyderabad, 2002.
3. S.B. Junarkar and H.J Shah, Applied Mechanics**,** Charotar publishers, New Delhi, 2001.
4. Basudeb Bhattacharyya, Engineering Mechanics, Oxford University Press, New Delhi, 2008.
5. A K Tayal, Engineering Mechanics, Umesh Publications, New Delhi, 2010.

22EGC01

ENGLISH

Instruction	2 L Hours per Week
Duration of Semester End Examination	3 Hours
Semester End Examination	60 Marks
CIE	40 Marks
Credits	2

Prerequisite: Basic knowledge of English grammar and vocabulary.

COURSE OBJECTIVES: This course will introduce the students:

1. To the role and importance of communication while developing their basic communication skills in English.
2. To basics of writing coherent paragraphs and formal Emails.
3. To techniques of writing a précis and formal letters by using acceptable grammar and appropriate vocabulary.
4. To description, definition and classification of processes while enabling them to draft formal reports following a proper structure.
5. To gaining adequate reading comprehension techniques.

COURSE OUTCOMES: After successful completion of the course the students will be able to:

1. Illustrate the nature, process and types of communication and communicate effectively without barriers.
2. Construct and compose coherent paragraphs, emails and adhering to appropriate mobile etiquette.
3. Apply techniques of precision to write a précis and formal letters by using acceptable grammar and appropriate vocabulary.
4. Distinguish formal from informal reports and demonstrate advanced writing skills by drafting formal reports.
5. Critique passages by applying effective reading techniques.

CO-PO Articulation Matrix

PO/PSO CO	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
CO1	1	1	1	1	1	2	2	2	3	3	2	3	1	2
CO2	1	1	1	1	1	2	2	1	1	2	1	3	1	2
CO3	1	2	1	1		2	2	1	1	3	1	3	1	2
CO4	1	2	1	1		2	2	2	2	2	2	3	2	2
CO5	1	2	1	2	1	3	3	2	3	3	2	3	1	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Understanding Communication in English: Introduction, nature and importance of communication; Process of communication; Types of communication - verbal and non-verbal; Barriers to communication; Intrapersonal and interpersonal communication; Understanding Johari Window.

Vocabulary &Grammar: The concept of Word Formation; Use of appropriate prepositions and articles.

UNIT-II

Developing Writing Skills I: Paragraph writing. – Structure and features of a paragraph; Cohesion and coherence. Rearranging jumbled sentences. Email and Mobile etiquette.

Vocabulary & Grammar: Use of cohesive devices and correct punctuation.

UNIT-III

Developing Writing Skills II: Précis Writing; Techniques of writing precisely. Letter Writing – Structure, format of a formal letter; Letter of request and the response.

Vocabulary and Grammar: Subject-verb agreement.

Use of prefixes and suffixes to form derivatives. Avoiding redundancies.

UNIT-IV

Developing Writing Skills III: Report writing – Importance, structure, elements of style of formal reports; Writing a formal report.

Vocabulary and Grammar: Avoiding ambiguity - Misplaced modifiers. Use of synonyms and antonyms.

UNIT-V

Developing Reading Skills: The reading process, purpose, different kinds of texts; Reading comprehension; Techniques of comprehension – skimming, scanning, drawing inferences and conclusions.

Vocabulary and Grammar: Words often Confused; Use of standard abbreviations.

TEXT BOOKS:

1. "Language and Life: A Skills Approach", Board of Editors, 2018th Edition, Orient Black Swan, 2018.
2. Swan Michael, "Practical English Usage", OUP, 1995.

SUGGESTED READINGS:

1. Wood F.T, "Remedial English Grammar", Macmillan, 2007.
2. Zinsser William, "On Writing Well", Harper Resource Book, 2001.
3. Sanjay Kumar and Pushp Lata, "Communication Skills", Oxford University Press, 2011.

22PYC10

PHYSICS LAB
(BIOTECH & CHEMICAL)

Instruction	3P Hours per week
Duration of SEE	3Hours
SEE	50Marks
CIE	50Marks
Credits	1.5

COURSE OBJECTIVES: This course aims to
1. Apply theoretical physics knowledge in doing experiments
2. Understand the behaviour of the light experimentally
3. Analyze the physical properties of magnetic and dielectric materials
4. Familiarize with motion of electrons in electric and magnetic fields

COURSE OUTCOMES: At the end of the course, the student will be able to
1. Interpret the errors in the results of an experiment.
2. Demonstrate the wave nature of light experimentally
3. Utilize physical properties of magnetic and dielectric materials for various applications
4. Make use of lasers and optical fibers for engineering applications
5. Explain light induced phenomenon and motion of electrons in electric and magnetic fields

CO-PO Articulation Matrix

PO/PSO CO	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
CO1	3	2	2	3	1	2	2	3	3	2	1	2	2	1
CO2	3	2	1	2	2	2	2	2	2	1	1	3		2
CO3	3	2	3	2	3	2	2	2	3	2	1	2	2	3
CO4	3	3	2	2	2	2	2	3	2	1	1	3	2	3
CO5	3	1	2	3	2	1	1	2	2	2	1	2		3

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

1.	Error Analysis	:	Estimation of errors in the determination of time period of a torsional pendulum
2.	Fresnel's Biprism	:	Determination of wavelength of given monochromatic source
3.	Newton's Rings	:	Determination of wavelength of given monochromatic source
4.	Single Slit Diffraction	:	Determination of wavelength of given monochromatic source
5.	Diffraction Grating	:	Determination of wavelengths of two yellow lines of light of mercury lamp
6.	Malus's Law	:	Verification of Malus's law
7.	Double Refraction	:	Determination of refractive indices of O-ray and E-ray of given calcite crystal
8.	Polarimeter	:	Determination of specific rotation of glucose
9.	Laser	:	Determination of wavelength of given semiconductor laser
10.	Optical Fiber	:	Determination of numerical aperture and power losses of given optical fiber
11.	Dielectric constant	:	Determination of dielectric constant of given PZT sample

12.	M & H Values	:	Determination of magnetic moment M of a bar magnet and absolute value H of horizontal component of earth's magnetic field
13.	B-H curve	:	Determination of hysteresis loss of given specimen
14.	Planck's constant	:	Determination of Planck's constant using photo cell
15.	e/m of an Electron	:	Determination of specific charge of an electron by J.J. Thomson method

NOTE: A minimum of TWELVE experiments should be done.

22EGC02

ENGLISH LAB

Instruction	2 P Hours per Week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	50 Marks
Credits	1

Prerequisite: Basic Knowledge of English Communication.

COURSE OBJECTIVES: This course will introduce the students

1. To nuances of Phonetics and give them sufficient practice in correct pronunciation.
2. To word stress and intonation.
3. To IELTS and TOEFL material for honing their listening skills.
4. To activities enabling them overcome their inhibitions while speaking in English with the focus being on fluency rather than accuracy.
5. To team work, role behaviour while developing their ability to discuss in groups and making oral presentations.

COURSE OUTCOMES: After successful completion of the course the students will be able to:

1. Define the speech sounds in English and understand the nuances of pronunciation in English.
2. Apply stress correctly and speak with the proper tone, intonation and rhythm.
3. Analyze IELTS and TOEFL listening comprehension texts to enhance their listening skills.
4. Determine the context and speak appropriately in various situations.
5. Design and present effective posters while working in teams, and discuss and participate in Group discussions.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1									1	2	1	3		
CO2									2	2	1	3	1	1
CO3									2	1	1	2	1	1
CO4	1	1	1	1	1	1	1	1	3	3	1	3	1	1
CO5		1	1	1	1	1	1	1	3	3	2	3	1	2

1 - Slightly, 2 - Moderately, 3 - Substantially

Exercises

1. **Introduction to English Phonetics**: Introduction to auditory, acoustic and articulatory phonetics, organs of speech: the respiratory, articulatory and phonatory systems.
2. **Sound system of English**: Phonetic sounds and phonemic sounds, introduction to International Phonetic Alphabet, classification and description of English phonemic sounds, minimal pairs. The syllable: types of syllables, consonant clusters.
3. **Word stress**: Primary stress, secondary stress, functional stress, rules of word stress.
4. **Rhythm & Intonation**: Introduction to Rhythm and Intonation. Major patterns, intonation of English with the semantic implications.
5. **Listening skills** – Practice with IELTS and TOEFL material.

6. **Public speaking –** Speaking with confidence and clarity in different contexts on various issues.
7. **Group Discussions -** Dynamics of a group discussion, group discussion techniques, body language.
8. **Pictionary –** weaving an imaginative story around a given picture.
9. **Information Gap Activity –** Writing a brief report on a newspaper headline by building on the hints given.
10. **Poster presentation –** Theme, poster preparation, team work and e presentation.

SUGGESTED READING:

1. T Balasubramanian, "A Textbook of English Phonetics for Indian Students", Macmillan, 2008.
2. J Sethi et al., "A Practical Course in English Pronunciation (with CD)", Prentice Hall India, 2005.
3. Priyadarshi Patnaik, "Group Discussions and Interviews", Cambridge University Press Pvt. Ltd., 2011.
4. Aruna Koneru, "Professional Speaking Skills", Oxford University Press, 2016.

22MEC01

CAD AND DRAFTING

Instruction	1 T + 3 D Hours per week
Duration of SEE	3 hours
SEE	50Marks
CIE	50Marks
Credits	2.5

COURSE OBJECTIVES: This course aims to

1. To get exposure to a cad package and its utility.
2. Understanding orthographic projections.
3. To visualize different solids and their sections in orthographic projection
4. To prepare the student to communicate effectively by using isometric projection.
5. To prepare the student to use the techniques, skills, and modern tools necessary for practice.

COURSE OUTCOMES: At the end of the course, the Students are able to

1. Become conversant with appropriate use of CAD software for drafting.
2. Recognize BIS, ISO Standards and conventions in Engineering Drafting.
3. Construct the projections of points, lines, planes, solids
4. Analyse the internal details of solids through sectional views
5. Create an isometric projections and views

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	3	3	2	1	2	2	2	1	2	3	1	3	2	1
CO2	3	2	2	1	2	2	2	1	2	2	1	2	2	
CO3	3	3	2	1	2	2	2	1	2	2	1	2	1	
CO4	3	3	3	2	2	2	2	1	2	2	1	2	1	1
CO5	3	2	2	1	2	2	2	1	2	2	1	2	2	1

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXERCISES:

1. Introduction to CAD package: Settings, draw, modify tools, dimensioning and documentation
2. Construction of Conic Sections by General method
3. Orthographic projection: Principles, conventions, Projection of points
4. Projection of straight lines: Simple position, inclined to one plane
5. Projection of straight lines inclined to both the planes (without traces and mid-point)
6. Projection of planes: Perpendicular planes
7. Projection of planes: Oblique planes
8. Projection of solids: Simple position
9. Projection of solids: Inclined to one plane
10. Sections of solids: Prism, pyramid in simple position
11. Sections of solids: Cone and cylinder in simple position
12. Isometric projections and views
13. Conversion of isometric views to orthographic projections and vice-versa.

TEXT BOOKS:

1. N.D.Bhatt, “Elementary Engineering Drawing”, Charotar Publishers, 2012.
2. K.Venugopal, “Engineering Drawing and Graphics + AutoCAD”, New Age International Pvt.Ltd, 2011.
3. Basanth Agrawal and C M Agrawal, “Engineering Drawing”, 2/e, McGraw-Hill Education (India) Pvt. Ltd.

SUGGESTED READING:

1. Shaw M.B and Rana B.C., “Engineering Drawing”, 2/e, Pearson, 2009.
2. K.L. Narayana and P.K. Kannaiah, “Text Book of Engineering Drawing”, Scitech Publications, 2011.

22MEC38

DIGITAL FABRICATION LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES: This course aims to

1. Give a feel of Engineering Practices & develop holistic understanding of various Engineering materials and Manufacturing processes.
2. Develop skills of manufacturing, safety, precision, quality, intelligent effort, optimization, positive & team work attitude to get things right the first time.
3. Provide basic knowledge of Steel, Plastic, Composite and other materials for suitable applications.
4. Study of Principle and hands on practice on techniques of fabrication, welding, casting, manufacturing, metrology, and allied skills.
5. Advance important hard & pertinent soft skills, productivity, create skilled manpower which is cognizant of industrial workshop components and processes and can communicate their work in a technical, clear and effective way.

COURSE OUTCOMES: After completion of this course, student will be able to

1. Understand safety measures to be followed in workshop to avoid accidents.
2. Identify various tools used in carpentry, house wiring and plumbing.
3. Make a given model by using workshop trades like carpentry, plumbing, House wiring and 3d modeling using solid works software for Additive Manufacturing.
4. Perform pre-processing operations on STL files for 3D printing, also understand reverse engineering process.
5. Conceptualize and produce simple device/mechanism of their choice.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	1	1	1	1				1				1		
CO2	1		1									1		2
CO3	1		1			1						1	2	2
CO4	1		1			1						1	2	2
CO5	2	2	2	1	3	1		1	1	2		2	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXERCISES:

GROUP-1

1. To make a lap joint on the given wooden piece according to the given dimensions.
2. To make a dove tail-joint on the given wooden piece according to the given dimensions.
3. A.Wiring of one light point controlled by one single pole switch, a three pin socket controlled by a single pole switch
   B. Wiring of two light points connected in series and controlled by single pole switch. Verify the above circuit with different bulbs. Wiring of two light points connected in parallel from two single pole switches and a three pin socket
4. Stair case wiring-wiring of one light point controlled from two different places independently using two 2- way switches.

5. To make external threads for GI pipes using die and connect the GI pipes as per the given diagram using taps, couplings & bends.
6. A. To connect the GI pipes as per the given diagram using, couplings, unions, reducer & bends.
   B. To connect the GI pipes as per the given diagram using shower, tap & valves and Demonstrate by giving water connection

GROUP-2

1. To Study the method of Additive Manufacturing process using a 3D printer
2. To create a 3D CAD model of a door bracket using a modeling software
3. To print a door bracket using an extruder type 3D Printer.
4. To create a 3D CAD model by reverse Engineering
5. To Design an innovative component using the CAD software
6. To Print the selected innovative component by the students using a 3D printer

TEXT BOOKS:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., Elements of Workshop Technology, Vol. I, 2008 and Vol. II, Media promoters and publishers private limited, Mumbai, 2010.
2. Kalpakjian S. And Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
3. Sachidanand Jha, 3D PRINTING PROJECTS: 200 3D Practice Drawings For 3D Printing On Your 3D Printer, June 7, 2019.

SUGGESTED READING:

1. Gowri P. Hariharan and A. Suresh Babu, Manufacturing Technology – I, Pearson Education, 2008.
2. Oliver Bothmann , 3D Printers: A Beginner's Guide , January 1, 2015

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
(In line with AICTE Model Curriculum with effect from AY 2023-24)

B. TECH BIOTECHNOLOGY

SEMESTER-III

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours Per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
	THEORY								
1	22CSC35	Data Structures Using Python	2	-	-	3	40	60	2
2	22BTC03	Process Principles and Reaction Engineering	3	-	-	3	40	60	3
3	22BTC04	Biochemistry	3	-	-	3	40	60	3
4	22BTC05	Microbiology	3	-	-	3	40	60	3
5	22BTC06	Cell and Molecular Biology	3	-	-	3	40	60	3
6	22BTC07	Genetics	3	-	-	3	40	60	3
7	22CEM01	Environmental Science	2	-	-	2	-	50	Non-credit
	PRACTICALS								
8	22CSC36	Data Structures Using Python Lab	-	-	2	3	50	50	1
9	22BTC08	Biochemistry Lab	-	-	3	3	50	50	1.5
10	22BTC09	Microbiology Lab	-	-	3	3	50	50	1.5
11	22BTI01	MOOCs/Internship - I	3-4 weeks / 90hrs			-	-	50	2
Total			**19**	**0**	**8**	**29**	**390**	**610**	**23**
Clock hours per week: 26									

L: Lecture D: Drawing T: Tutorial P: Practical /Project Seminar/Dissertation
CIE - Continuous Internal Evaluation SEE - Semester End Examination

22CSC35

DATA STRUCTURES USING PYTHON
(Common to Biotech, Chemical, Civil and Mechanical Engineering)

Instruction	2 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

COURSE OBJECTIVES: This course aims to
1. Introduce object-orientation concepts in python.
2. Get familiarized with asymptomatic analysis of various functions and implement different sorting techniques.
3. Introduce the linear data structures and their implementation.
4. Introduce and implement non-liner data structures.
5. Get acquainted with various string functions and hash functions.

COURSE OUTCOMES: After completion of this course, student will be able to
1. Understand Classes, Objects, linear data structures, nonlinear data structures, time complexity.
2. Use python packages to work with datasets.
3. Implement sorting, searching algorithms and analyse their performance.
4. Build optimal solutions using linear and nonlinear data structures, hashing.
5. Apply pattern matching algorithms for real time problems.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2									1	1	
CO2	2	2	2									1	2	
CO3	2	1	1		1							1	2	
CO4	2	2	2									1	1	
CO5	2	2	2									1	2	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I
Overview of Python, Concept of Class, and objects;
NumPy: The Basics of NumPy Arrays, Aggregations;
Pandas: Pandas Objects, Data Indexing and Selection;
Visualisation: Simple Line Plots, Simple Scatter Plots, Histograms, Binnings, and Density

UNIT-II
Introduction: Data Structures, Abstract Data Types, Algorithm, Analysis of Algorithms, Running Time Analysis, Commonly Used Rates of Growth, Big O Notation, Omega Notation, Theta Notation, Guidelines for Asymptotic Analysis
Sorting: Introduction, Classification of Sorting Algorithms, Selection Sort, Merge Sort, Quick Sort, Radix sort, Comparison of Sorting Algorithms

UNIT-III
Linked Lists: Linked List ADT, Singly Linked Lists, Doubly Linked Lists, Circular Linked Lists;
Stacks: Stack ADT, Applications;

Queues: Queue ADT, Applications

UNIT-IV

Trees: Introduction, Binary Trees, Types of Binary Trees, Properties of Binary Trees, Binary Tree Traversals, Binary Search Trees (BSTs);

Graph: Introduction, Applications of Graphs, Graph Representation, Graph Traversals

UNIT-V

String Algorithms: Introduction, String Matching Algorithm, Brute Force Method, String Matching with Finite Automata, KMP, Tries

Hashing: Hash Table ADT, Components of Hashing, Hash Table, Hash Function, Load Factor, Collisions, Collision Resolution Techniques, Separate Chaining, Open Addressing, Comparison of Collision Resolution Techniques

TEXT BOOKS:

1. Narasimha Karumanchi,"Data Structures and Algorithmic Thinking With Python", Career Monk Publications, 2016
2. Tony Gaddis, “Starting out with Python”, 4th Edition, Global Edition, Pearson Education Limited, 2019
3. Jake Vander Plas, “Python Data Science Handbook”, OReilly, 2017

SUGGESTED READING:

1. Wes McKinney, “Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython”,2nd Ed, OReilly, 2018
2. Michael T.Goodrich, Roberto Tamassia, Michael H. Goldwasser, “Data Structure and Algorithms in Python”, Wiley, 2013.
3. Kenneth A. Lambert, "Fundamentals of Python: Data Structures”, CengageLearning, 2018.

ONLINE RESOURCES:

1. https://visualgo.net/en
2. https://jakevdp.github.io/PythonDataScienceHandbook/
3. https://www.coursera.org/specializations/data-structures-algorithms3.
4. https://nptel.ac.in/courses/106/106/106106182/
5. https://www.cs.usfca.edu/~galles/visualization/Algorithms
6. https://www.edx.org/course/algorithms-and-data-structures

22BTC03

PROCESS PRINCIPLES AND REACTION ENGINEERING

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. The course aims to impart knowledge of the basic chemical engineering principles and techniques used in analyzing a biochemical process.
2. The course aims to provide the students with an understanding of how to represent experimental data in graphical form.
3. This course also aims to enable the students to evaluate material balances in different units.
4. The course aims at enabling the students to learn calculations regarding enthalpy and heat of reactions
5. The course aims to impart knowledge of homogenous reactions and enhance skills to formulate and analyze different types of reaction kinetics used in biochemical engineering.

COURSE OUTCOMES: After completion of this course, student will be able to

1. Grasp the fundamentals of physical variables, dimensions, units, equations with dimensional homogeneity, and measurement conventions, fostering their ability to apply these principles in practical engineering scenarios.
2. Analyze and present experimental data using graphs, including understanding errors, significant figures, statistics, and logarithmic coordinate graphs, while following proper data plotting procedures.
3. Confidently compute material balances for biotech processes, applying principles to real cases along with recycle, by-pass, and purge streams.
4. Solve enthalpy-related challenges in non-reactive and reactive scenarios, and apply energy balance concepts to practical cases within biotechnology processes
5. To predict growth kinetics and analyze reaction kinetics for biological systems.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2		2	2	2			2			3	3
CO2	2	2	2		2	2	2			3			2	3
CO3	2	2	2		2	2	2			2			2	1
CO4	2	2	2		2	2	2			2			2	1
CO5	2	2	2		2	2	2			2			2	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Engineering calculations: Physical variables, Dimensions, and Units: Substantial and Natural variables, Equations with and without Dimensional Homogeneity, Units and conversions; SI and MKS system of Units; Measurement conventions, Density, Specific gravity, and Specific volume. Concentration units for pure components, Moles, Chemical composition, Temperature, Pressure, Standard conditions, and Ideal gases; Ideal gas law, Definition of Stoichiometry.

UNIT-II

Presentation and Analysis of Data: Presentation and Analysis of Data, Errors in Data and Calculations, Significant Figures, Types of Error, Statistical Analysis, Presentation of Experimental Data, Data Analysis, Graph Paper with Logarithmic Coordinates, General Procedures for Plotting Data.

UNIT-III

Material balances: Law of conservation of mass, Types of material balance problem, Simplification of the general mass balance equation, Procedure for material balance calculations, material balance worked examples; Continuous filtration, batch mixing, Continuous fermentation, Xanthum gum production. Material balances with recycle, By-pass, and Purge streams.

UNIT-IV

Energy Balances: Basic Energy concepts, General energy balance equations, Enthalpy calculation procedures, Enthalpy Change in Non-Reactive Processes, Procedure for Energy-Balance Calculations without reaction, Enthalpy Change Due to Reaction, Heat of Reaction for Processes with Biomass Production, Fermentation energy balance equation worked examples (Ethanol fermentation and Citric acid production.

UNIT-V

Homogenous reactions: Basic reaction theory, Reaction; thermodynamics, Yield, Rate, Kinetics, Effect of temperature on reaction rate. Calculation of Reaction rates from experimental data; Average rate –Equal Area method. Mid-point slope method. General reaction kinetics for biological systems; Zero order and first-order kinetics, Michaelis - Menten Kinetics. Cell Growth Kinetics; Batch growth, balanced growth, Effect of Substrate concentration. Growth kinetics with Plasmid Instability, Plasmid instability in batch culture.

TEXT BOOKS:

1. Pauline M. Doran, 2013, Bio-process Engineering Principles, 2nd Edition, Academic Press.
2. Hougen and Watson K M and Ragatz R A, 1959, Chemical Process Principles, 2nd Edition, Wiley.
3. Bhatt B I and S M Vora, Stoichiometry**,** 2006, 4th edition, Tata McGraw Hill.
4. Chemical Reaction Engineering, Octave Leven Spiel, 3rd Edition, Wiley.

SUGGESTED READINGS:

1. David M. Himmelblau, James B. Riggs, “Basic Principles and Calculations in Chemical Engineering”, 8/e, Prentice Hall, 2012.
2. James E Bailey, David F Ollis, “Biochemical Engineering Fundamentals: Solutions Manual” McGraw-Hill Education, 1979.
3. Harvey W Blanch, Douglas S Clark “Biochemical Engineering”, 1st Edition, 1997

22BTC04

BIOCHEMISTRY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. Students will learn the structure of carbohydrates, lipids, proteins, and nucleic acids
2. Students will learn the functions of carbohydrates, lipids, proteins, and nucleic acids
3. Students will learn the metabolism of different biomolecules.

COURSE OUTCOMES: After completion of this course, student will be able to

1. Identify different biomolecule structures and describe the functions of various biomolecules.
2. Examine the energy yield from the catabolism of carbohydrates and explain the steps in anabolism.
3. Evaluate the energy yield from lipids and reconstruct lipids.
4. Outline steps involved in catabolism and anabolism of proteins.
5. Summarize steps involved in catabolism and anabolism of nucleic acids.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2				2	2	2	2	2		2	2	2
CO2	2	2				2	2	2	2	2		2	2	2
CO3	2	2				2	2	2	2	2		2	2	2
CO4	2	2				2	2	2	2	2		2	2	2
CO5	2	2				2	2	2	2	2		2	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Biomolecules: Introduction to biological buffers and its importance in biochemistry, pH, water, Biomolecules: Carbohydrates classification; Classification and nomenclature of lipids; Amino acid Classification and its structure, peptide bond structure; Proteins classification and biological functions; Protein structure primary structure, secondary structure, super secondary structures, Ramachandran Plot, tertiary and quaternary structure; Enzymes properties.

UNIT-II

Metabolism of Carbohydrates: Carbohydrate Metabolism: Glycolysis Preparatory phase and Payoff phase, Substrate level Phosphorylation, regulation of glycolysis, HMP Shunt, Citric Acid Cycle, anaplerotic reactions, Electron Transport System and Oxidative Phosphorylation, Mitchell's chemiosmotic hypothesis; Gluconeogenesis; Glycogen metabolism Glycogenolysis and Glycogenesis.

UNIT-III

Metabolism of Lipids: Lipid Metabolism: β - Oxidation of saturated, unsaturated fatty acid; Cholesterol Metabolism; Metabolic Pathways Biosynthesis of Saturated and Unsaturated Fatty Acids, synthesis of Triglycerol; Metabolism of Phospholipids and Sphingolipids.

UNIT-IV

Metabolism of Proteins: Amino acids metabolism Biosynthesis of aromatic amino acids, Peptides; Metabolic fate of Amino group; Nitrogen Excretion and Urea Cycle; Catabolism of aromatic and branched-chain amino acids; Transamination, Oxidative Deamination, and Oxidative Decarboxylation.

UNIT-V

Metabolism of Nucleic Acids: Structure of nucleotides, nucleosides, and nitrogenous bases; chemical structure of DNA and RNA; Nucleic Acid Metabolism De nova synthesis of Purine and Pyrimidine, salvage pathway, Ribonucleotides, synthesis of Deoxyribonucleotides; Degradation of Purine and Pyrimidine Nucleotides.

TEXT BOOKS:

1. David Lee Nelson and Michael M. Cox, Lehninger, "Principles of Biochemistry", 6th Edition, W.H. Freeman, 2013
2. Eric E.Conn, Paul K. Stumpf, George Bruening, Roy H. Doi, "Outlines of Biochemistry", 5th Edition, John Wiley and Sons, 2006.

SUGGESTED READINGS:

1. Donald Voet and Judith G. Voet, "Biochemistry", 4th edition, John Wiley & Sons, New York, 2011.
2. Reginald Garrett and Charles Grisham, "Biochemistry", 5th edition, Cengage Learning, 2012.
3. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, "Biochemistry", 6th edition, W.H. Freeman and Company, 2010.

22BTC05

MICROBIOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to
1. Understand the historical perspectives of microbiology.
2. Describe the prokaryotic cell structure
3. Classification of different groups of microorganisms.
4. Concepts of culture media preparation sterilization techniques and microbial growth.
5. Describe the roles of microorganisms in human health.

COURSE OUTCOMES: After completion of this course, student will be able to
1. Relate the contribution of various scientists in the development of microbiology
2. Classify microorganisms based on their characteristics
3. Apply the concept of culturing microorganisms aseptically
4. Explain various ecological aspects of microorganisms like diversity, distribution, specific interactions, and the effect that they have on ecosystems
5. Illustrate the mechanisms for the propagation of infectious diseases caused by the microorganism

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2		1	2	2	2	3		2		3	3	3
CO2	2	2		1	2	2	2		2	2		3	3	3
CO3	3	2		2	2	2	2	1	2	2		3	3	3
CO4	3	2		2	2	2	2		2	2		3	3	3
CO5	2	2		2	2	2	2	1	2	2		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

History and Introduction to Microbiology: History and scope of microbiology, contributions of Antony van Leuwenhoek, Louis Pasteur, Robert Koch, Iwanowskii, Edward Jenner; prokaryotic cell structure – plasma membranes, cytoplasmic matrix – inclusion bodies, ribosome, bacterial chromosome and plasmids, cell wall, components external to cell wall – capsule, slime layer, pili, fimbriae, flagella, bacterial endospores, and their formation.

UNIT-II

Classification of Microbial World: General and colony characters of major groups of microorganisms - algae, fungi, protozoa, bacteria, and virus; Identification of microorganisms by major taxonomical characteristics (morphological, physiological, ecological, cultural, metabolic/biochemical, immunological, and genetic); Classification of microorganisms - Haeckel's three kingdom concept, Whittaker's five kingdom concept, Three domain concept of Carl Woes.

UNIT-III

Microbial Nutrition and Growth: Methods of culturing of microorganisms - culture media, (liquid, semi-solid and solid media, synthetic media, and complex media), Isolation of pure cultures (streak, spread, and pour plate methods); Concept of sterilization - methods and their application- physical methods (heat, filtration and radiation), chemical methods (phenolics, alcohols, halogens, heavy metals, dyes, quaternary

ammonium compounds, aldehydes, gaseous agents); Methods of preservation of microorganisms and their importance (Bacterial cultures); Microbial growth - growth curve, mathematical expression of growth, measurement of microbial growth (cell numbers and cell mass).

UNIT-IV

Microbial Ecology: Terrestrial Environment: Soil microflora, Aquatic Environment: Microflora of Freshwater & Marine habitats, Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity. Microbe–Microbe Interactions Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents, key nutrient cycles: Carbon, Nitrogen, and Sulphur. Overview of metagenomics.

UNIT-V

Microbiology and Human Health: Normal microbial flora, Pathogenic microbes and their diseases - typhoid, T.B, syphilis, AIDS, Influenza. Food poisoning (*Staphylococci, C. botulinum*) Food intoxication. Dynamics of infectious disease (Endemics, Epidemics, and Pandemics) and related case studies.

TEXT BOOKS:

1. Gerard Tortora, Berdell Funke, Christine Case, Derek Weber, Warner Bair Pearson, Microbiology: An Introduction; 13th edition (January 8, 2018)
2. Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark, Brock Biology of Microorganisms, Publisher: Benjamin-Cummings Pub Co; 13th edition (17 December 2010)

SUGGESTED READINGS:

1. Powar C.B. and Daginawala H.F., "General Microbiology – Vol I & II", 2nd edition, Himalaya publishing house, 2005.
2. ArtiKapil, Ananthanarayan and Paniker"s "Text book of Microbiology", 9th edition, Orient Blackswan, 2013.
3. Roger Y Stanier, "General Microbiology", 5th edition, Palgrave Macmillan Limited, 1999.

22BTC06

CELL AND MOLECULAR BIOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. The student is made to understand the basics of cell biology i.e., the concept of cellular organelles and their functions.
2. Students are taught the structure of the cytoskeleton, and how it maintains the cell structure integrity.
3. The student is made to understand the basics of molecular biology and the central dogma of the genetic material

COURSE OUTCOMES: After completion of this course, student will be able to

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

1. Recognize the structure and functions of cell organelles.
2. Interpret the knowledge of the transport of metabolites and cell cycle checkpoints in their experimental work.
3. Distinguish the organization and Replication of DNA, damages, and repairs.
4. Identify the structure and function of transcripts and the mechanism of transcription by RNA polymerases.
5. Illustrate the mechanism of translation and post-translation mechanism.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2			2	2	2	3	3	3		3	3	3
CO2	2	2			2	2	2		2	3		3	3	3
CO3	2	2			2	2	2	1	2	3		3	3	3
CO4	2	2			2				2	3		3	3	3
CO5	2	2			2			1	3	3		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Cell Structure, Organelles, and their Functions: Cell structure and organization in bacteria, plants, and animal cells; structure and functions of the cell wall, lysosomes, ribosomes, Golgi complex, peroxisomes, glyoxysomes, mitochondria, plastids, endoplasmic reticulum, vacuoles, centrioles; cytoskeleton - composition, structure, and functions of microtubules, microfilaments and intermediate filaments; nucleus, its ultra-structure, (nuclear envelope, nucleoplasm, chromatin fibers).

UNIT-II

Membrane Transport and Cell Cycle: Prokaryotic and Eukaryotic -Bio membrane – lipid composition and structural organization, protein components and basic function, transport across the membrane – passive diffusion, facilitated diffusion, osmosis, active transport (Na+ /K+ Pump), cotransport; uniport, antiport, symport. Cell cycle: Different phases of cell cycle; checkpoints of cell cycle; Regulation of cell cycle - cyclins and cyclin-dependent kinases, cell-cell junctions, and Apoptosis.

UNIT-III

Organization, Replication, Damage and Repair of DNA: Structure of DNA–Watson and Crick's model; the role of histone and non-histone proteins in the structural organization of chromosomes; telomere and its importance; DNA Replication: Experimental evidence, enzymology of replication, complex replication apparatus; unidirectional, bi-directional and rolling circle replication; DNA damage and repair: Types of DNA damages- deamination, alkylation, pyrimidine dimers; DNA Repair mechanisms- photo reactivation, Excision repair & mismatch repair.

UNIT-IV

Mechanism of Transcription: Structure of promoters- RNA polymerases of the prokaryotic and eukaryotic organism; transcription- initiation, elongation, and termination; post-transcriptional processes of eukaryotic RNA: structure and functions of RNA - (rRNA, mRNA, tRNA, snRNA), prokaryotic and eukaryotic transcription. Processing of tRNA, rRNA, mRNA splicing; the concept of ribozyme, inhibitors of transcription.

UNIT-V

Mechanism of Translation: Ribosome- structural features; features of genetic code, wobble hypothesis; protein synthesis: translation in prokaryotes and eukaryotes- initiation of translation, elongation of a polypeptide chain, termination of translation; Post translation modification, Gene regulation by enhancers and silencers, inhibitors of protein synthesis.

TEXT BOOKS:

1. Geoffrey M. Cooper and Robert Hausman, "The cell: A molecular approach", 6th edition, Sinauer Associates, 2013.
2. Gerald Karp, "Cell and Molecular Biology": concepts and experiments, 6th edition, John Wiley & Sons, 2009.
3. David Freifelder, "Molecular Biology," 2nd edition, Narosa Publication, 2007.

SUGGESTED READINGS:

1. Rastogi S.C., "Cell and Molecular Biology", 2nd edition, New Age International, 2006.
2. Benjamin Lewin, Jocelyn Krebs, Elliott Goldstein, Stephen T. Kilpatrick, "Lewin's Genes XI," Jones and Bartlett Publishers, 2014.

22BTC07

GENETICS

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. To enable students to understand the basic concepts of genetics and inheritance of characteristics.
2. To impart knowledge of the structure of chromosomes, aberrations, mutations, and their causes.
3. To enlighten about consequences of linkage, crossing over, sex determination, and sex liked disorders.
4. To provide an insight into maternal inheritance and quantitative genetics.

COURSE OUTCOMES: After completion of this course, student will be able to

1. Estimate the laws of inheritance and gene interactions.
2. Illustrate the types of chromosomes, structure, aberrations, and mutations.
3. Predict and map the organization of genes due to the linkage and crossing-over mechanism.
4. Categorize sex determination, the chromosomal basis of genetic disorders, and sex-linked genes.
5. Illustrate maternal inheritance genotypic frequencies in a population and categorical data analysis.

CO-PO Articulation Matrix

PO/PSO CO	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
CO1	2	2	2			2	2					3	2	1
CO2	2	2	1	1	2	3	3					1	2	2
CO3	3	3	1			2	2	2	1	2		2	2	2
CO4	2	2	1	1	1	3	3	2		1		1	2	2
CO5	3	3	2	1	2	3	3	2		1		2	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Physical Basis of Heredity: Definitions; Genotype, phenotype, Heredity, Variations, Gene and Alleles, Back cross, Test cross; Mendel's laws of inheritance – segregation, independent assortment, modification of Mendelian principles: Dominance and recessive genes, co-dominance, incomplete dominance, Gene and Alleles, multiple alleles; coat color in rabbits and Blood groups. Gene interactions, epistatic interactions, pleiotropism. Lethal alleles, Penetrance (complete & incomplete), Expressivity, Pleiotropy, and Phenocopy.

UNIT-II

Chromosome Structure and Aberrations: Prokaryotic and eukaryotic genome; chromosomal aberrations-structural aberrations (deletions, duplication, inversion, and translocation), numerical aberrations (aneuploidy, euploidy, auto polyploidy, and allopolyploidy). Mutations – spontaneous, induced; physical and chemical mutagens; lethal mutation (characteristics and types), AMES test, applications of mutations.

UNIT-III

Linkage and Crossing Over: Concept of linkage and crossing over, the cytological basis of crossing over (in Drosophila and Maize), factors affecting recombination frequency, linkage maps; mechanism of recombination – model involving single-strand breaks and double-strand break in DNA duplex, the significance of Crossing over. Two-point and three-point test cross. Interference.

UNIT-IV

Sex Determination, Sex-Linked and Genetic Disorders: Sex chromosomes, sex determination mechanism Chromosomal: XX-XY, XX-XO, ZZ-ZW; Genic balance theory, Environmental, Hormonal and molecular basis. Y chromosome in Melandrium. Gynandromorphs. Dosage compensation: Maryleon's hypothesis; Inheritance of X-linked genes, sex-influenced traits in human beings. Garrod's inborn errors of metabolism.

UNIT-V

Extra Chromosomal Inheritance and Quantitative Genetics: Extra chromosomal inheritance – the inheritance of mitochondrial and chloroplast genes, maternal inheritance (CMS, *Mirabilis jalapa*). Transgressive segregation, quantitative characters, Gene frequency, gene pool, Hardy- Weinberg Law, equilibrium, Fitness and selection Goodness of fit Chi-square-test.

TEXT BOOKS:

1. Gardner, E. J., Simmons, M. J., Snustad, D. P. and Snustad, "Principles of Genetics", 8th edition, John Wiley and Sons, Inc. 2008.
2. Singh, B.D. "Genetics - 3rd edition", Kalyani Publications, 2004.
3. Snustad, D. Peter, Simmons Michael, "Principles of Genetics" 6th edition, John Wiley& Sons publication, 2011.

SUGGESTED READINGS:

1. Verma PS, Agrawal VK, "Cell Biology, Genetics, Molecular Biology, Evolution, and Ecology". 9th edition, S. Chand & Company Ltd., New Delhi, 2014.
2. Gupta PK, "Genetics", 5th Rev Edition (2nd Reprint), Rastogi Publications, 2018.

22CEM01

ENVIRONMENTAL SCIENCE
(MANDATORY COURSE)

Instruction	2 L Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	0

COURSE OBJECTIVES: This course aims to

1. To equip the students with inputs on the environment, natural resources and their conservation.
2. To study the interrelationship between the living organisms and the natural environment and also to enable the students to understand the structure and functioning of the ecosystems. To understand the importance of biodiversity and create awareness on its threats and conservation strategies.
3. To enable the students become aware of pollution of various environmental segments including their causes, effects, and control measures. To create awareness about environmental legislations in the context of national conventions.

COURSE OUTCOMES: After completion of this course, student will be able to

1. Identify the natural resources and realise the importance of water, food, forest, mineral, energy, land resources and effects of over utilisation.
2. Understand the concept of ecosystems and realise the importance of interlinking of food chains.
3. Contribute for the conservation of bio-diversity.
4. Suggest suitable remedial measure for the problems of environmental pollution and contribute for the framing of legislation for protection of environment.
5. Follow the environmental ethics and contribute to the mitigation and management of environmental disasters.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	3	1				2	2	2				1		
CO2	3	1				1	1	1				1	1	
CO3	3	1				2	2	2				1	1	
CO4	3	1				2	2	2	2			1		
CO5	3	1				2	2	3				1		

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Environmental Studies: Definition, Scope and importance, need for public awareness.

Natural resources: Use and over utilization of Natural Resources - Water resources, Food resources, Forest resources, Mineral resources, Energy resources, Land resources.

UNIT-II

Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, role of producers, consumers and decomposers, energy flow in an ecosystem, food chains, food webs, ecological pyramids, Nutrient cycling, Bio-geo chemical cycles, Terrestrial and Aquatic ecosystems.

UNIT-III

Biodiversity: Genetic, species and ecosystem biodiversity, Bio-geographical classification of India, India as a Mega diversity nation. Values of biodiversity, hot-spots of biodiversity, threats to biodiversity, endangered and endemic species of India, methods of conservation of biodiversity.

UNIT-IV

Environmental Pollution: Cause, effects and control measures of air pollution, water pollution, marine pollution, soil pollution, noise pollution and Solid waste management, nuclear hazards

Environmental Legislations: Environment protection Act, Air, Water, Forest & Wild life Acts, issues involved in enforcement of environmental legislation, responsibilities of state and central pollution control boards

UNIT-V

Social issues and the environment: Water conservation methods: Rain water harvesting and watershed management, Environmental ethics, Sustainable development and Climate change: Global warming, Ozone layer depletion, forest fires, and Contemporary issues.

TEXT BOOKS:

1. Y. Anjaneyulu, "Introduction to Environmental Science", B S Publications, 2004.
2. Suresh K. Dhameja, "Environmental Studies", S. K. Kataria& Sons, 2009.

SUGGESTED READING:

1. C. S. Rao," Environmental Pollution Control Engineering", Wiley, 1991.
2. S. S. Dara, "A Text Book of Environmental Chemistry &Pollution Control", S. Chand Limited, 2006.

22CSC36

DATA STRUCTURES USING PYTHON LAB

Instruction	2 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course aims to

1. To introduce data structures in python.
2. To familize with visualization techniques and tools in python.
3. To implement ADT for linear and nonlinear structures.
4. To analyze the performance of sorting and searching techniques.
5. To gain knowledge on applying data structures in real world problems.

COURSE OUTCOMES: After completion of this course, student will be able to

1. Demonstrate Classes, Objects, linear data structures, nonlinear data structures.
2. Store, retrieve and visualize datasets using Python built-in packages.
3. Evaluate the performance of sorting and searching techniques.
4. Build optimal solutions using linear data structures, nonlinear data structures and hashing.
5. Apply pattern matching algorithms for real time problems.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2		1							1	1	
CO2	2	2	2		1							1	2	
CO3	2	2	2		1							1	2	
CO4	2	2	2		1							1	2	
CO5	2	2	2		1							1	2	

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

1. Demonstration of class and objects.
2. Read a dataset, describe, visualize and provide inference.
3. Implement the Sorting algorithms: Selection Sort, Merge Sort, QuickSort, RadixSort.
4. Implementation of Search: Linear Search, Binary Search
5. Define Singl eLinked List ADT: Insertions, Deletions, Display, Detection of Loops,
6. Define Doubly Linked List ADT and perform all standard operations.
7. Define Stack and Queue ADTs and implement standard operations
8. Applications of Stacks and Queues.
9. Implementation of Binary Search Tree: Insertion, Deletion, Traversal
10. Implementation of Graph traversal techniques.
11. Implementation of Hashing.

TEXTBOOK:

1. Narasimha Karumanchi,"Data Structures and Algorithmic Thinking With Python",Career Monk Publications, 2016
2. Jake Vander Plas, Python Data Science Handbook, OReilly, 2017

SUGGESTED READING:

1. Michael T. Goodrich, Roberto Tamassia,Michael H. Goldwasser,“Data Structure and Algorithms in Python”, Wiley, 2013.
2. Kenneth A. Lambert, "Fundamentals of Python: Data Structures", Cengage Learning, 2018.
3. Narasimha Karumanchi, “Data Structures and Algorithms for GATE”, Career Monk Publications,2011
4. Wes McKinney, “Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython”, 2nd Ed, OReilly, 2018

WEB RESOURCES:

1. https://www.geeksforgeeks.org/data-structures/
2. https://www.coursera.org/specializations/data-structures-algorithms
3. https://nptel.ac.in/courses/106/106/106106182/
4. https://www.cs.usfca.edu/~galles/visualization/Algorithms

22BTC08

BIOCHEMISTRY LAB

Instruction	3 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES: This course aims to

1. Students will learn laboratory safety and standard operating procedures.
2. Students will learn how to estimate and analyze different biomolecules.

COURSE OUTCOMES: After completion of this course, student will be able to

1. Apply the laboratory safety and standard operating procedures and prepare the solutions and biological buffers.(Exp - 1,2,3,4)
2. Estimate and analyze carbohydrates by different methods.(Exp 5 & 6)
3. Estimate and analyze amino acids and proteins by different methods.(Exp 7, 8 & 9)
4. Estimate and analyze lipids and compare the acid value, Saponification value, and iodine valve of various lipids.(Exp 10 & 11)
5. Estimate and analyze nucleic acids.(Exp 12 & 13)

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	3		3	2	2	2	3	3	3		3	3	3
CO2	2	2		2	2	2	2	3	3	3		3	3	3
CO3	2	2		2	2	2	2	3	3	3		3	3	3
CO4	2	2		2		3	3	3	3	3		3	3	3
CO5	2	2		2	2	2	2	3	3	3		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

1. Introduction to Biochemistry Lab: Units, Volume / Weight measurements, concentration units.
2. Preparation of Solutions – percentage solutions, molar solutions, normal solutions, and dilution of stock solution.
3. Measurement of pH.
4. Preparation of buffers and reagents.
5. Estimation of Carbohydrates by Anthrone method.
6. Estimation of sugars from the given sample by DNS method. (Structured enquiry)
7. Estimation of Amino acids by Ninhydrin method.
8. Estimation of Proteins by Biuret method.
9. Estimation of Proteins by Lowry method.
10. Determination of Acid value, Saponification value, and Iodine Number of Fat.
11. Estimation of Cholesterol by Liebermann Burchard method.
12. Estimation of DNA by Diphenylamine method.
13. Estimation of RNA by Orcinol method. (Open-ended)

SUGGESTED READING:

1. David, T. Plummer, “An introduction to Practical Biochemistry”, 3rd edition, Tata McGraw Hill, 1988.
2. Beedu Shashidhar Rao, Vijay Deshpande, “Experimental Biochemistry – A student companion”, Anshan Pub, 2006.

22BTC09

MICROBIOLOGY LAB

Instruction	3 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES: This course aims to
1. Handle and focusing of Bright Field microscope
2. Perform physical and chemical sterilization methods for control of microorganisms
3. Prepare microbial culture media
4. Isolate pure cultures using various techniques
5. Perform different staining techniques.

COURSE OUTCOMES: After completion of this course, student will be able to
1. Examine the microbial cell structures using of Bright Field microscope (Exp. 1, 2)
2. Demonstrate sterilization of equipment and various types of media (Exp. 3)
3. Prepare the basic culture media for the growth of microorganisms (Exp. 4, 5, 6, 8)
4. Demonstrate the isolation of pure microbial culture from soil and water (Exp. 11,12)
5. Predict the nomenclature of microorganisms based on their metabolic activity (Exp. 7, 9, 10)

CO-PO Articulation Matrix

PO/PSO CO	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
CO1	2	2		2	2	2	2		3	2		3	2	2
CO2				2	2	2	2		3	2		3	3	3
CO3	2			2	2	2	2		3	2		3	3	3
CO4		2		2		2	2		3	2		3	3	3
CO5		2		2	2	2	2		3	2		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:
1. Calibration of Microscope and Measurement of Microorganisms-Micrometer.
2. Staining and Identification of Microorganisms: Simple and Differential Staining Techniques.
3. Sterilization techniques (Autoclaving, Hot Air Oven, Radiation, and filtration).
4. Preparation of culture media (a) broth type of media (b) Agar.
5. Culturing of microorganism (a) broth (b) pure culture techniques- Streak plate, Pour plate.
6. Antibiotic tests- Disc diffusion method, minimum inhibitory concentration.
7. Biochemical tests- IMIVC test, Catalase, Coagulase test, Gelatinase test, Oxidase.
8. Factors affecting bacterial growth and study of the growth curve.
9. Measurement of Microbial Growth by Turbidometry and enumeration of bacterial numbers by serial dilution.
10. Measurement of Microbial Growth by viable count.
11. Production of Beer and Wine (open-ended)
12. Coliform test (Structured enquiry)

SUGGESTED READINGS:

1. Microbiology: Laboratory Theory and Application 4th Edition Michael J. Leboffe, Burton E. Pierce Morton Publishing Company; 4th edition (January 1, 2015)
2. Gopal Reddy M, M.N. Reddy, D.V.R. SaiGopal and K.V. Mallaiah, "Laboratory Experiments in Microbiology",3rd edition, Himalaya Publishing House Pvt Ltd,2008,
3. Gunasekaran P., "Laboratory manual in Microbiology", 3rdedition, New Age International Publ., New Delhi, 2007.

22BTI01

MOOCS/INTERNSHIP – I

Instructions	3-4 Weeks
CIE	50 Marks
Credit	2

COURSE OBJECTIVES: This course aims to

1. Familiarize students in biotechnology and allied fields with industrial environments and state-of-the-art technologies.
2. Provide avenues for learning and skill development tailored to real-world technical and managerial requirements within the biotechnology sector.
3. Expose students to current technological breakthroughs relevant to biotechnology and its allied domains.
4. Cultivate an understanding of engineers' ethical responsibilities within the context of biotechnology, and facilitate interaction with industry and societal stakeholders to grasp the practical implications of their work.

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

1. Acquire foundational knowledge in a chosen, specialized area of modern biotechnology-(Assessed via mentor feedback/viva for interns, or the final exam score for MOOC students.)
2. Demonstrate initiative and professional responsibility in completing a designated work-based or self-directed learning assignment-(Assessed via mentor feedback on work ethic for interns, or the successful, timely completion of the MOOC for others.)
3. Analyze the relationship between theoretical principles and their real-world applications in the selected biotechnology domain-(Assessed via the "Evaluation of Industry"/report for interns, or exam questions that test application for MOOC students.)
4. Synthesize diverse information to form a coherent understanding of the subject matter-(Assessed via the report/presentation for interns, or overall exam performance for MOOC students.)
5. Articulate the knowledge and insights gained through a formal, structured evaluation method-(Assessed via the final report/presentation/viva for interns, or the official certificate and score for MOOC students.)

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2		2		1	2	2	2	2	3	2	3	3	3
CO2	2		2	2	3	2	2		3	3	2	3	3	3
CO3	2	2	2	2	2	2	2		2	3	2	3	3	3
CO4	2	2		1	2	2	2	3	3	2		3	3	3
CO5	2	2	2	2		2	2		3	3	2	3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

PROCESS TO BE FOLLOWED FOR CARRYING OUT INSTRUCTIONS TO STUDENTS:

1. Students may apply for internships through the AICTE Portal or through the CDC of the institute by filling out the application form IAP-101.
2. The industry shall scrutinize the students based on their criteria and communicate a provisional offer or confirmation letter to the student.
3. If students apply through the CDC, then the CDC shall nominate the students for various opportunities accordingly by issuing NOC (IAP-104).

4. The respective head of the department shall assign a faculty mentor.
5. Student shall undergo internship/industrial training at the concerned Industry/Organization by submitting the form, IAP-103.
6. During the internship, the Faculty Mentor will evaluate the performance of students twice either by visiting the Industry/Organization or through obtaining periodic reports from students.
7. Students shall submit an internship report to the industry/organization at the end of the internship program.
8. On successful completion of the Internship, Industry/Organization shall issue an Internship Certificate to the students
9. All the students should maintain discipline, professional ethics and follow the health and safety precautions during the internship
10. Students should get approval for MOOCS and Training Programs and the same evaluation process will be followed

INTERNSHIP GUIDELINES:

a) Student's Diary/Daily Log: The students should record the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. Students shall be ready to show the diary to the industry supervisor or the Faculty Mentor at any point of time. Failing to produce the same, the Intern may be debarred for the remaining period of his/her internship. A daily diary needs to be submitted to the Faculty Mentor at the end of the Internship along with the attendance record and an evaluation sheet duly signed and stamped by the industry. Daily diary is evaluated based on the following criteria:

- Regularity in maintenance of the diary/log
- Adequacy & quality of information recorded
- Drawing, sketches, and data recorded.
- Thought process and recording techniques used
- Organization of the information

b) Internship Report: At the end of the internship, each student should prepare a comprehensive report to indicate what he/she observed and learned in the training/internship period. It should be signed by the internship supervisor. The report will be evaluated by the Industry Supervisor on the basis of the following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

EVALUATION OF INTERNSHIP:

The industrial training/internship of the students will be evaluated in three stages:

a) Evaluation by the Industry (10 marks) (in the range of 1 to 10 where 1-Unsatisfactory; 10-Excellent)
b) Evaluation by faculty supervisor on the basis of site visit(s) or periodic communication (15 marks)
c) Evaluation through seminar presentation/Viva-Voce at the Institute (This can be reflected through marks assigned by Faculty Mentor (25 marks))

Evaluation through Seminar Presentation/Viva-Voce at the Institute: Students will give a seminar based on his/her training report before an Expert Committee constituted by the concerned department as per the norms of the institute. The evaluation will be based on the following criteria:

- Quality of content presented
- Proper planning for presentation
- Effectiveness of presentation
- Depth of knowledge and skills
- Attendance record, daily diary, and departmental reports shall be analyzed along with the internship Report

Monitoring/ Surprise Visits: During the internship program, the faculty mentor makes a surprise visit to the internship site, to check the student's presence physically. If the student is found to be absent without prior intimation to the concerned industry, entire training/internship may be canceled. Students should inform through email to the faculty mentor as well as the industry supervisor at least one day prior to avail leave.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
(In line with AICTE Model Curriculum with effect from AY 2023-24)

B. TECH BIOTECHNOLOGY

SEMESTER-IV

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours Per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
	THEORY								
1	22MTC11	Engineering Mathematics for Biotechnologists	3	1	-	3	40	60	4
2	22BTC10	Fermentation Technology	3	-	-	3	40	60	3
3	22BTC11	Immunology and Immunotechnology	3	-	-	3	40	60	3
4	22BTC12	Instrumental Methods in Biotechnology	3	-	-	3	40	60	3
5	22BTC13	Thermodynamics for Biotechnologists	3	-	-	3	40	60	3
6	22BTC14	Introduction to Anatomy and Physiology of Humans	3	-	-	3	40	60	3
7	22EGM01	Indian Constitution and Fundamental Principles	2	-	-	2	-	50	Non-credit
	PRACTICALS								
8	22BTC15	Fermentation Technology Lab	-	-	2	3	50	50	1
9	22BTC16	Immunology Lab	-	-	2	3	50	50	1
10	22BTC17	Instrumentation Lab	-	-	2	3	50	50	1
11	22BTU01	Upskilling Certification Course - I					25	-	0.5
Total			**20**	**1**	**6**	**26**	**415**	**560**	**22.5**
Clock hours per week: 27									

L: Lecture D: Drawing T: Tutorial P: Practical /Project Seminar/Dissertation
CIE - Continuous Internal Evaluation SEE - Semester End Examination

22MTC11

ENGINEERING MATHEMATICS FOR BIO-TECHNOLOGISTS
(**For Bio-Technology**)

Instruction	3 L+1T Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

COURSE OBJECTIVES:

1. To discusses solution of higher order differential equations.
2. To form PDE and solve Linear and Non-Linear equations.
3. To discuss differentiability of complex functions.
4. To evaluate Complex integrals.
5. To learn Numerical solution algebraic and transcendental equations.

COURSE OUTCOMES:

1. Describe the importance of media and other rheological parameters during the fermentation process (Expt. 1, 4, & 5).
2. Analyze the difference between batch and fed-batch processes (Expt. 2, & 3).
3. Demonstrate the preparation of media and its optimization using the statistical techniques (Expt. 9).
4. Estimate the growth kinetics of microorganisms (Expt. 6, 7, & 8).
5. Determine the volumetric mass transfer coefficient in fermentation (Expt. 11).
6. Perform fermentation for the production of a metabolite (Expt. 10).

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	3	2	1	1									1	
CO2	3	2	1	1									1	
CO3	2	2	1	1									1	
CO4	2	2	1	1									1	
CO5	3	3	1	1									1	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Differential Equations of Higher Order: Higher order linear differential equations with constants coefficients, Method to find complementary functions, Particular Integral when $x = e^{ax}, Sin\ ax, Cos\ ax,\ e^{ax}v(x),\ x^m\ v(x)$, Solutions of Cauchy-Euler differential equations, Method of Variation of Parameters.

UNIT-II

Partial Differential Equations: Formation of Partial Differential Equations, Linear Equations of First Order (Lagrange's Linear Equations), Solution of First Order Non-linear Partial Differential Equations (Standard forms) and Charpit's method. Solutions by method of separation of variables, Solution of one dimensional wave equation and its applications.

Unit-III

Complex Differentiation: Limit, Continuity and Derivative of complex function, Cauchy- Riemann equations in Cartesian coordinates (without proof), Analytic functions, Harmonic functions, Conjugate Harmonic functions Construction of Analytic function by Milne -Thompson method

UNIT-IV

Complex Integration: Complex line integral, Cauchy's theorem, Cauchy's integral formula (without Proof), Series of Complex Terms: Taylor's series, Laurent's series, Singularities of analytic functions : Isolated Singularity, Removable singularity Pole, Essential singularity Residues, Residues theorem. (without proof)

UNIT-V

Numerical Methods: Solution of Algebraic and Transcendental equations: Bisection method, Regular Falsi method and Newton - Raphson Method, Numerical solutions of first order Ordinary differential equations: Euler's method and Runge-kutta method of 4^{th}order.

TEXT BOOKS :

1. B.S.Grewal, "Higher Engineering Mathematics", 43^{rd} Edition, Khanna Publishers, 2015.
2. R.K JAIN and S.R.K IYENGER, "Advance engineering mathematics", 3^{rd} edition, Narosa publications, 2007.
3. Narayan Shanti and Mittal P.K. ,"Differential Calculus", 30^{th} edition, S Chand publishers, 2005.

SUGGESTED READING:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10^{th} edition, Wiley publishers, 2015.
2. "Introductory Methods of Numerical Analysis" Fifth edition, PHI learning PVT Ltd, 2012.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/111107098 (Unit-1 to Unit-5)
2. https://nptel.ac.in/courses/111107119 (Unit-1,2 &4)
3. https://nptel.ac.in/courses/111107105 (Unit -2 and Unit-8)

22BTC10

FERMENTATION TECHNOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. The course aims at providing knowledge to students on the scope and chronological development of fermentation technology.
2. To understand the types of the fermentation process and design of fermentation.
3. To learn about the ancillaries of the fermenter and their applications.
4. To gain in-depth knowledge about the working principles and operation of fermenters.

COURSE OUTCOMES: After completion of this course, student will be able to

1. Gain knowledge on diverse fermentation processes, the historical development of the industry, industrial applications, and emerging trends
2. Understand about controlling process parameters, media formulation in bioprocesses, and solid-state processes.
3. Determine the volumetric mass transfer coefficient and factors affecting the same in aerobic fermentation
4. Apply the knowledge of scale-up and scale-down techniques in fermenters and determine cell growth and sterilization kinetics
5. Apply the knowledge of different bioreactors like airlift, fed-batch, batch, and continuous in bioreactors while evaluating their performances in bioprocesses industries.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2			2	2			2		2	3	3
CO2	3	2	2		2	2	2		2	2		2	3	3
CO3	2	2	2		1	2	2			2		3	3	3
CO4	3	3	2									2	3	3
CO5	2	1	2		1	2	2		2	2		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Fermentation Processes: The range of fermentation processes; the chronological development of the fermentation industry; Industrial applications; Future trends in fermentations; Aseptic transfer of spore suspension with reference to *Penicillium chrysogenum*; Transfer of inoculums from seed tank to Fermenter.

UNIT-II

Basic Design of the Fermenter and Media: General requirements of fermentation processes, Basic design, and construction of fermenter and ancillaries, Typical media, Media formulation, energy resources, carbon and nitrogen components Solid- substrate, slurry fermentation, and its applications, Placket Burman design.

UNIT-III

Aeration and Agitation in Fermentations: Basic Mass transfer concepts; Oxygen transfer from gas bubble to cells; Oxygen transfer in fermentations; Bubble aeration and Mechanical agitation; Correlations for mass

transfer coefficients; Gas Hold up; Determination of oxygen transfer rates, KLa values; Other Factors affecting the values of mass transfer coefficients in fermentation vessels.

UNIT-IV

Selection, Scale-up, Operation and Control of Fermenters: Introduction, Scale up and its difficulties: Some considerations on aeration, agitation, and heat transfer, scale up and scale down. Bioreactor control and Instrumentation: Instrumentation for measurements and control of the parameters in active fermentation viz. pH, Temperature, DO, Foam and. Pressure

UNIT-V

Bioreactors/Fermentors: Batch, Fed-batch, and Continuous Fermentation systems; Dual and multiple fermentations; Comparison between batch and continuous fermentations; Steady state, unsteady state continuous fermentation theories; Examples of continuous fermentation; Practical problems with continuous operations. Monitoring and Control of fermentations, the behavior of microbes in different reactors viz. airlift, fluidized, batch, packed bed, Bubble column, trickle bed reactors.

TEXT BOOKS:

1. Pauline M. Doran, "Bioprocess Engineering Principles", Academic Press, 1995
2. Stanbury PF, Whitaker A, and Hall S J, "Principles of Fermentation Technology" 2nd edition, Elsevier, 2013.
3. Shuler M and Kargi F, Bioprocess Engineering, Prentice Hall of India Pvt. Ltd., New Delhi, 2002

SUGGESTED READINGS:

1. Bailey JE and Ollis DF, "Biochemical Engineering Fundamentals", 2 edition, McGraw-Hill, 1986
2. Harvey W. Blanch, Douglas S. Clark, "Biochemical Engineering" 1 edition, CRC, 1997.

22BTC11

IMMUNOLOGY AND IMMUNOTECHNOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. Students learn about the basic components and responses of the Immune system.
2. Knowledge of the structure of antigens and antibodies and the processing of antigens.
3. Students understand the significance of the complement system and hypersensitivity
4. The immunological basics for diseases are taught to the students.
5. Importance of antigen and antibody interactions.

COURSE OUTCOMES: After completion of this course, student will be able to

1. Identify immune system components and how they work in a coordinated way.
2. Differentiate the structure of antigen-antibody and the methods of processing antigen.
3. Analyze the immune system-related underlying causes of hypersensitivity and complement systems.
4. Desribe the immune system-related diseases, medical complications, and prevention of diseases.
5. Apply the principles of immunological techniques in the development of medical diagnostic kits.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1					2	2	2	2	2	2		3	2	3
CO2	2				2	3	3	3	2	2		3	2	3
CO3					2	3	3	3	2	2		3	2	3
CO4		2	2		3	3	3	3	2	2		3	2	3
CO5	3	2	2		3	3	3	3	3	2		3	2	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Immune System: Introduction to immunity; types of immunity – innate and adaptive immunity, humoral and cell-mediated immune response; hematopoiesis; cells of the immune system; organs of the immune system–the primary (bone marrow and thymus) and secondary (lymph node, spleen, MALT, GALT) lymphoid organs; pro-inflammatory and anti-inflammatory cytokines.

UNIT-II

Antigen and Antibody - Structure, Properties; Processing and Presentation of Antigen: Antigen–immunogenicity and antigenicity, factors influencing immunogenicity; haptens and adjuvants, epitopes; Immunoglobulin– structure, classes, and function; antigenic determinants of immunoglobulin – isotype, allotype, idiotype; Major histocompatibility complex (MHC) organization, classes, and function; Antigen processing and presentation – the role of antigen-presenting cells, endogenous antigens (cytosolic pathway), exogenous antigens (endocytic pathway), presentation of no peptide antigen.

UNIT-III

The Complement System and Hypersensitivity: Complement system – components, function, activation (classical and alternative pathway); Types and Mechanism of hypersensitive reactions – type I (IgE mediated hypersensitivity), type II (antibody-mediated cytotoxic hypersensitivity), type III (Immune complex-mediated hypersensitivity), type IV (delayed type hypersensitivity).

UNIT-IV

Medical Applications of Immunology: Autoimmunity – organ-specific (Insulin Dependent Diabetes Mellitus, Myasthenia Gravis) and systemic (Systemic Lupus Erythematosus, Rheumatoid Arthritis) autoimmune diseases, treatment of autoimmune diseases; Transplantation – the immunological basis of graft rejection, immunosuppressive therapy (general and specific); immunoprophylaxis (attenuated, inactivated and DNA vaccines); immunology of cancer- tumor antigens, immune response to the tumor, cancer immunotherapy.

UNIT-V

Immunological techniques: Production of monoclonal antibodies by hybridoma technology and its applications. Strength of antigen and antibody interaction, affinity, avidity, cross-reactivity, precipitation, agglutination, immune electrophoresis, RIA, ELISA, western blotting, immunofluorescence, FACS.

TEXT BOOKS:

1. Jenni Punt, Sharon Stanford, Patricia Jones, Judith A Owen., "Kuby Immunology", 8th edition, WH Freeman, 2018.
2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, "Roitt's Essential Immunology", 13th edition, Wiley-Blackwell, 2017.

SUGGESTED READING:

1. Kenneth Murphy, Casey Weaver "Janeway's Immunobiology", 9th edition, Garland Science, 2016.
2. Abdul K. Abbas, Andrew H. Lichtman, Shiv Pillai, "Cellular and Molecular Immunology", 10th edition, Elsevier, 2021.
3. Sunil Kumar Mohanty, K. Sai Leela, "Textbook of Immunology", 2nd edition, Jaypee Brothers Medical Publishers, 2014.

22BTC12

INSTRUMENTAL METHODS IN BIOTECHNOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. Types of analytical methods, instruments used for analysis, and the importance of microscopy
2. Types of instruments used for isolation of Bimolecular and Subcellular organelles
3. Types of chromatographic techniques
4. Charge-based separation techniques
5. The principles and applications of spectroscopic methods

COURSE OUTCOMES: After completion of this course, student will be able to

1. Explain the instrumental errors and working of different microscopes.
2. Describe various techniques to isolate cellular components and products.
3. Compare various techniques in the purification of cellular products.
4. Illustrate various electrophoresis techniques to isolate DNA/Protein from a mixture.
5. Explain the working of various spectroscopic instruments.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2	2	2	2	2		1	3		3	2	3
CO2	2	2	2	2	2	3	3					3	2	3
CO3			2		2	2	2	2		3		3	2	3
CO4	2	2	2		2	3	3	3	2	3		3	2	2
CO5	3	2	2	2	3	2	2	3	3	3		3	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Analytical Methods and Microscopy: Types of Analytical Methods - Instruments for Analysis (Types) Uncertainties in Instrumental measurements - Sensitivity and detection limit for instruments; principle, procedure, and applications of the Bright field, Darkfield, fluorescent, and electron microscopy.

UNIT-II

Instruments For Isolation Techniques: Cell disruption by the French press, Sonification, freeze-thaw technique; use of liquid N_2 and chemical approaches involved in cell disruption; Isolation of Biomolecules and cell organelles: centrifugation; basic principles of sedimentation, sedimentation coefficient, Svedberg Unit; various types of centrifuges, their uses, rotors, fixed angle, vertical, swing out, zonal rotors; preparative centrifugation, differential density gradient centrifugation, analytical ultra-centrifugation; Materials used in the preparation of density gradient- sucrose & cesium chloride; Isolation of subcellular organelles and Biomolecules. Determination of molecular weight and purity of Biomolecules by analytical ultra-centrifugation.

UNIT-III

Basic Chromatographic Techniques: Partition chromatography, Counter current distribution, adsorption chromatography: Paper, TLC& GLC. Methods based on size: Gel permeation chromatography, principle, application- Molecular weight determination. Affinity chromatography, application & technique for

purification of proteins and nucleic acids. Principle and application of Ion exchange chromatography, use of ion exchange- cation& anion exchangers.

UNIT-IV

Charge-Based Separation Techniques: Electrophoresis: Migration of charged molecules in electric field-moving boundary, paper, cellulose acetate, starch gel electrophoresis, SDS PAGE, Determination of molecular weight, pH, and salt gradients for elution of proteins, amino acids, iso-electric focusing, and its significance. Identification of specific proteins by western blotting. Agarose gel electrophoresis-separation of DNA & RNA, by agarose gel electrophoresis, recovery of DNA fragments from agarose gels, southern & northern blot techniques, and their significance, pulse field gel electrophoresis.

UNIT-V

Spectrometric Identification Techniques: Basic concepts of spectroscopy, Visible & UV spectroscopy & Explain Beer lamberts law; Principles and application of Colorimetry & Flame photometry, Nephelometry; Principles and applications of atomic absorption Spectrophotometry; Principles & applications of IR, ESR NMR & Mass spectroscopy; Explains the laws of photometry.

TEXT BOOKS:

1. Dinesh Kumar Chatanta, Prahlad Singh Mehra Instrumental Methods of Analysis in Biotechnology I K International Publishing House Pvt. Ltd (2012 Edition)
2. Keith Wilson and John Walker, "Principles and Techniques of Biochemistry and Molecular Biology", 6th edition, Cambridge University Press, 2005.
3. Sivasankar, "Instrumental Methods of Analysis", Oxford higher education, OUP, India, 2012.

SUGGESTED READING:

1. S. Malathi, Pallavi Mangesh Patil, Sunil Kumar, Instrumental Methods Of Analysis Thakur Publication Pvt Ltd (2020 Edition)
2. Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. Vyvyan, Introduction to Spectroscopy, Cengage Learning India Private Limited (2015 Edition)
3. GW Ewing, "Instrumental Methods of Chemical Analysis", 4th edition, McGraw-Hill, 1985.
4. Hobert H Willard D. L. Merritt and J.R.J.A. Dean, "Instrumental Methods of Analysis", CBS Publishers & Distributors, 1992.
5. Skoog DA, "Fundamentals of Analytical Chemistry", Thomson Brooks/Cole, 2004.

22BTC13

THERMODYNAMICS FOR BIOTECHNOLOGISTS

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. The course aims at providing the students with knowledge about thermodynamic principles to solve practical problems.
2. The course also gives an insight into the concepts of solution thermodynamics.
3. The course aims to give the students an understanding of chemical and phase equilibrium conditions.
4. The course also deals with bioenergetics.
5. The course aims to provide students with the knowledge to perform stoichiometric and energetic analysis of cell growth and product formation

COURSE OUTCOMES: After completion of this course, student will be able to

1. Comprehensively analyze heat and work effects within closed systems and cyclic processes.
2. Learn about the limitations of the First Law of Thermodynamics, the qualitative aspects of the Second Law, entropy calculations for ideal gases, and the application of Maxwell relations and residual properties.
3. Calculate partial molar properties in binary systems, comprehend chemical potential, Raoult's and Henry's laws, and apply correlations to evaluate activity coefficients, enabling them to analyze solution thermodynamics effectively.
4. Calculate vapor-liquid equilibria in binary systems and understand the fundamentals of chemical reaction equilibria.
5. Understand metabolic pathway energetics, energy coupling via ATP and NADH, analyze cell growth energetics, explore microbial growth thermodynamics, and apply energy balance equations to aerobic cultures in cell culture processes.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	1	2	2	3	3	2	3	3		3	3	3
CO2	2	2	1	2	2	3	3	2	3	3		3	2	3
CO3	2	2	1	2	2	3	3	2	3	3		3	2	1
CO4	2	2	1	2	2	3	3	2	3	3		3	2	1
CO5	2	2	1	2	2	3	3	2	3	3		3	2	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction To Thermodynamics: System Definition and Classification of the System – closed and open systems based on the number of components, exchange of mass, and heat. State and Path Functions, equilibrium, Phase rule. Thermodynamic Properties of fluids. Forms of energy, classification of properties. I-Law of Thermodynamics, application of I-law to closed.

Volumetric Properties of Fluids: PVT behavior of pure fluids. Real and Ideal Gas. Equations of state – Ideal gas law, Virial equations of state (restricted to first two terms). Cubic equations of state – Vander Waals and Redlich Kwong. Processes involving ideal gases (isochoric, isobaric, isothermal, adiabatic, polytropic – simple applications)

UNIT-II

The Second Law Of Thermodynamics: Limitations to I-law, qualitative statement of Kelvin Plank and Clausius versions of II-law, entropy – definition, entropy and heat calculations for ideal gases. Maxwell relations – problems not included, Residual properties – definition (VR, HR, SR, GR – basic property relations for ideal gases, problems not included).

UNIT-III

Solution Thermodynamics: Partial molar properties – definition and simple applications involving the calculation of partial molar properties for binary systems using analytical methods (no graphical method). Concepts of Chemical potential and fugacity (for pure species and species in solution). Lewis Randall rule, Raoult's law, Henry's law Definition and simple applications. Excess properties definition and fundamental relation for excess Gibbs free energy, (problems not included). Activity and activity coefficients, correlations to calculate activity coefficients Margules, Van Laar, and applications involving binary systems.

UNIT-IV

Topics In Phase Equilibria And Chemical Reaction Equilibria: Vapor-liquid equilibrium calculations for binary systems - P-x-y, T-x-y diagrams, using simple Raoult's law to the binary mixture. Chemical Reaction Equilibria: Equilibrium criteria for homogenous chemical reactions. Standard Gibbs energy change of reaction, **Reaction coordinate** –definition. Evaluation of equilibrium constant – numerical problems not included. Effect of pressure and temperature on equilibrium constant – qualitative treatment, simple problems involving temperature dependence of equilibrium constant. Calculation of equilibrium conversions and yields for single reactions.

UNIT-V

Bioenergetics: Energetics of Metabolic Pathways, Energy coupling (ATP & NADH). Stoichiometry and energetic analysis of Cell Growth and Product Formation. Thermodynamics of microbial growth. Oxygen consumption and heat evolution in aerobic cultures. Energy balance equation for cell culture

TEXT BOOKS:

1. J.M.Smith, H.C. Van Ness and M.M. Abbott, "Introduction to Chemical Engineering Thermodynamics", 6th ed, TMH, 2003.
2. J.A. Roels, "Energetics and kinetics in biotechnology", Elsevier, 1983.
3. Y.V.C. Rao, Revised edition, "An introduction to thermodynamics", Universities Press, 2004.

SUGGESTED READING:

1. Robert A. Alberty, "Biochemical Thermodynamics: Applications of Mathematica", John Wiley and Sons, 2006.
2. Stanley I. Sandler, "Chemical and Engineering Thermodynamics", 3rd Edition, Wiley, 1999.
3. K.V. Narayanan, "A Textbook of Chemical Engineering Thermodynamics", PHI Learning Pvt. Ltd, 2004.

22BTC14

INTRODUCTION TO ANATOMY AND PHYSIOLOGY OF HUMANS

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. Student gets an overview of the human body tissues and endocrine system.
2. The various organs associated with skeletal, muscular, digestion, and excretion are taught.
3. Heart structure and functioning are detailed, including the gaseous exchange that occurs through the respiratory system.
4. Knowledge of the Spinal cord, the associated nerves, and the different sense organs are imparted.
5. Reproductive anatomy and physiology are explained.

COURSE OUTCOMES: After completion of this course, student will be able to

1. Outline the structure of the Human body and explain the structure and function of endocrine glands
2. Discuss the anatomical structures and the physiological functions of the skeletal, muscular, and digestive systems.
3. Explain the anatomical structures and the physiological functions of the excretory, circulatory, and respiratory systems.
4. Describe the anatomical structures and the physiological functions of the nervous system and other sensory systems.
5. Discuss the anatomical structures and the physiological functions of the reproductive system and the physiology of the blood

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2					2	2	1	2	2		2	2	1
CO2	2					3	3	2	2	2		2	2	2
CO3	2					3	3	2	2	2		2	2	2
CO4	2					3	3	2	2	2		2	2	2
CO5	2					3	3	2	2	2		2	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Anatomical Terms and Endocrine Glands: Definition of Anatomy and Physiology; Major types of Human Tissues. Various systems of the human body and their general roles; Homeostasis; Types of endocrine glands, Anatomy and physiology of pituitary, thyroid, pancreas.

UNIT-II

Anatomy and Physiology of Skeletal, Muscular and Digestive System: Structure and function of bones, Bone cells osteoblast, osteocytes, and osteoclast; Structure and function of muscles, Histology of Muscle Fibers, Sarcomere; Digestive system- organs and functions; the role of liver and pancreas.

UNIT- III

Anatomy and Physiology of Excretory System, Circulatory System, and Respiratory System: Excretory system - kidney and urinary bladder, physiology of excretory system - urine formation; Circulatory system - anatomy of heart, heartbeat, blood circulation; Anatomy of blood vessels - arteries and veins; Respiratory system-anatomy of lungs and mechanism of respiration.

UNIT-IV

Anatomy and Physiology of Nervous System and Other Sensory Systems: Nervous system- peripheral and autonomous nervous system; Spinal nerves and Cranial nerves, the transmission of nerve impulse, reflex arc; Special senses - eye, ear, tongue, and nose.

UNIT-V

Anatomy and Physiology of Reproductive System and Blood Physiology: Mechanism of blood oxygenation, Blood pressure recording, and regulating techniques; Reproductive system - male and female reproductive organs and physiology; menstrual cycle

TEXT BOOKS:

1. Cinnamon VanPutte, Jennifer Regan, Andrew Russo, Rod Seeley, Trent Stephens, Philip Tate "Seeley's Anatomy and Physiology" 12th edition, McGraw Hill Education, 2019
2. Elaine N. Marieb "Essentials of Human Anatomy and Physiology", 8th Edition, Pearson Education, New Delhi 2006

SUGGESTED READING:

1. Eric Widmaier, Hershel Raff, Kevin "Vander's Human Physiology: The Mechanisms of Body Function" McGraw- Hill Science/Engineering/Math, 13th edition, 2013.
2. Anthony A. Goodman – "Understanding the Human Body - An Introduction to Anatomy and Physiology"-The Teaching Company, 2004

22EGM01

INDIAN CONSTITUTION AND FUNDAMENTAL PRINCIPLES

Instruction	2 L Hours per week
Duration of SEE	2 Hours
Semester End Examination	50 Marks
CIE	-
Credits	0

Prerequisite: Basic awareness of Indian Constitution and Government.

COURSE OBJECTIVES: The course will introduce the students to

1. Understand the history of framing of the Indian Constitution.
2. Awareness on Fundamental Rights, Duties and Directive Principles of State Policy.
3. Explore the organization of Union Government, and functions of President and Prime Minister.
4. Gain an insight into the inter-functionality of Union Legislature and Judiciary
5. Educate on the local governance and problems in development of rural and urban areas.

COURSE OUTCOMES: After successful completion of the course the students will be able to

1. Understand the history of framing of the Indian Constitution and its features.
2. Assess the realization of Fundamental Rights and Directive Principles of State Policy.
3. Analyze the challenges to federal system and position of the President and the Prime Minister in the Union Government.
4. Underline the role of the Legislature and the Judiciary in Union Government and their mutual relations.
5. Evolve the development of the local governments in India and assess the role of Collector in district administration.

CO-PO ARTICULATION MATRIX

PO/PSO CO	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
CO1			1			1	1	1	1					
CO2			2			3	3	2	1				3	1
CO3			1			1	1							
CO4			1			1	1						2	
CO5			2			3	3	1	1				2	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Constitutional History and Framing of Indian Constitution

East India Company rule (1757-1857): Social, Economic, Political and Administrative impact of Company rule in India. British Rule (1858-1947): Indian National Movement, Government of India Acts 1909, 1919 and 1935, and Indian Independence Act 1947. Framing of the Indian Constitution: Constituent Assembly, Preamble and Salient Features.

UNIT-II

Fundamental Rights, Duties and Directive Principles of State Policy

The Fundamental Rights**:** Features and significance of Rights. Fundamental Duties: Importance and the legal status of Duties. Directive Principles of State Policy: Socialist, Gandhian and Liberal-intellectual principles, importance and relevance.

UNIT-III

Union Government and its Administration

Federalism: Division of legislative and financial powers between the Union and the State. Union Executive: Role and position of President, Prime Minister and Council of Ministers. Emergency Provisions: National Emergency, Constitutional Emergency and Financial Emergency.

UNIT-IV

Union Legislature and Judiciary

Union Legislature: Parliament of India-Composition and functions of Parliament, and Parliamentary Committees. Union Judiciary: Supreme Court of India-Composition and Functions.

UNIT-V

Local Self Governments

Rural Local Governments: Zilla Parishad- CEO and functions of Zilla Parishad, Mandal Parishad- Role of Elected and Officials, Gram Panchayat- Sarpanch, Secretary and Gram Sabha. Urban Local Governments: Structure and functions of Municipalities and Municipal Corporations. District Collector: Powers and functions of Collector.

TEXT BOOKS:

1. Sastry Ravindra, (Ed), "Indian Government & Politics", Telugu Akademy, 2nd edition, 2018.
2. "Indian Constitution at Work", NCERT, First edition 2006, Reprinted in 2022.

SUGGESTED READING:

1. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1st Edition, 2015.
3. Granville Austin, "The Indian Constitution: The Cornerstone of a Nation", OUP, 2nd Edition, 1999.
4. M.V. Pylee, "India's Constitution", S. Chand Publishing, 16th Edition, 2017.
5. Rajeev Bhargava (ed), "Politics and Ethics of the Indian Constitution", OUP, 2008.

22BTC15

FERMENTATION TECHNOLOGY LAB

Instruction	2 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course aims to

To provide hands-on training to students to practically see the integrated bioprocess operations right from the beginning of medium preparation to fermenter operation

COURSE OUTCOMES: After completion of this course, student will be able to

1. Describe the importance of media and other rheological parameters during the fermentation process (Expt. 1, 4, & 5).
2. Analyze the difference between batch and fed-batch processes (Expt. 2, & 3).
3. Demonstrate the preparation of media and its optimization using the statistical techniques (Expt. 9).
4. Estimate the growth kinetics of microorganisms (Expt. 6, 7, 8, & 10).
5. Determine the volumetric mass transfer coefficient in fermentation (Expt. 11).

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2	2	3	2	2		2	2		3	3	3
CO2	2	2	2	2	2	2	2		2	2		2	3	3
CO3	2	2	2	3	2	2	2		3	3		2	2	2
CO4	3	2	2	3	2	2	2		3	3		2	3	2
CO5	2	2	2	2	3	2	2		2	2		3	3	3
CO6	2	2	2	2	3	2	2		2	2		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

1. Bioreactor instrumentation and its control
2. Study of Batch Fermentation Process using *E. Coli*
3. Study of Fed-Batch Fermentation Process using *E. Coli*
4. Study of rheological parameters in the fermentation broth
5. Study of whole cell/enzyme immobilization and determine its activity (Open-ended)
6. Estimation of Specific growth rate and doubling time of a microorganism
7. Substrate utilization and product formation kinetics
8. Estimation of Monod parameters and determine the growth kinetics (Structured)
9. Media optimization by using Plackett-Burman design (Structured)
10. Production of citric acid by *Aspergillus niger* and its estimation by titrimetric method
11. Determination of K_La by Sulphite oxidation method

SUGGESTED READINGS:

1. Bioprocess Engineering Principles" by Pauline M. Doran
2. Bioprocess Engineering: Basic Concepts" by Michael L. Shuler, Fikret Kargi, Matthew DeLisa

22BTC16

IMMUNOLOGY LAB

Instruction	2 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course aims to
1. Students can identify the significance of blood grouping and cells.
2. Students learn the applications of agglutination reactions.
3. Students learn the applications of Precipitation reactions.
4. Students learn about the types of Immunoelectrophoresis.
5. Students learn to prepare the diagnostic kits.

COURSE OUTCOMES: After completion of this course, student will be able to
1. Classify the blood groups, cells, and predict the diseases. (Exp. 1, 2, 3 & 4)
2. Demonstrate bacterial agglutination reactions (Exp. 5 & 6)
3. Measure the concentration of antigens and serotypes by using precipitation reactions.(Exp. 7 & 8)
4. Interpret the concentration of the analytes using electrophoretic techniques.(Exp. 9 & 10)
5. Analyze the importance of ELISA techniques. (Exp. 11)

CO-PO Articulation Matrix

PO/PSO CO	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
CO1		2	2	2	3	3	3	3	2	2		3	3	3
CO2	2	3		2	3	2	2	3	3	2		3	3	3
CO3	2	2		2	3	3	3	3	2	3		3	3	3
CO4			2	2	3	3	3	3	2	2		3	2	3
CO5	2		2	2	3	2	2	3	2	2		3	2	3

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:
1. ABO Blood grouping and identification of Rh typing,
2. Total and differential count of RBC & WBC by micropipette method. (Structured enquiry)
3. Isolation and microscopic visualization of T cells and B cells.
4. Erythrocyte sedimentation rate.
5. WIDAL test.
6. VDRL tests.
7. Radial immunodiffusion test.
8. Ouchterlony double diffusion for Antigen Antibody Patterns.
9. Immunoelectrophoresis.
10. Rocket Immunoelectrophoresis.
11. Enzyme-Linked Immunosorbent Assay for antigen capture and antibody capture. (Open-ended)

SUGGESTED READINGS:

1. Arti Nigam, Archana Ayyagari, "Lab Manual in Biochemistry, Immunology, and Biotechnology", Tata McGraw Hill Education, 2007.
2. S. Ramakrishna and K. N. Sulochana, "Manual of Medical Laboratory Techniques", 1st edition, Jaypee Brothers Medical Publishers, 2012.

22BTC17

INSTRUMENTATION LAB

Instruction	2 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course aims to

1. Understand the basic concepts for the operation of pH and spectrophotometer.
2. Estimate the micro and macro molecules by using chromatography techniques.
3. Separate the biomolecules with the application of different methods of electrophoresis.

COURSE OUTCOMES: After completion of this course, student will be able to

1. Apply the instrumentation techniques to their real-life applications (Exp. 1, 2, 3,4)
2. Demonstrate the preliminary identification of biomolecules by partition chromatography method (Exp. 8, 9)
3. Design the experiment to find the molecular weight of an unknown protein (Exp. 10)
4. Examine the analytes by using a UV-Visible spectrophotometer, Conductivity meter, Nephelometer, and flame photometer (Exp. 5,6,7,11,12, 13)
5. Justify their results on the separation of biomolecules by differential centrifugation methods. (Exp. 14, 15)

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2	2	3	3	3	3	2	2		3	3	3
CO2	2	2		2	3	2	2	3	3	2		3	3	3
CO3	2	2	2	2	3	2	2	3	2	2		3	3	3
CO4	2		2	2	3	3	3	3		2		3	3	3
CO5	2	2	1	2	3	2	2	3		2		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

1. The calibration of the pH meter and measurement of pH for different solutions
2. Estimation of Ascorbic acid by colorimetric assay
3. Estimation of unknown samples by using a conductivity meter
4. Estimation of different macromolecules by visible spectrophotometer
5. Verification of Lambert - Beers law by UV -VIS spectrophotometer
6. Estimation of proteins and nucleic acids by UV method
7. Estimation of turbidity using Nephelometer
8. The separation of different macromolecules by Thin layer chromatography (Structured enquiry)
9. The separation of different macromolecules by paper chromatography (Open-ended)
10. The separation of different macromolecules by SDS-PAGE
11. Estimation of minerals by Flame photometry
12. Estimation of Thiamine and Riboflavin by Fluorimetry
13. Preparation of Standard curve using UV-VIS & Flame Photometry
14. Fractionation of Plasma Proteins by Electrophoresis
15. Membrane protein extraction by differential centrifugation

SUGGESTED READING:

1. Sivasankar, Instrumental Methods of Analysis, Oxford higher education, OUP, India, 2012.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
In line with the AICTE Model Curriculum with effect from AY 2024-25

B. Tech BIOTECHNOLOGY

SEMESTER-V

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours Per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
	THEORY								
1	22BTC18	Fluid Mechanics and Heat Transfer	3	-	-	3	40	60	3
2	22BTC19	Genetic Engineering and rDNA Technology	3	-	-	3	40	60	3
3	22BTC20	Plant Biotechnology	3	-	-	3	40	60	3
4	22BTEXX	Professional Elective -I	3	-	-	3	40	60	3
5	22EEM01	Universal Human Values-II: Understanding Harmony	1	-	-	-	50	-	1
	PRACTICALS								
6	22BTC21	Fluid Mechanics and Heat Transfer Lab	-	-	3	3	50	50	1.5
7	22BTC22	Genetic Engineering Lab	-	-	3	3	50	50	1.5
8	22BTC23	Plant Biotechnology Lab	-	-	3	3	50	50	1.5
9	22EGC03	Employability Skills	-	-	2	3	50	50	1
10	22BTI02	Industrial/Rural Internship - II	3-4 weeks / 90hrs			-	50	-	2
Total			**13**	**0**	**11**	**24**	**460**	**440**	**20.5**
Clock hours per week: 24									

L: Lecture **T: Tutorial** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

22BTEXX	**Professional Elective – I**
22BTE01	Industrial Biotechnology
22BTE02	Virology
22BTE03	Developmental Biology
22BTE04	Intellectual Property Rights and Bioethics
22BTE05	Artificial Intelligence in Biology

22BTC18

FLUID MECHANICS AND HEAT TRANSFER

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. This course aims at providing knowledge on basic concepts in flow of fluids, flow field, flow past immersed bodies.
2. The course is designed to give an understanding on measurement of viscosity, flow measuring devices.
3. The course also deals with basic concepts in heat transfer, evaporation and condensation.

COURSE OUTCOMES: At the end of the course, students will be able to

1. How to measure the viscosity of different fluids in bioprocessing and its effect on fermentation.
2. Derive a relation between pressure drop and viscosity.
3. Compare and contrast the merits and demerits of different flow measuring devices.
4. Calculate the rate of heat transfer through various geometries.
5. Calculate the overall heat transfer coefficient in different evaporators and condensers.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2	2			2	2			2		2	3	3
CO2	3	2	2		2	2	2		2	2		2	3	3
CO3	2	2	2		1	2	2			2		3	3	3
CO4	3	3	2									2	3	3
CO5	2	1	2		1	2	2		2	2		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Basic Concepts in Flow of Fluids: Introduction, Nature of fluid, Rheology of fluids -Newton's law of viscosity; Concept of Newtonian and non-Newtonian Fluids-Different types of non-Newtonian fluids with examples in bioprocessing; Measurement of viscosity using impeller viscometer, plate and cone viscometer, coaxial cylinder viscometer, etc.

UNIT-II

Flow Field: Friction losses in laminar flow through a circular tube (Hagen-Poiseuille equation), Friction losses in turbulent flow (Fanning equation), Pumping of fluids flow through pipes, average velocity, flow regimes, boundary layer concept. Laminar and turbulent flow – characterization by Reynold's number, pressure drop due to skin friction and form friction, friction factor chart, Hagen - Poiseuille equation.

UNIT-III

Flow Past Immersed Bodies: Definition of drag and drag coefficient; Friction in flow through beds of solids (Ergun Equation); Brief introduction to flow of compressible fluids; Flow measuring and monitoring systems- valves, bends, elbows, prevention of leaks, mechanical seals, stuffing box; Flow measuring devices-manometers, orifice-meter, venturimeter and rotameter; Brief description of Pumps (principal of centrifugal and positive displacement pumps) and Blowers.

UNIT-IV

Basic Concepts in Heat Transfer: Introduction and Mechanisms of heat transfer; Conduction heat transfer (through slab, cylinder & Sphere); Conduction through solids in series, forced convection heat transfer inside pipes, Introduction to radiation heat transfer, Chilling and freezing of food and biological materials; Heat transfer correlations and calculations, basic heat exchange equipment.

UNIT-V

Basic Concepts in Evaporation and Condensation: Introduction, Types of evaporation equipment and operation methods; Overall heat transfer coefficients in evaporators; simple material balances; Calculation methods for single effect evaporators, Evaporation of biological materials; Types of condensation, numerical problems, and condensation equipment.

TEXT BOOKS:

1. W L McCabe and JC Smith, "UNIT-Operations in Chemical Engineering", ISBN-10. 9339213238 · ISBN-13. 978-8184959635 · Edition. Seventh · Publisher. McGraw Hill Education · Publication date. 1 July 2017
2. Christie J. Geankoplis, "Transport Processes and UNIT-Operations", 3rd edition, Prentice Hall India Pvt. Ltd. 1993

SUGGESTED READING:

1. Kothandaraman CP, Rudramoorthy R, "Basic Fluid Mechanics", New Age International Publishers, New Delhi,1998.
2. Sachdeva RC, "Fundamentals of Engineering Heat and Mass Transfer", New Age International Publishers, New Delhi, 1996.
3. Pauline M. Doran, "Bioprocess Engineering Principles", Academic press, 1995.

E-RESOURCES:

1. MIT Open Courseware (OCW) - Fluid Mechanics, Website: MIT OCW - Fluid Mechanics
2. Coursera - Fluid Mechanics by University of Minnesota, Website: Coursera - Fluid Mechanics
3. Coursera - Fundamentals of Heat Transfer by University of Michigan Website: Coursera - Fundamentals of Heat Transfer

22BTC19

GENETIC ENGINEERING AND rDNA TECHNOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To provide theoretical concepts, basic principles and tools used in rDNA technology.
2. To learn essential features and various vectors used in gene cloning and rDNA technology.
3. To learn the principle, methodology and applications of PCR and molecular markers.
4. To learn the range of cloning strategies those are employed to clone a DNA sequence.
5. To know how rDNA technology is used to produce proteins.

COURSE OUTCOMES: At the end of the course, students will be able to

1. Explain the basic principles and tools used in rDNA research starting from the isolation of nucleic acid, enzymes etc.
2. Compare various types of cloning vectors and expression vectors and their use in rDNA technology.
3. Discuss the principle, types and applications of PCR and molecular markers.
4. Describe the cloning strategies and sequencing methods.
5. Summarize the high-level expression of proteins in different hosts and the production of recombinant proteins for the human welfare

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2			3				2	2		2	2	2
CO2	2	2			3				2	2		2	3	2
CO3	2	2			3	2	2		2	2		3	3	2
CO4	2	2			3	2	2		2	2		3	3	2
CO5	2	2	2		3	3	3	2	2	2		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Isolation and Purification of DNA and Enzymes Used in Cloning: Isolation and purification of nucleic acids (genomic/plasmid DNA& RNA), quantification and storage of nucleic acids; Agarose gel electrophoresis; Enzymes used in genetic engineering - Restriction enzymes – Exo and Endo nucleases, Methylases, Polymerases, Ligase, Phosphatase, Kinase, DNase, RNase; Homopolymer tailing, Linkers & Adaptors; Restriction mapping; Blotting techniques – Southern, Northern and Western Blotting.

UNIT-II

Cloning Vehicles: Essential features of cloning vectors; Cloning vectors - Plasmid vectors - pBR 322, pUC 18/19; Phage vectors – λZAP, λEMBL4; M13 derived vectors –M13mp18; Phagemid- Blue script vectors; Cosmid- pJB8; Artificial chromosomes - BAC, YAC; Viral Vectors – SV40, Baculovirus, Retrovirus; Ti-Plasmid; Expression vectors - pET vectors.

UNIT-III

Polymerase Chain Reaction and Molecular Markers: PCR – Principle, Designing of primers, PCR Methodology, RT-PCR, Multiplex PCR, PCR for site-directed mutagenesis, Applications of PCR; Molecular marker – RFLP, RAPD, AFLP.

UNIT-IV

Cloning Strategies and DNA sequencing: Construction of cDNA and Genomic library; Gene transfer techniques: biological methods, chemical methods, physical or mechanical methods, Agrobacterium-mediated gene transfer in plants; Detection of clones with the desired gene; DNA Sequencing-Chain termination DNA Sequencing, Pyrosequencing, automation of DNA sequencing.

UNIT-V

Expression of Recombinant Proteins and Applications of rDNA Technology: High-level expression of proteins in different host systems in E. coli, yeast, insect, and mammalian cells; Applications of rDNA Technology - Recombinant Insulin, Recombinant Factor VIII, Golden rice. Introduction to Gene therapy (Ex vivo & In vivo), a case study of ADA as an example. Safety guidelines for rDNA research.

TEXT BOOKS:

1. Brown, T.A., "Gene Cloning and DNA Analysis: An Introduction", 8th edition. Wiley Blackwell, 2020.
2. Primrose, S.B., Twyman, R.M., "Principles of Gene Manipulation and Genomics", 7th edition, John Wiley & Sons, 2013.
3. Glick, B.R., Patten, C.L, "Molecular Biotechnology: Principles and applications of Recombinant DNA", 6th edition, ASM Press, 2022.

SUGGESTED READING:

1. Desmond S T Nicholl, "An Introduction to Genetic Engineering", 3rd edition, Cambridge End Press, 2008.
2. Richard J. Reece, "Analysis of Genes and Genomes", Wiley, 2004.

E-RESOURCES:

1. Dr. Trivedi, IITG. Genetic Engineering: Theory and Application. website link: https://onlinecourses.nptel.ac.in/noc19_bt15/preview

22BTC20

PLANT BIOTECHNOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: The course aims to

1. Enable the students to understand explicitly the basic concepts and applications of Plant Tissue culture.
2. To understand the developmental pathways of callus induction and plant regeneration.
3. To understand the techniques for the production of secondary metabolites in vitro using plant cell and tissue culture.
4. To understand the methods of gene transfer in plants for the production of Transgenics.
5. To understand the various strategies and sources of transgenes for crop improvement.

COURSE OUTCOMES:At the end of the course, the students are able to

1. Describe the theoretical concepts behind the establishment of in vitro techniques.
2. Explain the importance and applications of various in vitro techniques.
3. Identify methods used for the production of plant secondary metabolites in in vitro at a commercial scale.
4. Analyze the appropriate vectors and gene transfer methods for the production of Transgenics.
5. Outline the strategies for the production of transgenics for crop improvement and environmental concerns.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2	2		2	2	2	2				3	3	2
CO2	2	2	1		2	2	2	1				2	3	2
CO3	2	3	2		2	3	3	2	1		2	2	3	2
CO4	2	2	2		1	2	2	2				2	2	2
CO5	2	3	2		2	3	3	2			1	3	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Plant Tissue Culture: Introduction to cell and tissue culture: History, Totipotency, Plasticity, Cell Theory, Tissue culture media (composition, preparation); Sterilization techniques; Callus and cell suspension culture; Organogenesis and Embryogenesis and their applications.

UNIT-II

Tissue Culture in Crop Improvement: Micropropagation of virus-free plants; Somaclonal variation; Haploids in plant breeding; Genetic fidelity of plants raised through tissue culture; Germplasm conservation (Cryopreservation). Protoplast isolation, culture and fusion, Somatic hybridization and its applications.

UNIT-III

Molecular Farming & Industrial Products: In vitro production of short-chain and long-chain fatty acids; Industrial enzymes; Production of secondary metabolites from plant cell cultures using Cell suspension cultures, Immobilized cell systems, Precursor feeding (elicitation), and hairy roots. Bioreactor systems and models for mass cultivation of plant cells.

UNIT-IV

Plant Genetic Engineering - I Techniques: Agrobacterium-mediated gene transfer; Plant vectors and their use in genetic manipulation; Direct gene transfer methods: electroporation, microinjection, particle bombardment, and chemical methods. Marker-free transgenics and environmental, social and legal issues associated with transgenic plants.

UNIT-V

Plant Genetic Engineering - II Productivity and Safety Regulations: Transgenics in crop improvement: Biotic Stress resistance: Herbicide, Insect, Disease, virus, etc., Abiotic stress tolerance: Drought, Temperature, Salt. Transgenics for improved nutritional quality, storage, and longer shelf life. Edible vaccines and Nutraceuticals; Environmental impact and gene flow.

TEXT BOOKS:

1. Bhojwani SS and Razdan, "Plant Tissue Culture Theory and Practice", Elsevier Science, 2004.
2. Chawla HS, "Introduction to Plant Biotechnology", 4th edition, Oxford and IBH Publishers, 2002.

SUGGESTED READING:

1. Nigel G Halford, "Plant Biotechnology: Current and future applications of genetically modified crops", John Wiley & Sons Ld. 2006
2. Surabh Bhatia, Kiran Sharma, Randhir Dahiya and, Tanmoy Bera, "Modern Applications of Plant Biotechnology in Pharmaceutical Sciences", Elsevier publication, Academic press, 2015.

22BTE01

INDUSTRIAL BIOTECHNOLOGY
(Professional Elective-I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To know about the bioprocess overview and various primary metabolites
2. To know about the production and application of microbial metabolites
3. To make the student understand the production of enzymes
4. To make the student understand the biotechnologically important products like recombinant proteins, vaccines, etc.
5. To make the student understand the importance and production of various beverages

COURSE OUTCOMES: By the end of the course, students will be able to:

1. Describe the importance of Industrial Bioprocesses
2. Illustrate the significance of advancements in fermentation for biobased product production
3. Manipulate the ideas for the production of microbial metabolites
4. Apply the concept of biosynthesizing enzymes and other important products
5. Analyze the concept of producing modern products like recombinant vaccines and monoclonal antibodies in industries

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	3	2		2	2	2	2	2	2		2	3	2
CO2	2	2	2		2	2	2	2	2	3		3	3	3
CO3	2	2	2		2	2	2	2	2	2		2	3	3
CO4	2	2	2		2	2	2	2	2	2		2	3	3
CO5	2	2	2		2	2	2	2	2	2		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to basic Industrial Bioprocess: Fermentation; Basic concepts of upstream and downstream processing in Bioprocess; Medium characteristics and biochemical pathways of various organisms; Feedstocks - Renewable sources of biomass for biobased products; Sterilization-Air and medium; Bioreactor/Fermenter- Significance and Design; Industrial waste treatment

UNIT-II

Advances in industrial bioprocesses: rDNA technology- significance and applications; Development of industrial strains; Lifecycle of the microbial cell, microbial growth kinetics, product formation, and substrate utilization; Various applications of fermentation in Industrial Biotechnology- Insulin

UNIT-III

Production of Microbial Metabolites: Primary Metabolites: Organic acids -Citric acid, Lactic acid; Amino acids -Glutamic acid, Phenylalanine; Alcohols –Ethanol; Secondary metabolites: Antibiotics-Penicillin, VitaminB_{12}

UNIT-IV

Production of Enzymes and Other Products: Production of industrial enzymes (proteases & amylases), Production of biopesticides, Biofertilizers, Biopreservatives (Nisin), biopolymers (Xanthan gum & PHB), fermented milk products (Cheese, Yogurt), Beverages (Beer, Wine), Baker's yeast, SCP, Biodiesel

UNIT-V

Production of Modern Biotechnology Products: Production of recombinant proteins having therapeutic and diagnostic applications (human growth hormone & Interferon), Industrial Production, Purification, and Process development of recombinant vaccines (hepatitis B vaccine, cholera vaccine) and monoclonal antibodies

TEXT BOOKS:

1. Christoph Wittmann, James C. Liao "Industrial Biotechnology: Products and Processes" Wiley-VCH Verlag GmbH & Co. KGaA 2016.
2. Debabrata Das, Soumya Pandit "Industrial Biotechnology". 1st Edition, CRC Press 2021
3. Devarajan Thangadurai and Jeyabalan Sangeetha "Industrial Biotechnology-Sustainable Production and Bioresource Utilization" CRC Press 2016.

SUGGESTED READING:

1. Loveleen Kaur "Industrial Biotechnology: Principles and Applications Biotechnology in agriculture, industry and medicine" Nova Publishers, 2015
2. Trevor Palmer, Philip Bonner, "Enzymes", 2nd edition, Woodhead Publishing, 2007.
3. Heinrich Klefenz "Industrial Pharmaceutical Biotechnology" Wiley-VCH Verlag GmbH, 2002

E-RESOURCES

1. NPTEL Course- NOC: Industrial Biotechnology, by Prof. Debabrata Das, IIT Kharagpur
2. Coursera Course- Industrial Biotechnology offered by the University of Manchester
3. Coursera- Introduction to Industrial Bioprocess Development by Technical University of Denmark (DTU).

22BTE02

VIROLOGY
(Professional Elective -I)

Instruction	3L Hours per week
Duration of SEE	3Hours
SEE	60Marks
CIE	40Marks
Credits	3

COURSE OBJECTIVES: Students are made to understand the following concepts during their course of time:

1. To learn the morphology and genetics of viruses.
2. To recognize the procedures for the cultivation of plant & animal viruses.
3. To be aware of the characterization of viruses.
4. To elaborate the detailed features of plant viruses and bacteriophages.
5. To earn the lifecycles of animal viruses and development of vaccines.

COURSE OUTCOMES: By the end of the course the students are able to

1. Explain the morphology of viruses and pathology of sub viruses.
2. Compare the techniques for the cultivation of plant & animal viruses.
3. Outline various characterization techniques for the detection of viruses.
4. Illustrate the structural, functional and disease control measures of plant viruses.
5. Describe the classification, pathogenesis of animal viruses and therapeutic strategy for vaccine development.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2				2	2	2	3	2	3		3	3	3
CO2	2				2	3	3	3	2	3		3	3	3
CO3	2				2	3	3	3	2	3		2	3	3
CO4	2					3	3	3	2	3		2	3	3
CO5	2					3	3	3	2	3		2	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Virology: Brief outline of discovery of Viruses; Properties of Viruses; Morphology of Viruses- Structure, Capsid Architecture, Envelopes and peplomers; Chemistry of Viruses- Viral Proteins, Genome- Structure and Types; Study of sub viral agents- Brief account on Diseases caused by Viroids- PSTV, Cadang- cadang; Prions-Scrape, Creutzfeldt-Jakob; Satellite viruses.

UNIT-II

Cultivation of Viruses: General methods of cultivation of viruses- in embryonated eggs, cultivation of animal and plant viruses; cultivation of bacteriophages, Isolation and purification of viruses- plant viruses, animal viruses; Criteria of purity, Maintenance and preservation of infectivity.

UNIT-III

Characterization of viruses: Characterization of viruses-Electron microscopy, X-ray crystallography, sedimentation analysis. Enumeration of viruses by electron microscopy, plaque assay, acid endpoint method, Haemagglutinin assay; Detection of viruses - By serological characterization, detection of viral antigen, detection of viral nucleic acid; chemical determination, UltrastructureandlifecyclesofBacteriophages-Ml3, T4andlambda.

UNIT-IV

Plant Viruses: Taxonomy; Symptoms of diseases caused by plant viruses (Morphological, Physiological, and Histological); Ultrastructure and life cycles of TMV; transmission of plant viruses- Mechanical and biological (vector and non-vector); Basic control measures of plant diseases- vector and chemical control, biopesticides with examples.

UNIT-V

Animal viruses: Taxonomy; Detailed structure and a brief account of life cycles of RNA viruses- Polio, Influenza, Rotavirus, Coronaviruses: Covid 19andHIV; Ultrastructure and brief account on lifecycles of DNA viruses- Vaccina, SV40 and Hepatitis Virus; Viral vaccines-types and preparation of conventional vaccines.

TEXT BOOKS:

1. Dimmock NJ, Easton AJ Easton, Leppard KN. "Introduction to Modern Virology", 7th edition, Publishers: Wiley-Blackwell, 2016.
2. Matthews REF "Fundamentals of Plant Virology". Academic Press, San Diego, 1992.

SUGGESTED READINGs:

1. Carter J and Saunders V "Virology: Principles and Applications" John Wiley and Sons Ltd, 2007.
2. Morag C, Timbury M, Churchill Livingstone, "Medical Virology", London, 1994.

22BTE03

DEVELOPMENTAL BIOLOGY
(Professional Elective -I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. Students are made to understand the basic concepts of developmental biology.
2. Students are taught the structure of gametes, and how they are generated.
3. Students are taught the influence of genes on body axis formation in Drosophila and Mammals.
4. Students are enlightened about the later embryonic developments i.e. Organogenesis.
5. Students are made aware of sex determination in Drosophila and Mammals.

COURSE OUTCOMES:

At the end of the course, the students are able to

1. Discuss basic concepts of Developmental Biology.
2. Describe the anatomy of gametes and the biochemistry involved in gamete recognition
3. Analyze the role of genes in the body axis formation of drosophila.
4. Outline the importance and differentiation of germinal layers into different organs and compare the role of genes in the sex determination of Drosophila and Mammals.
5. Explain the genetic anomalies that lead to diseases.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2					3	3	3	2	2		3	1	2
CO2	2					3	3	3	2	2		3	1	2
CO3	2					3	3	3	2	2		2	1	2
CO4	2					3	3	3	2	2		2	2	2
CO5	2					3	3	3	2	2		2	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Developmental Biology: Overview of anatomical approach, Evolutionary Embryology, Medical embryology & teratology, Mathematical modeling for development, Stages of animal development: The Frog life cycle, Development dynamics of cell specification (Autonomous, Conditional, Syncytial and Morphogenetic Gradients), Induction and Competence.

UNIT-II

Gametogenesis and Fertilization in Mammals: Structure of Gametes: Sperm, Egg, Spermatogenesis and oogenesis in Mammals, Recognition of egg and sperm, Mammalian Fertilization (Fusion of Gametes and prevention of Polyspermy).

UNIT-III

Drosophila Embryonic Development: Early Drosophila developments: Fertilization, Cleavage, Gastrulation, Segmentation and the Anterior-Posterior body plan, Segmentation genes (Gap Genes, pair rule genes and segment polarity genes), The Homeotic selector genes, Generating Dorsal-Ventral axis.

UNIT-IV

Organogenesis and Sex Determination: The emergence of Ectoderm-The Central nervous system and Epidermis, Mesoderm – Osteogenesis and Myogenesis, Lateral plate mesoderm and endoderm – the Heart, Blood cells, Endoderm - Digestive tube and Respiratory tube, Sex determination in Drosophila and Mammals.

UNIT-V

Ramifications of Developmental Biology: Medical Implications of Developmental biology: Genetic errors of human development, Infertility, In Vitro fertilization (IVF) and Teratogenesis (disruptors of teratogenesis), Developmental biology and future of medicine.

TEXT BOOKS:

1. ManjuYadav, "Molecular Developmental Biology" Discovery Publishing, September, 2008.
2. Scott F Gilbert, Michael JF Barresi. "Developmental Biology", 11th edition, Sinauer Associates, Inc, 2013.

SUGGESTED READING:

1. Snustad P, Simmons and Jenkins, "Principles of Genetics", 2nd Edition, John Wiley Publications, 1999.
2. P.C.Jain , "Elements of Developmental Biology" International Publications, 2013.

22BTE04

INTELLECTUAL PROPERTY RIGHTS AND BIOETHICS
(Professional Elective-I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course is intended to impact awareness on intellectual property rights and various regulatory issues related to IPR

COURSE OUTCOMES:
1. Demonstrate a breadth of knowledge in Intellectual property
2. Understand the overview of Patents, Searching, filling and drafting of Patents
3. Understand the overview of copyright, GI, trademark, and trade secret
4. Understand about different national and international: Conventions and Treaties Governing the IPRs
5. Understand various aspects of bioethics and its practical implications

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2			2	2	1				3	2	2
CO2	2	2	2		2			1	1	1		2	2	2
CO3	2	2	2			2	2					3	2	2
CO4	2	2	2			3	3	2	1	1		3	2	2
CO5	2		2			3	3	3		1		2	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to IPR: Discovery, Invention, Creativity, Innovation, History & Significance of IPR, Overview of IPR- Patent, Copyright, Trade Mark, Trade Secret, GI, Industrial Design & Integrated Circuit, Non-patentable criteria.

UNIT-II

Patents: Patents-Patentability Criteria, Types of Patents-Process, Product & Utility Modes, Software Patenting and protection, Patent infringement- Case studies- Apple Vs Samsung, Elfish LLC VS Microsoft, Overview of Patent search- Types of Searching, Public & Private Searching Databases, Basics of Patent Filing & Drafting, Indian Patents Law.

UNIT-III

Copyrights, Geographical Indications, Trademark and Trade secrets: Types of Copyrights, Procedure for filing, copyright infringement, Copyright Law, Geographical Indications- Tirupati Laddu, Darjeeling Tea, Basmati rice. Trade Marks- Commercial importance, protection, registration, Case Studies- Sabena and Sabena, Castrol Vs Pentagon, Trade Secrets- Case Studies-Kentucky Fried Chicken (KFC), Coca-Cola.

UNIT-IV

Protection of Industrial Designs & International Conventions & Treaties: Industrial Designs- Scope, protection, filing, infringement; Overview of WTP. GATT. TRIPS. WIPO, Patent Cooperation Treaty (PCT), International IPR Agreements Regulating Plant Varieties and Plant Breeders' Rights.

UNIT-V

Bioethics: Principles of bioethics: Legality, morality and ethics, autonomy, human rights, beneficence, privacy, justice, equity etc. The expanding scope of ethics from biomedical practice to biotechnology, bioethics vs. business ethics, The legal, institutional and socioeconomic impacts of biotechnology; biotechnology and social responsibility, Biosafety regulations and national and international guidelines with regard to recombinant DNA technology. Guidelines for research in transgenic plants. National and international regulations for food and pharma products.

TEXT BOOK:

1. Deborah E. Bouchoux, Intellectual Property for Paralegals- The law of Trademarks, Copyrights, Patents & Trade secrets, 3rd Edition, Cengagelearning,2012.
2. N.S. Gopalakrishnan& T.G. Agitha, Principles of Intellectual Property, Eastern Book Company, Lucknow, 2009.
3. Goel and Parashar. IPR, Biosafety, and Bioethics Pearson Education India; First edition (1 January 2013)

SUGGESTED READINGs:

1. M.M. S. Karki, Intellectual Property Rights: Basic Concepts, AtlanticPublishers, 2009.
2. Neeraj Pandey & Khushdeep Dharni, Intellectual Property Rights, Phi Learning Pvt. Ltd.
3. Ajit Parulekar and Sarita D'Souza, Indian Patents Law- Legal & Business Implications; Macmillan India Ltd, 2006.
4. B.L. Wadehra, Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd.India2000.
5. P. Narayanan; Law of Copyright and Industrial Designs; Eastern Law House, Delhi, 2010.

22BT E05

ARTIFICIAL INTELLIGENCE IN BIOLOGY
(Professional Elective -I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES

1. Become familiar with basic principles of AI towards problem-solving, inference, perception knowledge representation, and learning
2. Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks, and other machine learning models.
3. To understand the applications of AI, and expert systems.

COURSE OUTCOMES: At the end of the course, the students are able to:

1. Compare AI with human intelligence and traditional information processing and discuss its strengths and limitations.
2. Apply the basic principle, models and algorithms of AI to recognize, model, and solve problems in the analysis and design of information systems and also to solve molecular biology problems.
3. Relate language processing to address the questions related to DNA
4. Explain the neural networks in biology, especially in protein characterization etc.
5. Outline an expert system for the identification of optimized solutions.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
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CO2	3	2	2		3			2	2	2		3	3	
CO3	3	2	2		2			2	2	2		3	3	
CO4	3	2	2		2			2	2	2		3	3	
CO5	3	2	2		3			2	2	2		2	3	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Artificial Intelligence Introduction: Overview of Artificial Intelligence (AI); The AI Problems; AI Techniques; The level of the model; Criteria for success.

Problems, Problem Spaces, and Search: Problem as a State Space Search; Production Systems; Problem Characteristics; Production Systems Characteristics; Issues in the Design of Search Problems

UNIT-II

Heuristic Search Techniques: Generate-and-test; Hill-Climbing; Simulation Annealing; Best-First-Search; Local Search, Greedy Algorithms; Problem Reduction; Constraint Satisfaction; Means-ends Analysis

RNA secondary structure prediction problem (*2˚RNA*): Secondary Structure of RNA; Structure and Free Energy—A Mathematical Model; RNA secondary structure prediction as a Search problem

UNIT-III

Computational Linguistics

Formal Language Theory: The Formal Specification of Languages; Chomsky Hierarchy and Subdivisions; Lindenmayer Systems; Properties of Language Families; Parsing. Computational Applications of Language Theory: Natural Language; Computer Languages and Pattern Recognition; Developmental Grammars; Gene Grammars

Structural Linguistics of Nucleic Acids: Properties of Reverse Complementarity; Closure Properties for Nucleic Acids. Structural Grammars for Nucleic Acids: Context-Free and Indexed Grammars;

UNIT-IV

Artificial Neural Networks: Introduction: Model of a neuron; Feedback and Feed-forward Networks; Training Procedure; Network Optimization.

Protein Structure Prediction with Neural Networks: a -Helix, b-Strand, and Coil Predictions; b-turn Predictions; Secondary Structure Composition Predictions.

UNIT-V

Evolutionary Algorithms: Introduction; Evolution of Solutions; Components in a Genetic Algorithm; Representation of a Solution in the Genetic Algorithm; Operation of the Genetic Algorithm; Evolution; Selection and Crossover Strategies; Encoding; Repairing String Damage; Fine Tuning; Traps; Other Evolutionary Algorithms

Genomic Regulatory Networks and Modeling Development: Description of Sample Problem; Representations of Potential Solutions; Simple Model of Development, Developmental Procedures; Fitness Evaluation; Overall Evolution.

TEXT BOOKS:

1. Elaine Rich, Kevin Knight, Shivashankar B. Nair; Artificial Intelligence; Third Edition; Tata McGraw Hill. 2017
2. Lawrence Hunter; Artificial Intelligence and Molecular Biology; AAAI Press, First Edition
3. Hugh Cartwright, Using Artificial Intelligence in Chemistry and Biology- A Practical Guide, CRC Press, Taylor & Francis Group (2008)

22BTC21

FLUID MECHANICS AND HEAT TRANSFER LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES:

1. This lab course is designed to understand the mechanics of fluid flow, analysis of various processes viz., Flow measuring devices (Venturimeter, Mouthpiece, and Triangular notch.) and heat exchangers.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Calculate the coefficient of discharge of different flow measuring devices and Reynold's Number based on the distinction between the types of flow. (Expt. 1,2,3,4,5)
2. Determine the friction losses in pipe fittings & verify Bernoulli's Theorem. (Expt. 6,7)
3. Predict the Thermal conductivity of homogeneous wall insulating powder under steady-state conditions. (Expt.8)
4. Determine the heat transfer coefficient in Natural, Forced convection using PIN FIN apparatus and Predict the emissivity of a non-black surface. (Expt. 9,10,11)
5. Calculate the overall heat transfer coefficient for parallel flow and counter flow in a Double pipe heat exchanger. (Expt. 12,13)

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2	2	2	3	2	2		2	2		3	3	3
CO2	2	2	2	2	2	2	2		2	2		2	3	3
CO3	2	2	2	3	2	2	2		3	3		2	2	2
CO4	3	2	2	3	2	2	2		3	3		2	3	2
CO5	2	2	2	2	3	2	2		2	2		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

At least 10 experiments are to be conducted from the following list of experiments.

LIST OF EXPERIMENTS

1. Determination of discharge coefficient for orifice meter and venturimeter and their variation with Reynolds number.
2. Determination of discharge coefficient for Mouthpiece for constant head method and time of fall method.
3. Determination of weir meter constant K for v-notch and rectangular notch.
4. Calibration of rotameter and study of variation of flow rate with tube to float diameter.
5. Determination of viscosity of different fluids.
6. Determination of friction losses in pipe fittings.
7. Determination of Reynold's Number based on the types of flow.
8. Verification of Bernoulli's Theorem.
9. Determination of Thermal conductivity of homogeneous wall insulating powder under steady-state conditions.
10. Determination of heat transfer coefficient in Natural convection.

11. Determination of heat transfer coefficient in forced convection.
12. Determination of emissivity of nonblack surface.
13. Determination of Overall heat transfer coefficient for parallel flow in a double pipe heat exchanger.
14. Determination of Overall heat transfer coefficient for counter flow in a double pipe heat exchanger.

SUGGESTED READING:

1. WL Mc Cabe and JC Smith, "UnitoperationsinChemicalEngineering", 7th edition, McGraw Hill Intl. Ed, 2019.

E-RESOURCES:

1. NPTEL – NOC: Fluid and particle mechanics, Prof. Sumesh, Prof. Basavaraju, IIT Madras
2. NPTEL – NOC: Heat Transfer, Prof, Sunando Dasgupta, IIT Kharagpur.

22BTC22

GENETIC ENGINEERING LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES:

1. To know the isolation and analysis of DNA.
2. To know the incision of DNA by using the restriction endonucleases.
3. To learn the amplification of DNA by polymerase chain reaction
4. To understand the cloning strategies of DNA.
5. To know about DNA sequencing and expression of recombinant protein from transformed bacterial cultures.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Demonstrate the isolation and visualization of nucleic acids. (Expt. 1,2,3)
2. Characterize the DNA by restriction digestion and restriction mapping. (Expt. 4,5)
3. Plan different steps involved in cloning strategies of DNA (Expt. 6,7,8,9,10)
4. Perform the polymerase chain reaction. (Expt. 11)
5. Analyze the DNA Sequencing and recombinant protein by using SDS PAGE (Expt. 12,13)

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2	2		2	2	3	3	2	3	3		3	3	3
CO2	2	2		2	3	3	3	2	3	3		3	3	3
CO3	2	2		2	2	3	3	2	3	3		3	3	3
CO4	2	2		2	2	3	3	2	3	3		3	3	3
CO5	2	3		2	3	3	3	2	3	3		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

At least 10 experiments are to be conducted from the following list of experiments.

LIST OF EXPERIMENTS

1. Isolation of genomic DNA
2. Isolation of plasmid DNA
3. Visualization of Genomic and Plasmid DNA on Agarose gels
4. Restriction digestion
5. Restriction mapping (Structured inquiry)
6. Gel elution.
7. DNA ligation.
8. Preparation of competent cells.
9. Genetic transformation and screening for recombinant bacterial cells.
10. Blotting techniques- southern blotting.
11. Amplification of DNA fragments by Polymerase Chain Reaction (PCR).
12. DNA sequencing- Sanger's Method
13. Analysis of Recombinant Proteins using SDS-PAGE (open-ended experiment)

SUGGESTED READING:

1. Green MR and Sambrook J, "Molecular Cloning-A laboratory manual", Vol I, II and III, Cold Spring \ Harbor Laboratory Press, 2012

22BTC23

PLANT BIOTECHNOLOGY LAB

Instruction	3 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES:

1. The students should be able to understand explicitly the concepts of Plant Tissue culture
2. Develop their skills in plant tissues culture techniques in horticultural/medicinally important plants.
3. Get extensive exposure to various techniques of plant cell and tissue culture.
4. To develop a protocol for genetic transformation using Agrobacterium strains.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Prepare plant tissue culture medium for in vitro studies. (Expt 1,2)
2. Execute the protocols for Surface sterilization, Organ culture, and Callus induction using various explants. (Expt 3,4,5,10)
3. Develop in vitro techniques for micropropagation of meristem /nodal explants of horticulture and medicinal plants. (Expt. 6,7,8,9)
4. Demonstrate the Protoplast isolation from various plant tissues using enzymatic methods. (Exp.11)
5. Develop a system for genetic transformation in plants using Agrobacterium strains (Expt 12)

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2	2	2	2	2	2			1	3	3	3
CO2	2	2	1	2	2	3	3	1		1		2	3	3
CO3	2	2	2	2	2	3	3	2	1	1	2	2	3	3
CO4	2	1	1	2	2	2	2	2		1		2	1	2
CO5	2	2	1	2	2	3	3	2			1	3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

At least 10 experiments are to be conducted from the following list of experiments.

LIST OF EXPERIMENTS

1. Preparation of MS Stock solutions
2. Preparation of MS Plant Tissue Culture Media (Structured inquiry)
3. Surface sterilization
4. Callus induction from a mature embryo/ leaf/ root/anther. etc.
5. Cell suspension cultures initiation and establishment
6. Organogenesis and Embryogenesis
7. Meristem tip culture for the production of virus-free plants
8. Micropropagation of horticultural/medicinally important plants (open-ended experiment)
9. Root induction and acclimatization of in vitro plantlets
10. Production of synthetic seeds.
11. Protoplast isolation (demo)
12. Agrobacterium-mediated gene transfer: induction of Hairy roots

SUGGESTED READING:

1. H. Jones and John M. Walker, "Plant Gene Transfer and Expression Protocols: Methods in Molecular Biology, 49, Humana Press, 1996.
2. J. G. Chirikjian, Biotechnology: Theory and Techniques (Plant Biotechnology, Animal Cell Culture and Immunobiotechnology), Jones & Bartlett Publishers, U.K., 1996.

22EGCO3

EMPLOYABILITY SKILLS

Instruction	2 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Prerequisite: Basic Knowledge of Soft skills in the professional setting.

COURSE OBJECTIVES: To help the students

1. Learn the art of communication; participate in group discussions and case studies with confidence and to make effective presentations.
2. With- resume packaging, preparing them to face interviews.
3. Build an impressive personality through effective time management, leadership qualities, self- confidence and assertiveness.
4. Understand professional etiquette and to make them learn academic ethics and value system.
5. To be competent in verbal aptitude.

COURSE OUTCOMES: By the end of the course**,** the students will be able to

1. Become effective communicators, participate in group discussions with confidence and be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals, learn to manage time effectively and deal with stress.
4. Make the transition smoothly from campus to work, use media with etiquette and understand the academic ethics.
5. Enrich their vocabulary, frame accurate sentences and comprehend passages confidently.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1		1				1	1	2	3	3	1	3		1
CO2								1		2		1		
CO3						1	1	1	2	1	1	3		1
CO4		1	1			1	1	2	3	3	1	3		2
CO5								1	2	2	1	3		

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT I

Verbal Aptitude: Error Detection, Articles, Prepositions, Tenses, Concord and Transformation of Sentences-Jumbled Words/Sentences- Vocabulary, Synonyms, Antonyms, One Word Substitutes, Idioms and Phrases, Word/Sentence/Text Completion- Reading Comprehension.

UNIT II

Group Discussion & Presentation Skills: Dynamics of Group Discussion-Case Studies-Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Accuracy, Coherence. Elements of Effective Presentation – Structure of a Presentation – Presentation tools – Body language - Preparing an Effective PPT.

UNIT III

Behavioural Skills: Personal strength analysis-Effective Time Management- Goal Setting-Stress management-

Corporate Culture – Grooming and etiquette-Statement of Purpose (SOP).

UNIT IV

Mini Project: Research-Hypothesis-Developing a Questionnaire-Data Collection-Analysis-General and Technical Report - Writing an Abstract –Technical Report Writing-Plagiarism-Project Seminar.

UNIT V

Interview Skills: Cover Letter and Résumé writing – Structure and Presentation, Planning, Defining the Career Objective, Projecting ones Strengths and Skill-sets – Interviews: Concept and Process, Pre- Interview Planning, Opening Strategies, Answering Strategies, Mock Interviews.

TEXT BOOKS:

1. Leena Sen, "Communication Skills", Prentice-Hall of India, 2005.
2. Gulati and Sarvesh, "Corporate Soft Skills", New Delhi: Rupa and Co., 2006.
3. Edgar Thorpe and Showick Thorpe, "Objective English", 2nd edition, Pearson Education, 2007.
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010.

SUGGESTED READING:

1. Van Emden, Joan, and Lucinda Becker, "Presentation Skills for Students", New York: Palgrave Macmillan, 2004.
2. R.S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", 2018.
3. Covey and Stephen R, "The Habits of Highly Effective People", New York: Free Press, 1989.
4. Shalini Verma, "Body Language - Your Success Mantra", S Chand, 2006.

22BTI02

INDUSTRIAL / RURAL INTERNSHIP-II

Instruction	3-4 week
Duration of Internship	90 Hours
CIE	50 Marks
Credits	2

COURSE OBJECTIVES: This course aims to:

1. Expose students to industrial and rural environments, including those relevant to biotechnology.
2. Create awareness of current industrial technological developments, particularly in the field of biotechnology.
3. Provide opportunities to understand the social, economic, and administrative considerations within organizations and rural areas, with a focus on biotechnological applications where applicable.

COURSE OUTCOMES: Upon completion of this course, students will be able to:

1. Execute established biotechnological protocols and techniques with precision and adherence to organizational safety standards. (Assessed primarily by the Mentor Evaluation and confirmed in the Viva-Voce.)
2. Uphold professional standards of conduct, including teamwork, ethical responsibility, and effective communication within the organizational culture. (Assessed primarily by the Mentor Evaluation.)
3. Analyze the purpose and importance of assigned tasks and protocols within the host organization's workflow and quality management framework. (Assessed primarily by the "Evaluation of the Industry" component and the Report.)
4. Accurately document observations, manage scientific data, and interpret results in the context of the specific project or operational goal. (Assessed primarily through the quality of the Report, Presentation of data, and Viva-Voce questioning.)
5. Communicate the internship activities, technical findings, and professional growth effectively through a structured written report and oral presentation. (Assessed directly by the quality of the final Presentation and Report.)

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2		2		1	2	2	2	2	3	2	3	3	3
CO2	2		2	2	3	2	2		3	3	2	3	3	3
CO3	2	2	2	2	2	2	2		2	3	2	3	3	3
CO4	2	2		1	2	2	2	3	3	2		3	3	3
CO5	2	2	2	2		2	2		3	3	2	3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

INTERNSHIP GUIDELINES:

a) Student's Diary/Daily Log: The students should record the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. Students shall be ready to show the diary to the industry supervisor or the Faculty Mentor at any point of time. Failing to produce the same, the Intern may be debarred for the remaining period of his/her internship. A daily diary needs to be submitted to the Faculty Mentor at the end of the Internship along with the attendance record and an evaluation sheet duly signed and stamped by the industry. Daily diary is evaluated based on the following criteria:

- Regularity in maintenance of the diary/log
- Adequacy & quality of information recorded
- Drawing, sketches, and data recorded.

- Thought process and recording techniques used
- Organization of the information

b) Internship Report: At the end of the internship, each student should prepare a comprehensive report to indicate what he/she observed and learned in the training/internship period. It should be signed by the internship supervisor. The report will be evaluated by the Industry Supervisor on the basis of the following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

EVALUATION OF INTERNSHIP:

The industrial training/internship of the students will be evaluated in three stages:

d) Evaluation by the Industry (10 marks) (in the range of 1 to 10 where 1-Unsatisfactory; 10-Excellent)
e) Evaluation by faculty supervisor on the basis of site visit(s) or periodic communication (15 marks)
f) Evaluation through seminar presentation/Viva-Voce at the Institute (This can be reflected through marks assigned by Faculty Mentor (25 marks))

Evaluation through Seminar Presentation/Viva-Voce at the Institute: Students will give a seminar based on his/her training report before an Expert Committee constituted by the concerned department as per the norms of the institute. The evaluation will be based on the following criteria:

- Quality of content presented
- Proper planning for presentation
- Effectiveness of presentation
- Depth of knowledge and skills
- Attendance record, daily diary, and departmental reports shall be analyzed along with the internship Report

Monitoring/ Surprise Visits: During the internship program, the faculty mentor makes a surprise visit to the internship site, to check the student's presence physically. If the student is found to be absent without prior intimation to the concerned industry, entire training/internship may be canceled. Students should inform through email to the faculty mentor as well as the industry supervisor at least one day prior to avail leave.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
In line with the AICTE Model Curriculum with effect from AY 2024-25

B. Tech BIOTECHNOLOGY

SEMESTER-VI

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours Per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
	THEORY								
1	22BTC24	Bioseparation Engineering	3	-	-	3	40	60	3
2	22BTC25	Bioinformatics and Computational Biology	3	-	-	3	40	60	3
3	22BTC26	Mass Transfer Operations	3	-	-	3	40	60	3
4	22BTEXX	Professional Elective – II	3	-	-	3	40	60	3
5		Open Elective- I	3	-	-	3	40	60	3
	PRACTICALS								
6	22BTC27	Bioseparation Engineering Lab	-	-	3	3	50	50	1.5
7	22BTC28	Bioinformatics and Computational Biology Lab	-	-	3	3	50	50	1.5
8	22BTC29	Mini Project	-	-	4	-	50	-	2
9	22BTU02	Upskilling Certification Course - II	-	-		-	25	-	0.5
Total			**15**	**0**	**10**	**21**	**375**	**400**	**20.5**
Clock hours per week:25									

L: Lecture T: Tutorial P: Practical

CIE – Continuous Internal Evaluation SEE – Semester End Examination

BTEXX	**Professional Elective – II**	**Open Elective – I**		
22BTE06	Good Manufacturing and Laboratory Practices	1	22MTO03	Biostatistics
22BTE07	Medical Biotechnology	2	22EGO01	Technical Writing Skills
22BTE08	Phytochemical and Herbal Products	3	22CIO01	Fundamentals of IoT
22BTE09	Regulatory Affairs and Clinical Trials	4	22CAO01	Foundations of Artificial Intelligence and Machine Learning
22BTE10	Structural Biology			

22BTC24

BIOSEPARATION ENGINEERING

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. Student is made to understand the role and importance of downstream processing.
2. Students are taught the various techniques of cell disruption and the principles of solid liquid separation processes, filtration and centrifugation
3. Students are made to understand the principles of membrane-based separations and their applications.
4. Students are enlightened about chromatographic separations, types and their importance in product purification.
5. Students are made to study the principle of crystallization, drying and lyophilization.

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

1. Outline the key aspects of downstream processing of biotechnological process and develop process design for bioproducts.
2. Distinguish the various techniques of cell disruption and UNIT-operations for separation of bioproducts.
3. Compare various membrane separation processes as well as various product enrichment operations.
4. Interpret various applications of chromatographic techniques for separation of bioproducts.
5. Analyze various product finishing techniques and case studies of important bioproducts

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	3	2			2	2	2		2		2	3	3
CO2	2	3	2			2	2	2		2		2	3	3
CO3	2	3	2			2	2	2		2		2	3	3
CO4	2	3	2			3	3	2		2		2	3	3
CO5	2	3	2			3	3	2		2		2	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Role of Downstream Processing in Biotechnology: Role and Importance of Downstream Processing in Biotechnological Processes; Characterization of Biomolecules (CD spectroscopy, UV-Vis, and FTIR) and fermentation broths; Physico-chemical basis of Bio-separations; Process design criteria for bioproducts and downstream process economics.

UNIT-II

Primary Separation and Recovery Processes: Cell Disruption methods for intracellular products: Mechanical, Chemical, and Enzymatic Methods; Separation techniques for removal of insoluble and biomass: Flocculation, Sedimentation, and Centrifugation; Filtration: Theory, Equipment-depth filters, Plate and frame filters, Pressure leaf filters, Continuous rotary drum filters, Filter media, and Filter aids, Problems on specific resistance of the cake, time taken for filtration, and compressibility of cake.

UNIT-III

Product Enrichment Operations: Membrane-based separations: Types of membranes, Types of flow (Crossflow, Tangential flow and Mixed flow), Types of membrane-based separations (Microfiltration,

Ultrafiltration, Dialysis, Electro dialysis, Reverse Osmosis), Design and configuration of membrane separation equipment and Applications, Solution diffusion model, Capillary flow model; Aqueous Two-phase extraction of proteins; Precipitation of proteins with salts and organic solvents; Adsorption processes.

UNIT-IV

Product Purification: Chromatographic separations: Principles, Classification, General description of column chromatography (GC, HPLC; IMAC, Bio-affinity Chromatography); Design and selection of chromatographic matrices; Large-scale chromatographic separation processes.

UNIT-V

Finishing techniques: Pervaporation; Supercritical fluid extraction; Electrophoretic Separations; Final Product Polishing (Crystallization and Industrial crystallizers; Drying and Industrial dryers, and Lyophilization); Case studies (Citric acid / Penicillin and Low volume high value product like recombinant proteins).

TEXT BOOKS:

1. Sivasankar B, J M Asenjo, Separation processes in Biotechnology, Marcel-Dekker, 1993.
2. Keith Wilson, John Walker, John M. Walker, Principles and Techniques of Practical Biochemistry 5th edition Cambridge University Press, 2000.

SUGGESTED READING:

1. Prasad, Krishna Kant, and Nooralabettu Krishna Prasad, Downstream process technology: a new horizon in biotechnology, PHI Learning Pvt. Ltd., 2010.
2. Ladisch and Michael R., Bioseparation engineering: principles, practice, and economics, Wiley publications, 2001.

E-RESOURCES:

1. NPTEL course: Principles of Downstream Techniques in Bioprocess by Prof. Mukesh Doble, IIT Madras.
2. NPTEL course: Membrane Technology by Prof. Kaustubha Mohanty, IIT Guwahati
3. NPTEL course: Novel Separation Processes by Prof. S. De, IIT Kharagpur.

22BTC25

BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To provide elementary knowledge in bioinformatics and biological information available to a biologist on the web and learn how to use these resources on their own.
2. To learn the fundamentals of biological databases and sequence alignment.
3. To understand the evolutionary relationship among organisms.
4. To learn methods for determining the order of the nucleotide and predicting the gene.
5. To aid in understanding structural bioinformatics and Docking.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Retrieve and analyze information from different types of biological databases
2. Identify the methods used for sequence alignment
3. Construct an evolutionary tree by using different methods and software tools
4. Sequence, assemble genome sequences, and predict the gene.
5. Predict Protein structure and demonstrate docking methods for Identification of lead molecules

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	1	1			2	3	3		2	2		2	3	
CO2	2	2			3	3	3		2	2		2	3	
CO3	2	2			3	3	3		2	2		2	3	
CO4	2	2			3	3	3		2	2		3	3	
CO5	2	2			3	3	3		2	2		3	3	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Bioinformatics and Biological Databases: Bioinformatics - Scope, and application of Bioinformatics; Biological databases - types of biological database, file formats for biological sequence (NCBI, EMBL, SWISS-PROT, FASTA); Information retrieval from biological Databases.

UNIT-II

Sequence Alignments: Sequence database search- FASTA, BLAST, various versions of BLAST and FASTA; Amino acid substitution matrices - PAM and BLOSUM. Sequence Alignment - Local, Global alignment; Methods of Pairwise sequence alignment; Methods of Multiple Sequence alignment.

UNIT-III

Phylogenetic Analysis: Understanding Evolutionary process; Relationship of phylogenetic Analysis to sequence alignment; Concept of evolutionary trees; Methods of Phylogenetic analysis, Tree Evaluation, Problems in Phylogenetic Analysis, Automated Tools for Phylogenetic Analysis.

UNIT-IV

Genome Sequencing and Gene Prediction: DNA sequencing, Genome Mapping; Genome sequencing, cDNA sequencing, Genome Sequence Assembly and tools; Genome Annotation; Human genome project; Basis of Gene Prediction, Gene Prediction Methods in Microbial genomes and eukaryotes, Other Gene Prediction Tools.

UNIT-V

Structural Bioinformatics and Molecular Docking: Protein structure basics, protein structure classification, visualization and comparison, protein secondary structure prediction, and protein tertiary structure prediction; Methods of Docking – Flexible and Rigid Docking, Applications and limitations of docking, Docking algorithms – Genetic algorithm; QSAR.

TEXT BOOKS:

1. David Mount, "Bioinformatics Sequence and Genome Analysis", 2nd Edition, CBS Publishers and Distributors Pvt. Ltd., 2005.
2. Rastogi SC, Mendiratta N, and Rastogi P, "Bioinformatics: Methods and Applications Genomics, Proteomics and Drug Discovery", 4th edition, PHI Learning Private Limited, New Delhi, 2013.
3. Jin Xiong, "Essential Bioinformatics", 1st Edition, Cambridge University Press, 2007.

SUGGESTED READING:

1. Baxebanis AD and Francis Ouellette BF, "Bioinformatics a practical guide the analysis of genes and proteins", 2nd edition, John Wiley and Sons, Inc., Publication, 2001.
2. Vittal R Srinivas, "Bioinformatics: A modern approach. PHI Learning Private Limited", New Delhi, 2009.

22BTC26

MASS TRANSFER OPERATIONS

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To provide the students with knowledge about various UNIT-operations such as absorption, distillation, extraction, leaching.
2. To give insight about various membrane separation processes such as adsorption, ion exchange, dialysis, and the application of these UNIT-operations in commercial aspects of biotechnology.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Predict the rate of mass transfer in solids, liquids and gases.
2. Determine the number of trays needed for separation by Distillation.
3. Understand the equilibrium relations and the equipment for separation by Extraction and Leaching.
4. Calculate the rate and time of drying in constant head and falling rate methods.
5. Distinguish between Liquid and gas permeation processes and understand Adsorption and ion exchange.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2	1	2	2	2	2	1	2	2		3	3	3
CO2	2	2	1	2	2	2	2	1	2	3		3	2	3
CO3	2	2	1	2	2	2	2	1	2	2		3	2	1
CO4	2	2	1	2	2	2	2	1	2	2		3	2	1
CO5	2	2	1	2	2	2	2	1	3	2		3	2	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Principles of Mass Transfer: Introduction to Mass transfer and Diffusion, Molecular diffusion in Gases, Molecular diffusion in Liquids, Molecular diffusion in Biological solutions and gels, Molecular diffusion in Solids, Inter phase mass transfer .**Gas-Liquid operations:** Equilibrium relations between phases, Mass transfer between phases, Choice of solvent for absorption, Single stage and multi stage co current and counter current operations, Estimation of Mass transfer coefficient, packed columns and plate columns.

UNIT-II

Principles of VLE for Binary System: Phase rule and Raoul's law, Boiling point diagrams and x-y plots, Relative volatility, Flash distillation, Differential distillation, Simple steam distillation. Distillation with reflux and McCabe - Thiele method. Special Cases for rectification using McCabe - Thiele; Stripping column distillation, Enriching Column distillation, Rectification with direct steam injection, Rectification with single side stream.

UNIT-III

Liquid-Liquid Extraction and Leaching: Introduction to Extraction process: Equilibrium relations in extraction, Analytical and graphical solutions for single and multistage operations co-current and counter current operations without reflux. Equipment for liquid-liquid extraction: mixer settlers for extraction, Plate and Agitated Tower Contactors for Extraction, Packed and spray Extraction towers. Introduction to leaching process: Equilibrium diagrams for leaching, Equipment for Leaching, analytical and graphical solutions for

single and multi-stage counter current operations.

UNIT-IV

Basic Concepts in Drying of Process Materials: Methods of drying, Equipment for drying; Free moisture content of materials; Concept of bound and unbound moisture content of biological materials; Rate of drying curves; Calculation methods for constant-rate & falling rate drying methods; Freeze drying of biological materials.

UNIT-V

Adsorption And Membrane Separation Process: Theory of adsorption, Industrial adsorbents, Adsorption equilibria, Frendlich equation-single and multiple operations- processing variables and adsorption cycles; Introduction and Types of Membrane separation process: Principles of ion exchange. Dialysis, Gas permeation membrane processes, types of membranes and permeability for separation of gases, Introduction to types of flow in gas permeation.

TEXT BOOKS

1. C J Geankoplis, “Transport Processes in Chemical Operations”, 4th edition, Prentice Hall India, 2015.
2. Robert E Treybal, “Mass Transfer operations”, 3rd edition. McGraw-Hill, 2020
3. W.L. McCabe, J.C. Smith and P. Harriot, "UNIT-Operations of Chemical Engineering", 7th Edn., McGraw Hill Book Co., New York, 2019.

SUGGESTED READING

1. Jaime Benitez, “Principles and Modern Applications of Mass Transfer Operations”, 3rd edition, 2017.
2. J M Coulson and J F Richardson, “Chemical Engineering”, Vol-II, 3rd edition, Pergamom Press.

E-RESOURCES:

1. NPTEL Course- NOC: Mass Transfer Operations, by Prof. Bishnupada Mandal, IIT Guwahati.

22BTE06

GOOD MANUFACTURING & GOOD LABORATORY PRACTICES
(Professional Elective -II)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. Basic understanding of the regulatory requirement of cGMP
2. To know about drug development approval process and regulations related to clinical trials
3. To safely practice laboratory protocols

COURSE OUTCOMES: After studying this course, students will be able to:

1. Learn and adopt quickly in a GMP environment and understand the principles and applications of the GMP and GLP.
2. Evaluate the criteria for drug approval related documentation and quality systems Importance of GMP and GLP for drug regulation
3. Describe quality assurance, design of quality systems, risk analysis and risk assessment
4. Able to apply knowledge of laws related to drug development approval process and regulations related to clinical trials
5. Safety practice basic laboratory procedures and protocols, maintain laboratory records compliant with current industry standards.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	1		2	1	3	3	2	2	2		1	3	2
CO2	2	2			1	2	2	1	2	3		1	3	3
CO3	2	2		2	1	2	2	2	2	2		1	2	3
CO4	2	1		1	1	2	2	1	2	2		2	2	2
CO5	2	2		1	2	2	2	1	2	3		2	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to GMP and GLP: Introduction to Good Manufacturing Laboratory Practice, Definitions, History, Requirement of GLP and GMP compliance for regulatory approval. Role of FDA in CGMP; Recent milestones in FDA. Good Documentation Practice (GDP), Data Integrity & ALCOA principles

UNIT-II

Ethics and design of experiments in GMP: Ethics in manufacturing and control, Principles of quality by design (QBD), Introduction to the concept of Design of Experiment (DOE) Application of QBD principles in Biotech product development. Deviation/CAPA/Change Control, OOS, Failure investigation, self-inspection

UNIT-III

Case studies in GMP: Example of QBD and DOE in Process Development, Example of DOE in analytical development, Introduction to ICH guidelines and their usage. National and international regulatory authorities and their function,. Risk management methods and tools; FMEA, HACCP. Risk Management-ICH Q9, Risk Management Tools

UNIT-IV

A**pproval and regulation process in GMP:** Pharmaceutical Jurisprudence and Laws related to Product design, Drug Development & Approval Process, Regulation of Clinical and Preclinical Studies State level(DCA)and central level(DCGI/CDSCO**)** .Production/Premises- Requirement of Rooms, Equipment, Classification of rooms, sterile production, maintenance of hygiene

UNIT-V

General measures in GLP practices General Rules/Protocols for Lab Safety measures, Precaution and Safety in handling of chemicals, Laboratory tools, Glassware's and instruments. Internal and External Audit, Basic SOP for instrument handling and maintenance, Qualification/Calibration/Maintenance- Definitions: Qualification/validation/calibration/maintenance. Steps in qualification- DQ, IQ, OQ, PQ. Validation of computer systems

TEXT BOOKS:

1. Sarwar Beg, Md Saquib Hasnain, Pharmaceutical Quality by Design: Principles and Applications, Academic Press, (2019)
2. Emmet P. Tobin, cGMP Starter Guide: Principles in Good Manufacturing Practices for Beginners; Createspace Independent Publishing Platform (2016)
3. Good Manufacturing Practices for Pharmaceuticals: GMP in Practice. Mr. B N Cooper, Createspace Independent Publishing Platform (2017)

REFERENCE BOOKS:

1. Good Manufacturing Practices for Pharmaceuticals: Edited by Graham P. Bunn. Seventh edition. Boca Raton, Florida, DRUGS AND THEPHARMACEUTICAL SCIENCES A Series of Textbooks and Monographs Series Executive Editor James Swarbrick, CRC Press, Taylor & Francis Group, (2019)
2. ICH guidelines available in the official website: ICH Official web site : ICH
3. Handbook of Good Laboratory Practices-World Health Organization (WHO)

ONLINE RESOURCES:

https://uspharmacopeia.csod.com/phnx/driver.aspx?routename=Learning/Curriculum/CurriculumPlayer&TargetUser=111017&curriculumLoId=a78fd65e-ed64-4051-81fe-3f6b63609188

22BTE07

MEDICAL BIOTECHNOLOGY

(Professional Elective -II)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To understand the scope and importance of medical biotechnology
2. To understand the differences between the normal cells and cancer cells and various diagnostic methods used in cancer detection.
3. To gain in-depth knowledge about the clinical applications of stem cells & tissue engineering.
4. The course aims at providing knowledge about the working principles and types of advanced materials used in medical field.
5. To learn current molecular therapies and bioethical issues.

COURSE OUTCOMES: At the end of the course the students are able to

1. Outline the various types of genetic disorders.
2. Compare the etiology, diagnosis, and treatment of Cancer.
3. Explain the concepts of Stem cell therapy and Tissue engineering.
4. Discuss the principles and applications of biomedical devices and molecular diagnostics.
5. Classify the molecular therapies and bioethical issues.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
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CO2	2				3	2	2		3	3		3	2	2
CO3	2	2			3	2	2		3	3		3	2	3
CO4	2	2			3	2	2		3	3		3	2	2
CO5	2	2			2	2	2		3	3		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Medical Biotechnology: Introduction, scope and importance of medical biotechnology; The genetic basis of the disease; chromosomal disorders; single gene disorders-modes of inheritance, Thalassemia, Sickle cell anaemia, Cystic fibrosis, Tay Sachs disease, Fragile–X-syndrome; polygenetic disorders; Alzheimer's disease, Type-1 Diabetes and mitochondrial disorders (neurological disorders).

UNIT-II

Medical Oncology: Cancer types; Normal cells vs. cancer cells; cancer genetics; oncogenes and their proteins; tumor suppressor genes and their functions, diagnosis of cancer, Treatment of cancer; Radiation therapy, chemotherapy.

UNIT-III

Stem Cell Treatment and Tissue Engineering: Cellular therapy, stem cells- definition, types, properties and uses of stem cells; sources of embryonic and adult stem cells; Induced Pluripotent Stem cells, concept of tissue engineering; role of scaffolds; clinical applications of stem cells; stem cell banking and ethical issues.

UNIT-IV

Biomedical Devices, Molecular Diagnostics and Biomarkers: Concepts in Biomaterials; principle, properties of Biomaterials and applications of different types of biomedical devices; pacemakers, drug coated stents, knee replacement implants, dental implants, prosthetics), molecular diagnostics by DNA approaches (Taq MAN approach, RT-PCR, Applications of biosensors in medicine. Cellular imaging, in vivo imaging of the biomarkers of the disease, epigenetic markers, fluid-based biomarkers, imaging-based biomarkers (PET, MRI).

UNIT-V

Molecular Therapeutics and Bioethical Issues: Types of molecular therapies; protein therapy by recombinant Monoclonal Antibodies, Enzymes (DNase-1, Alpha-1antitrypsin), Lactic acid bacteria by Leptin, antisense therapy, recombinant vaccines; Bioethical issues in IVF, surrogacy and cloning technologies.

TEXT BOOKS:

1. Judith Pongracz, Mary Keen, "Medical Biotechnology", illustrated edition, Elsevier Health Sciences, 2009.
2. Bernard R Glick, Cheryl L. Patton, Terry L. Delovitch, "Medical biotechnology",1st edition, ASM press, 2013.

SUGGESTED READINGs:

1. Truepenny, Emerys "Elemental Medical Genetics", 14th edition, Churchill Livingstone, 2012.
2. R.J.B. King, Robins, "Cancer Biology", 3rdedition, Prentice Hall, 2006.

22BTE08

PHYTOCHEMICALS AND HERBAL PRODUCTS

(Professional Elective -II)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To impart knowledge on medicinal plants and the extraction of crude drugs.
2. To provide comprehensive knowledge on analysis, types, and detection of phytochemicals and adulterants.
3. To impart knowledge on the applications of various phytochemicals and herbal products.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Classify the sources of various crude drugs and their medicinal values.
2. Outline the procedures involved in the detection, extraction, and analysis of crude drugs and adulterants.
3. Interpret the structure, types and extraction procedure of different plant secondary products.
4. Outline the applications of phytochemicals.
5. Discuss the various aspects of herbal products and licensing of herbal drugs

CO-PO/PSO Articulation Matrix

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

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Crude Drugs, Medicinal and Aromatic Plants: Crude Drugs - Scope and Importance, Classification (Taxonomical, Morphological, Chemical, Pharmacological); Collection and processing of Crude Drugs; Utilization of Medicinal and Aromatic Plants in India; Genetics as applied to Medicinal herbs; Biogenesis of Phytopharmaceuticals.

UNIT-II

Analysis Of Phytochemicals: Methods of Drug evaluation (Morphological, Microscopic, Physical and Chemical); Preliminary screening, Assay of Drugs - Biological evaluation/assays, Microbiological methods, Chemical Methods of Analysis and Detection of Adulterants: Chemical estimations; Drug adulteration - Types of adulterants.

UNIT-III

Types Of Phytochemicals: Carbohydrates and their derived products- Structures, types and extraction methods: Glycosides - Digitalis, Aloe, Dioscorea; Volatile Oils - Clove, Mentha; Alkaloids - Taxus, Papaver, Cinchona; Flavonoids-and Resins; Tannins (Hydrolysable and Condensed types).

UNIT-IV

Applications Of Phytochemicals: Application of phytochemicals in industry and healthcare; Biocides, Bio-fungicides, Biopesticides.

UNIT-V

Herbal Products: History, Scope, and Current aspects of herbs and herbal medicines; Classification of active components of therapeutic plant and herbal products; Preparation of standardized extracts of Garcinea, Forskolin, Garlic, Turmeric and Capsicum, issues of licensing of herbal drugs.

TEXT BOOKS:

1. Kokate CK, Purohit AP, and Gokhale SB, "Pharmacognosy", 4th edition, Nirali Prakashan, 1996.
2. Trease and Evans WC Evans, "Pharmacognosy", 14th edition, Harcourt Brace & Company. 1989.
3. Hornok L, "Cultivation & Processing of Medicinal Plants" Chichester, U. K: J. Wiley & Sons.1992.

SUGGESTED READING:

1. Natural Products in medicine: A Biosynthetic Approach Wiley. 1997
2. Chaudhri RD, "Herbal Drugs industry, A practical approach to Industrial Pharmacognosy" Eastern publishers, 2nd reprint, New Delhi. 1999.

22BT E09

REGULATORY AFFAIRS AND CLINICAL TRIALS
(Professional Elective–II)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To make the students understand about Intellectual property rights and their importance, National and
2. International regulatory affairs, GCP & ICH guidelines.
3. To introduce and provide a comprehensive introduction to Regulatory Affairs as typically practiced by
4. Regulatory Affairs professionals in medical device and biopharma companies.
5. To enable students to follow the Current trends in Clinical research and regulations.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Classify the role of regulatory committees in controlling the risk and information on ethical issues linked to research on animal models, and transgenics.
2. Summarize the Government of India's rules and regulations about the ICH, GCP, and FDA guidelines.
3. Discuss the role of regulatory affairs and their significance globally.
4. Outline the criteria for drug approval-related documentation.
5. Discuss the various phases of clinical trials and the basis of approval of new drugs, their outcome in new drug discovery.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1			2			3	2	2	1	2	1	1	2	3
CO2	1	2	2			3	2	1		1		1	1	2
CO3	1	1		1		2	1	3	1		1	1	1	2
CO4	2	1		1	1	2	2	2		1	1	1	2	2
CO5	2	1		1	1	2	2	2		1	1	1	2	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Regulatory affairs: Definitions of ACT, regulation, guidance, responsibilities of RA professionals. Investigational New Drug, applications. Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBSC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), Recombinant DNA Guidelines (1990),

UNIT-II

Regulatory Affairs- India: Indian contest- requirements and guidelines of GMP, understanding of Drugs and Cosmetic Act 1940 and rules 1945 with SUGGESTED READING schedule M, U & Y. The Narcotics Drugs and Psychotropic Substances Act Medicinal and Toilet Preparations (Excise Duties) Act, 1955 The Pharmacy Act, 1948 Types of ANDA filing (Para I, II, III, IV filing) Clinical trial approval by Drug Controller General of India (DCGI, CDSCO) Exclusivities (NCE, NS, NP, NDF, PED, ODE, PC). ADR: definition and classification

UNIT-III

Regulatory Affairs- Global: Introduction to FDA, WHO, Code of Federal Regulations, ICH guidelines in

Pharmaco vigilance. Related quality systems- objectives and guidelines of USFDA, WHO & European Medicines Agency and its responsibility, EU clinical trial directive. Requirement of GLP: Guidance and recommendation on Dissolution and Bio-equivalence requirement. Hatch Waxmann Act.

UNIT-IV

Documentation And Protocols: Documentation: Types related to the pharmaceuticals industry, protocols, harmonizing formulation development for global fillings, NDA, ANDA, IND, BLA, CTD, DMF, Dealing with post approval changes- SUPAC, handling and maintenance including electronic documentation, 510K device application.

UNIT-V

Introduction To Clinical Research: History, Importance, Phases, Scope and stakeholders in clinical research, Declaration of Helenski, 2000 amendment, Principles of GCP, Roles and responsibilities in clinical research according to ICH GCP, Sponsor, Investigator, Essential documentation, Confidentiality issues. Clinical data management system, Double data entry.

TEXT BOOKS:

1. Good Clinical Practices, Central Drugs Standard Control Organization, Govt. of India Drugs and Cosmetics Act, 1940.
2. Dominique PB and Gerhardt Nahler, "International Clinical Trial", Volume 1 & 2, Interpharm Press,
3. Denver, Colorado.

SUGGESTED READING:

1. Code of Federal Regulations by USFDA-Download
2. ICH-GCP Guidelines-Download.
3. Fleming DA, Hunt DL, "Biological Safety Principles and Practices", 3rd edition, ASM Press, Washington, 2000.

22BTE10

STRUCTURAL BIOLOGY
(Professional Elective -II)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course focuses on

1. To provide the foundation for understanding, the basic structural biology of macromolecules such as Proteins, DNA, and RNA.
2. To give an understanding of the energetics and kinetics of proteins that will facilitate application to current and future research problems.
3. To provide knowledge about various biophysical techniques for protein structure determination.
4. To give an understanding of various bioinformatics tools in structural biology.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Demonstrates the hierarchy in protein organization and structure-function relationship
2. Outlines the mechanisms, dynamics, and physical interactions that maintain protein structure.
3. Demonstrate the basic techniques involved in determining the structure of biomolecules
4. Assess conceptual basics of structural dynamics of other macromolecules DNA, RNA & enzyme
5. Illustrates the computer-based visualizations and molecular simulations

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2					2	2			2		2	3	3
CO2	2					2	2			2		2	2	2
CO3	2	2		2	2	2	2			2		3	3	2
CO4	2				2	2	2			2		2	3	3
CO5	2	2		2	2	2	2			2		3	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Protein Structural Biology: Conformational effect of amino acid on protein structure, basic polypeptide stereochemistry, hierarchy in protein folds: secondary structure, tertiary structure, quaternary structure. Motifs and domains of protein structures. Structure Conformational analysis.

UNIT-II

Protein Kinetics and Energetics: Mechanism of Protein folding- kinetics intermediates- transition states. Thermodynamics of protein stability: Driving forces in protein folding - Estimation of solvation free energies. Bonds and energies in macromolecules- Covalent, Ionic, coordinate, hydrophobic, and Vander walls interactions. Phase problem and methods of phase separation

UNIT-III

Methods for structure determination: Basics of Crystallization, methods of protein crystallization, Macromolecular crystallography: X-ray crystallography, Bragg equation, scattering factor, Nuclear Magnetic Resonance (NMR), Single particle Cryo-Electron Microscopy, FRET advantages and disadvantages of all the processes.

UNIT-IV

DNA, RNA, and Enzyme structures: DNA and RNA secondary structures (duplex, triplex, quadruplexes,

and aptamers), RNA secondary structure prediction. Structural dynamics: Dynamics of Protein-RNA complexes, Enzyme-ligand interaction, Structure-function relationship.

UNIT-V

Computational Structure Biology: Protein Structure visualization tools, Protein fold-function relationships, best practices on the use of protein structures from protein data bank: Protein Data Bank (PDB) and EM Data Bank, BioMagResBank (BMRB). Introduction to molecular dynamics simulation, the need for simulation in studying biology, case studies on structure-based drug designing and protein engineering.

TEXT BOOKS:

1. Liljas L, Nissen P, Lindblom G, Textbook of Structural Biology, Volume 8 of Series in Structural Biology, World Scientific, 2016.
2. Introduction to Protein Architecture: The Structural Biology of Proteins, 2014, Lesk A. M., Oxford University Press; 4th revised Edition.
3. Schwede T, Computational Structural Biology: Methods and Applications, World Scientific, 2008.

SUGGESTED READINGs:

1. Principles of nucleic acid structure, by Stephen Neidle.
2. K.P.Murphy. Protein structure, stability and folding (2001) Humana press. ISBN 0-89603682-0
3. Arthur M. Lesk Introduction to protein architecture (2001) Oxford University Press. ISBN0198504748
4. The Art of Molecular Dynamics Simulation by D. C. Rapaport Cambridge University Press; 2nd edition 2004.
5. Biochemistry, Berg J, M., Stryer L., Tymoczko J, Gatto G. WH Freeman & Co, 2019, 9th Edition.

22MTO03

BIOSTATISTICS
(For Bio-Technology only)

Instruction:	3L Hours per week
Duration:	3 Hours
End Exam:	60 Marks
CIE:	40 Marks
Credits:	3

COURSE OBJECTIVES:

1. Learn the language and core concepts of Statistics
2. Understand basic principles of Random variable and probability function
3. Learn the procedure to fit the random phenomenon using Probability distributions
4. Understand the concept of testing of hypothesis.
5. Learn the methods for analyzing data using Analysis of Variance.

COURSE OUTCOMES: On the successful completion of this course, the student shall be able to

1. Use basic counting techniques to compute probability
2. Compute conditional probabilities using Bayes Theorem
3. Use the probability distributions for fitting of random behavior
4. Find confidence intervals for parameter estimation
5. Setup one way & two way classification for analyzing the data

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2	1	1								2	1	1
CO2	2	2	1	1								2	1	1
CO3	2	2	1	1								2	1	1
CO4	2	2	1	1								2	1	1
CO5	2	2	1	1								2	1	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

BASIC STATISTICS: Types of data – Methods of collection of data-Graphical representation of data-Histogram-Boxplot-Pie chart. Frequency distribution, Measures of central tendencies, Measures of dispersion, Skewness, Bowley's coefficient, Karl Pearson's coefficient of skewness, Kurtosis, Correlation-Lines of regression, properties of correlation coefficients, applications of Bio-technology.

UNIT-II

RANDOM VARIABLES: Basic theorems of Probability, conditional probability, Baye's theorem, Random variable- types of Random variable-probability mass function-probability density functions-Mathematical Expectation, Variance, Co-Variance and their properties, Moments about a point and Moments about the Mean.

UNIT-III

PROBABILITY DISTRIBUTIONS: Discrete probability distribution: Binomial Distribution, Mean, Variance, MGF, CGF, Poisson distribution, Mean, Variance, MGF, CGF, fitting of Poisson distribution. Continuous Probability Distributions: Normal distribution, Standard Normal random variable Expectation, Variance, MGF , CGF, Properties of Normal Curve and Areas under Normal curve.

UNIT-IV

LARGE SAMPLE TEST: Test of significance, null and alternative hypotheses, Errors in sampling, level of significance, critical region, one tailed and two tailed tests.. Large sample test: Test of significance for single proportion, difference of proportions, single mean and difference of means. Difference of Standard Deviations.

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UNIT-V

SMALL SAMPLE TEST: Test of significance, t-Test for single mean, differences of Means. F- test for equality of two population variances , $\chi^2 - test$,Goodness of fit test, test of independent of attributes-r x c-tables, Analysis of variance, Assumptions for ANOVA test, One way Classification ,Two Way Classification.

TEXT BOOKS:

1. S.C. Gupta and Dr.V.K.Kapor,"Fundamentals of Mathematical Statistics: A Modern Approach", tenth edition, Publishers: Sultan Chand & Sons,2005
2. A.K. Sharma ,"Text Book of Bio-Statistics"; Discovery Publishing House, 2005.

SUGGESTED READING:

1. Mahajan, "Methods in Bio-Statistics", Japee Brothers Publishers, 2002.
2. P.S.S Sunder Rao and J. Richard, "Introduction to Bio-Statistics and Research Methods" fifth edition, PHI Learning Pvt. Ltd.2012.
3. S.C. Gupta and Dr.V.K. Kapoor, "Fundamentals of Applied Statistics", tenth edition, Publishers: Sultan Chand & Sons,2005

ONLINE RESOURCE:

1. https://archive.nptel.ac.in/courses/102/101/102101056/

22EGO01

TECHNICAL WRITING SKILLS

(Open Elective -BE/B.Tech - Common to all Branches)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Language proficiency and the ability to simplify complex technical concepts for a diverse audience.

COURSE OBJECTIVES: The course will introduce the students to:

1. Process of communication and channels of communication in general writing and technical writing in particular.
2. Learn Technical Writing including sentence structure and be able to understand and use technology specific words.
3. Write business letters and technical articles.
4. Write technical reports and technical proposals.
5. Learn to write agenda, record minutes of a meeting, draft memos. Understand how to make technical presentations.

COURSE OUTCOMES: After successful completion of the course students will be able to:

1. Communicate effectively, without barriers and understand aspects of technical communication.
2. Differentiate between general writing and technical writing and write error free sentences using technology specific words.
3. Apply techniques of writing in business correspondence and in writing articles.
4. Draft technical reports and technical proposals.
5. Prepare agenda and minutes of a meeting and demonstrate effective technical presentation skills.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1		2	1	1		1	1	2	3	3	2	3	1	1
CO2		1		1				1	2	2	1	2	1	1
CO3		2		2		1	1	1	2	3	2	2	2	1
CO4	2	2	1	3		2	2	1	3	3	2	2	2	2
CO5	1	1	1	1		1	1	1	3	3	2	2	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Communication – Nature and process.

Channels of Communication – Downward, upward and horizontal communication. Barriers to communication.

Technical Communication – Definition, oral and written communication. Importance and need for Technical communication. Nature of Technical Communication. Aspects and forms of Technical communication. Technical communication Skills – Listening, Speaking, Reading & Writing.

UNIT-II

Technical Writing – Techniques of writing. Selection of words and phrases in technical writing. Differences between technical writing and general writing. Abstract and specific words. Sentence structure and requisites of sentence construction. Paragraph length and structure.

UNIT-III

Business correspondence – Sales letters, letters of Quotation, Claim and Adjustment letters.

Technical Articles: Nature and significance, types. Journal articles and Conference papers, elements of technical articles.

UNIT-IV

Technical Reports: Types, significance, structure, style and writing of reports. Routine reports, Project reports.

Technical Proposals: Definition, types, characteristics, structure and significance.

UNIT-V

Mechanics of Meetings: Preparation of agenda, participation, chairing and writing minutes of a meeting. Memorandum. Seminars, workshops and conferences.

Technical Presentations: Defining purpose, audience and locale, organizing content, preparing an outline, use of Audio Visual Aids, nuances of delivery, importance of body language and voice dynamics.

TEXT BOOKS:

1. Meenakshi Raman & Sangeeta Sharma, "Technical Communications-Principles and Practice", Oxford University Press, Second Edition, 2012.
2. M Ashraf Rizvi, "Effective Technical Communication", Tata McGraw Hill Education Pvt Ltd, 2012.

SUGGESTED READING:

1. Kavita Tyagi & Padma Misra, "Basic Technical Communication", PHI Learning Pvt Ltd, 2012.
2. R.C Sharma & Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw Hill, 2003

WEB RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc18_mg13/preview
2. https://www.technical-writing-training-and-certification.com/
3. https://academy.whatfix.com/technical-writing-skills

22CIO01

FUNDAMENTALS OF IoT

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-Requisites: Programming Basics, Computer Architecture and Micro Processor.

COURSE OBJECTIVES:

1. Impart necessary and practical knowledge of components in Internet of Things.
2. Understand working of IoT Systems.
3. Develop skills required to build IoT based systems.

COURSE OUTCOMES: By the end of this course, students should be able to:

1. Understand the various concepts, terminologies and architecture of IoT systems.
2. Classify various sensing devices and actuator types.
3. Understand the Associated IOT Technologies.
4. Develop the IoT application using the different board.
5. Understand and apply various protocols for design of IoT systems.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	1	1	1	1	1							1		
CO2	1	1		1								1		
CO3	1	1		1	2							1		
CO4	2	2	1	1	1	1	1	1		1	1	2		
CO5	2	2	2	1	1							1	1	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to IoT: IoT Definition, IoT Characteristics, IoT Applications, Key Components of IoT System Things/Device, Gateway, Cloud/Server, Analytics, User Interface, Architecture of IoT.

IoT Challenges: Design Challenges, Security Challenges.

UNIT-II

Machine-to-Machine Communications, Difference between IoT and M2M.

IoT Sensing and Actuation: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations, Actuators, Actuator Types, Actuator Characteristics.

Associated IoT technologies: Cloud Computing: Introduction, Virtualization, Cloud Models, Service-Level Agreement in Cloud Computing, Sensor-Cloud: Sensors-as-a-Service.

UNIT-III

Programming with Arduino Uno: ARDUINO UNO board Block diagram, Sketch Structure, Data types & Built in Constants, Operators: Arithmetic, Bitwise, Compound, Comparison, and Boolean, Control statements and Loops, Functions and library functions, LED Blinking using Arduino, Serial Communication Functions,

Introduction to Raspberry Pi Programming, Sample Implementation of IoT with Raspberry Pi

UNIT-IV

IoT Protocols: MQTT, CoAP, XMPP, AMQP, Bluetooth Low Energy (BLE), ZigBee, Z-Wave, RPL.

UNIT-V

IoT Case Studies And Future Trends: Vehicular IoT – Introduction, Healthcare IoT – Introduction, Case Studies, IoT Analytics – Introduction Smart City-Smart Lighting, Smart Parking Environment, Agricultural IoT – Introduction and Case Studies.

TEXT BOOK:

1. Sudip Misra, Anandarup Mukherjee, Arijit Roy, “Introduction to IoT”, Cambridge University Press 2021.
2. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2014.

SUGGESTED READING:

1. S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.
2. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013.

E-RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc24_cs35/preview
2. https://www.nabto.com/guide-iot-protocols-standards/

22CAO01

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Probability and Statistics

COURSE OBJECTIVES:

1. The objective of the course is to provide a strong foundation of fundamental concepts in Artificial Intelligence
2. A basic exposition to the goals and methods of Artificial Intelligence, and fundamentals of machine learning

COURSE OUTCOMES: At the end of this course, the student will be able to

1. Enumerate the history and foundations of Artificial Intelligence.
2. Apply the basic principles of AI in problem solving.
3. Choose the appropriate representation of Knowledge.
4. Enumerate the Perspectives in Machine Learning and various applications of Machine Learning.
5. Model, design and develop solutions to real world problems using Machine Learning Algorithms.

CO-PO Articulation Matrix

PO/PSO / CO	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
CO1	3	1		1							1	1	2	
CO2	3	2	2	3	3	1	1		1	1	1	1	2	
CO3	3	3	2	2	2	1	1		1		1	1	2	
CO4	3	2	2	2	2	1	1	1	1		1	1	2	
CO5	3	2	2	2	2	1	1		1		1	1	2	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction: What is AI?, The Foundations of Artificial Intelligence, The History of Artificial Intelligence, AI techniques, Defining problem as a state space search and Applications of AI.
Problems – tic-tac-toe, 8- puzzle problem, Water Jug Problem.

UNIT-II

Problem Solving: Problem-Solving Agents, Hill climbing, Best-first-search – OR Graphs – A* Algorithm, Problem reduction – AND-OR Graphs – AO* Algorithm and cryptarithmetic problem.

UNIT-III

Game Playing : Mini-max search, Alpha-beta cutoffs.

Knowledge Representation: Knowledge-Based Agents, Approaches to Knowledge Representation, Propositional Logic.

UNIT-IV

Introduction to Machine Learning:

What is Machine Learning, Types of Machine learning, Life Cycle of Machine learning, Applications of ML.

Data Pre-processing Techniques: Missing values, Outlier, Feature Scaling, Feature selection and Data splitting with training and test sets.

UNIT-V

Classification Algorithms: Decision Trees, Naïve Bayes classifiers and SVM: Linear SVM, Performance Metrics with Classification.

Regression Algorithms: Linear Regression, Logistic regression, Performance Metrics with regression and Clustering.

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Pearson.
2. Tom M. Mitchell, Machine Learning, McGraw Hill Edition, 2013.
3. E. Rich K .Knight, and B. Nair, Artificial Intelligence, 3rdEdition, TMH, 1 July 2017 2.
4. Giuseppe Bonaccorso, "Machine Learning Algorithms", 2nd Edition, Packt, 2018.

REFERENCE BOOKS:

1. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, 2011.
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill.
3. David Poole and Alan Mackworth, "Artificial Intelligence: Foundations for Computational Agents",Cambridge University Press 2010.
4. Trivedi, M.C., "A Classical Approach to Artifical Intelligence", Khanna Publishing House, Delhi.
5. Christopher Bishop, Pattern Recognition and Machine Learning (PRML) , Springer, 2007.
6. ShaiShalev-Shwartz and Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms (UML), Cambridge University Press, 2014.

WEB RESOURCES:

1. https://nptel.ac.in/courses/106105077
2. https://nptel.ac.in/courses/106106126
3. https://aima.cs.berkeley.edu
4. https://ai.berkeley,edu/project_overview.html
5. http://www.zuj.edu.jo/download/machine-learning-tom-mitchell-pdf/
6. http://www.ntu.edu.sg/home/egbhuang/pdf/ieee-is-elm.pdf
7. https://swayam.gov.in/nd1_noc20_cs73/preview

22BTC27

BIOSEPARATION ENGINEERING LAB

Instruction	3 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES:

1. To provide an opportunity to experimentally verify the theoretical concepts studied.
2. To give extensive exposure to various UNIT-operations of downstream processing.
3. To design a protocol for the separation of bioproduct based on characteristics.

COURSE OUTCOMES: At the end of the course, the students will be able to

1. Evaluate various techniques for cell disruption, filtration, and separation of bioproducts. (Expt: 1-5)
2. Analyze the optimum product enrichment techniques like precipitation and extraction followed by separation. (Expt: 6-9)
3. Demonstrate the chromatographic separation process for a given compound. (Expt: 10-12)
4. Apply a strategy for final product purification/ polishing of a bioproduct. (Expt: 13, 14)
5. Develop methods for determining enzyme activity. (Expt: 15)

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2		3	2	3	3	2	3	3		3	3	3
CO2	2	2		3	2	3	3	2	3	3		3	3	3
CO3	2	2		3	2	3	3	2	3	3		3	3	3
CO4	2	2		3	2	3	3	2	3	3		3	3	3
CO5	2	2		3	2	3	3	2	3	3		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

At least 10 experiments to be conducted from the following list of experiments.

List of Experiments: Cell Disruption of microorganisms by Enzymatic method

1. Cell Disruption of plant cells/animal cells by Physical methods (Temperature or Osmolysis)
2. Cell Disruption of microorganisms by Ultrasonication method
3. Separation of solids from liquid by Sedimentation and Centrifugation
4. Separation of microorganisms from fermentation broth by Microfiltration or Ultrafiltration
5. Separation of protein by Ammonium Sulphate Precipitation (Structured inquiry)
6. Isolation and quantification of protein from milk by Isoelectric Precipitation
7. Separation of solute particles by Dialysis
8. Separation of biomolecules by Aqueous two-phase extraction.
9. Separation of biomolecules by Gel Exclusion Chromatography.
10. Purification of lysozyme from chicken egg white extract by Ion Exchange Chromatography.
11. Purification of proteins by Affinity Chromatography.
12. Separation of a binary mixture by simple distillation.
13. Purification of bioproducts by drying or crystallization or lyophilization
14. Estimation of Alpha-amylase activity (open ended Experiment)

SUGGESTED READING:

1. David Plummer, "An introduction to Practical Biochemistry" 3rd edition, John Wiley & Sons
2. Principles and Techniques of Biochemistry and Molecular Biology by Keith John Walker John Walker, Cambridge University Press; 6 edition (2005).
3. Laboratory Manual in Biochemistry By J. Jayaraman, Kunthala Jayaramanj, New Age International

22BTC28

BIOINFORMATICS AND COMPUTATIONAL BIOLOGY LAB

Instruction	3 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVE:

1. To provide practical instructions to the students on using the specific databases and learn how to use these resources on their own and analyze the output.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Retrieve the information from biological databases (Expt. 1,2)
2. Utilize BLAST and FASTA online tools to identify the sequence similarity (Expt. 3, 4)
3. Use online sequence alignment tools and construction of evolutionary tree by phylogenetic analysis (Expt. 5,6,7)
4. Predict genes and design primers and construct restriction map. (Expt. 8, 9, 10, 11)
5. Retrieve macromolecular structures and perform docking of a ligand to its target (Expt 12, 13)

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	1	2	2	2	2	3	3		2	2		3	3	
CO2	2	2	2	2	2	3	3		2	2		3	3	
CO3	2	2	2	2	2	3	3		2	2		3	3	
CO4	2	2	2	3	2	3	3		2	2		3	3	
CO5	2	3	2	3	3	3	3		2	2		3	3	

1 - Slightly, 2 - Moderately, 3 - Substantially

Atleast 10 experiments to be conducted from the following list of experiments.

List of Experiments:

1. Searching Bibliographic databases for relevant information.
2. Sequence retrieval from DNA and protein databases.
3. BLAST services.
4. FASTA services.
5. Pair-wise comparison of sequences (Local and global alignment).
6. Multiple Sequence Alignment.
7. Evolutionary studies/ Phylogenetic Analysis.
8. Identification of Genes in Genomes.
9. NCBI ORF Finder.
10. Restriction Mapping (Structured inquiry)
11. Primer Design (Open-ended experiment)
12. Protein Databank retrieval and visualization.
13. Molecular docking with Auto docking Vina

SUGGESTED READING:

1. Baxebanis AD and Francis Ouellette BF, "Bioinformatics a practical guide the analysis of genes and proteins", 2nd edition, John Wiley and Sons, Inc., Publication, 2001.

22BTC29

MINI PROJECT

Instruction	4 P Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	2

Prerequisite: Knowledge of basic lab techniques and tools in Biotechnology

COURSE OBJECTIVES: This course aims to:

1. To enable students learning by practical realization.
2. To develop the capability to analyze and solve real world problems.
3. To develop technical writing and presentation skills.

COURSE OUTCOMES: Upon completion of this course, students will be able to:

1. Formulate mini project proposal through a literature survey.
2. Plan, design, and analyze the proposed mini project.
3. To Simulate and execute the mini project for validation.
4. Enhance oral presentation skills.
5. Prepare and submit the mini project report.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2	2						2	3		3	2	3
CO2	2	2	2	2	3	2	2		3	3		3	2	3
CO3	2	2	2	3	3	3	3		3	3		3	3	2
CO4	2			3					2	2		2	2	3
CO5	2	2		2	2				2	3		2	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

The students are required to choose emerging technology topic for mini project related to the domain. The students have to design and simulate/ implement as per the given schedule. Students have to give an oral presentation in the presence of the department review committee, finally report of the mini project work has to be submitted for evaluation.

Schedule

S. no	Description	Duration
1	Problem identification/selection	2 weeks
2	Preparation of abstract	1 Week
3	Design, implementation and execution of the project	7 Weeks
4	Documentation and mini project presentation	4 Weeks

Guidelines for the Evaluation

S. no	Description	Duration
1	Weekly Assessment	20
2	PPT Preparation	5
3	Presentation	10
4	Queries and Answer	5
5	Documentation of mini project	10
	Total	**50**

Guidelines:

1. Each student will be allotted to a faculty supervisor for mentoring.
2. Mini projects may be targeted to achieve practical competencies.
3. Mini projects shall have inter-disciplinary/ industry relevance.
4. All the results obtained are to be clearly presented and documented with the reasons/explanations.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
In line with the AICTE Model Curriculum with effect from AY 2025-26

B. Tech BIOTECHNOLOGY

SEMESTER-VII

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours Per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
	THEORY								
1	22BTC30	Animal Biotechnology	3	-	-	3	40	60	3
2	22BTC31	Enzyme Technology	3	-	-	3	40	60	3
3	22MBC01	Engineering Economics and Accountancy	3	-	-	3	40	60	3
4	22BTEXX	Professional Elective –III	3	-	-	3	40	60	3
5		Open Elective –II	3	-	-	3	40	60	3
	PRACTICALS								
6	22BTC32	Animal Biotechnology Lab	-	-	3	3	50	50	1.5
7	22BTC33	Project Part - I	-	-	4	-	50	-	2
Total			**15**	**0**	**7**	**18**	**300**	**350**	**18.5**
Clock hours per week: 22									

L: Lecture T: Tutorial P: Practical

CIE – Continuous Internal Evaluation SEE - Semester End Examination

22BTEXX	**Professional Elective – III**
22BTE11	Environmental Biotechnology
22BTE12	Pharmaceutical Biotechnology
22BTE13	Genome editing
22BTE14	Biomaterials
22BTE15	Genomics and Proteomics

	Open Elective - II
22EGO02	Gender Sensitization
22MEO02	3D Printing
22EEO04	Waste Management
22CAO03	Foundations of Deep Learning

22BTC30

ANIMAL BIOTECHNOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. Students are expected to understand the techniques used for animal cell culture.
2. Students will learn various steps involved in the establishment of primary culture, maintenance and scale-up of animal cells.
3. Students will know about the measurement of cell viability & cytotoxicity and cell death.
4. Students are expected to know about stem cells and their applications.
5. Students will know about IVF and embryo transfer, cloning and gene transfer methods for the generation of transgenic animals and their applications.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Explain the animal cell culture requirements and techniques.
2. Outline the establishment maintenance and scale-up of animal cell culture.
3. Discuss Stem cells and their applications and procedure for measurement of cell viability and cytotoxicity and cell death.
4. Explain various methods for IVF and embryo transfer, cloning and generation of transgenic animals and their applications.
5. Outline various applications of animal biotechnology.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2			2	2	2	2	2	2		3	3	3
CO2	2	2			3	2	2	2	2	2		3	2	3
CO3	2	2			3	2	2	3	2	2		3	3	2
CO4	2				2	2	2	2	2	2		3	2	3
CO5	2	2			3	3	3	3	2	2		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Animal Cell Tissue Culture: History and scope of animal cell tissue culture, advantages and disadvantages of tissue culture; Laboratory facilities for animal tissue culture; Aseptic techniques; the substrate on which cells grow; Treatment of substrate surfaces; Culture media for cells and tissues.

UNIT-II

Primary Culture and Cell Lines: Disaggregation (Enzymatic and Mechanical) of tissue and Primary culture. Culture cells and evolution of cell lines. Maintenance of cultures- Cell lines, Cell separation, Cell synchronization; Cloning of cell lines; Cell transformation; Bioreactors for animal cell culture; Scaling-up of animal cell culture.

UNIT-III

Stem Cells, Cell Viability and Toxicity: Stem cells, types of stem cells, embryonic stem cells and their applications; Measurement of cell viability and cytotoxicity, Measurement of cell death; Senescence, Apoptosis, Necrosis.

UNIT-IV

Embryo Transfer, Cloning and Transgenic Animals: Artificial insemination, in vitro fertilization and embryo transfer; Cloning of animals - Reproductive cloning, Therapeutic cloning; Gene transfer or Transfection methods; Transgenic animals- Mice, Sheep, Pig, Rabbit, Goat, Cow and fish.

UNIT-V

Applications of Animal Biotechnology: Application of animal cell culture; Mammalian cell products; viral vaccines produced from animal cell cultures. Three-dimensional culture; Tissue engineering.

TEXT BOOKS:

1. Ian Freshney, R., "Culture of Animal Cells: A manual of basic technique and specialized applications" Seventh edition, John Wiley and Sons, 2016.
2. John Masters, "Animal Cell Culture: A practical approach" OUP Oxford, 2000.
3. Gupta P.K., "Biotechnology and Genomics" Rastogi Publications, 1st edition, 6th reprint, 2013.

SUGGESTED READING:

1. Srivastava, A.K., Singh, R.K., Yadav, M.P., "Animal Biotechnology" Oxford & IBH Publishing Co. Pvt. Ltd., 2005.
2. Ranga, M.M., "Animal Biotechnology", 3 reprint, Agrobios, India, 2010.

22BTC31

ENZYME TECHNOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To learn about basic aspects of enzymes.
2. To understand the catalytic strategies and mechanism of enzyme action.
3. To learn the role of enzyme kinetics and its action.
4. To understand the methods of enzyme immobilization
5. To study about mass transfer kinetics of immobilized enzymes.

COURSE OUTCOMES: At the end of the course, students will be able to

1. Discuss the nomenclature and classification, properties, isolation and purification of enzymes.
2. Describe the catalytic strategies and mechanism of enzyme action
3. Interpret the kinetics of enzyme action and inhibition.
4. Compare various enzyme immobilization techniques and analyze the mass transfer effects in immobilized enzyme systems.
5. Assess the applications of enzymes in different fields.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	3				3	3	2	3	3		3	2	2
CO2	2	3				3	3	2	3	3		3	2	2
CO3	2	3				3	3	2	3	3		3	2	3
CO4	2	3				3	3	2	3	3		3	2	2
CO5	2	3				3	3	2	3	3		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Enzymes: Enzyme, coenzymes, cofactor; general properties of enzymes; Enzyme nomenclature; Classification of enzymes based upon the type of reaction they catalyze, Factors affecting the rates of chemical reactions - Collision theory, transition state theory, Mechanism of catalysis; isolation and purification of crude enzyme extracts from the plant, animal and microbial sources; Development of enzymatic assays.

UNIT-II

Catalytic Strategies and Mechanisms of Enzyme Action: Catalytic strategies – Lysozyme, Ribonuclease A, Carboxypeptidase A, chymotrypsin; Mechanisms of enzyme action; Concept of active site and energetics of enzyme-substrate complex formation; Specificity of enzyme action.

UNIT-III

Kinetics of Enzyme Action and Enzyme Inhibition: Kinetics of single substrate reactions; Turn over number; Derivation of Michaelis -Menten equation; Kinetics of Multi-substrate reaction; Types of Enzyme Inhibition - Reversible inhibition and Irreversible inhibition; Allosteric enzymes.

UNIT-IV

Enzyme Immobilization and Mass Transfer Effects in Immobilized Enzyme Systems: Physical and chemical techniques for enzyme immobilization - adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding; Overview of applications of immobilized enzyme systems; Analysis of Film and pore Diffusion Effects on the kinetics of Immobilized Enzyme Reactions; Formulation of dimensionless groups and calculation of Effectiveness Factors.

UNIT-V

Applications of Enzymes: Applications of commercial enzymes- Proteases; Amylases; Lipases; Cellulases; Pectinases; Isomerases in food, pharmaceutical and other industries; Enzymes for analytical and diagnostic purposes.

TEXT BOOKS

1. Trevor Palmer, Philip Bonner, "Enzymes", 2nd edition, Woodhead Publishing, 2007.
2. Andreas S. Bommarius, Bettina R. Riebel, "Biocatalysis - Fundamentals and Applications", Wiley-VCH, 2004.

SUGGESTED BOOKS

1. Shanmugan, S., "Enzyme technology" I. K. International PvtLtd, 2009.
2. Voet and Voet J.G, "Biochemistry", 4nd edition, John C.WileyandSons, 2010.

E RESOURCES

1. Coursera - Industrial Biotechnology by University of Manchester,Website: Coursera - Industrial Biotechnology
2. edX - Principles of Biochemistry by Harvard University, Website: edX - Principles of Biochemistry
3. NPTEL - Enzyme Science and Engineering by IIT Kharagpur, Website: NPTEL - Enzyme Science and Engineering

22MBC01

ENGINEERING ECONOMICS AND ACCOUNTANCY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to:

1. To demonstrate the importance of Managerial Economics in Decision Making.
2. To explain the concept of Accountancy and provide basic knowledge on preparation of Final accounts.
3. To understand the importance of Project Evaluation in achieving a firm's Objective.

COURSE OUTCOMES: Upon completion of this Course, student will be able to:

1. Apply fundamental knowledge of Managerial Economics concepts and tools.
2. Analyze various aspects of Demand Analysis, Supply and Demand Forecasting.
3. Understand Production and Cost relationships to make best use of resources available.
4. Apply Accountancy Concepts and Conventions and preparation of Final Accounts.
5. Evaluate Capital and Capital Budgeting decision based on any technique.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	1	1	3	1	1	1	1	1	1	1				
CO2	2	2	2	2		1	1	1		1		1	1	
CO3	1	2	1	2	2	1	1	1		1			1	
CO4	2	2	1	2	2	1	1	3		1				
CO5	1	3	1	2	1	1	1			1	2	1		

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Managerial Economics: Introduction to Economics and its evolution - Managerial Economics - its Nature and Scope, Importance; Relationship with other Subjects. Its usefulness to Engineers; Basic concepts of Managerial economics - Incremental, Time perspective, Discounting Principle, Opportunity Cost, Equimarginal Principle, Contribution, Negotiation Principle.

UNIT-II

Demand and Supply Analysis: Demand Analysis - Concept of Demand, Determinants, Law of demand - Assumptions and Exceptions; Elasticity of demand - Price, Income and Cross elasticity - simple numerical problems; Concept of Supply - Determinants of Supply, Law of Supply; Demand Forecasting - Methods.

UNIT-III

Production and Cost Analysis: Theory of Production - Production function - Isoquants and Isocosts, MRTS, Input-Output Relations; Laws of returns.

Cost Analysis: Cost concepts – Types of Costs, Cost-Output Relationship – Short Run and Long Run; Market structures – Types of Competition, Features of Perfect Competition, Price Output Determination under Perfect Competition, Features of Monopoly Competition, Price Output Determination under Monopoly Competition Break-even Analysis – Concepts, Assumptions, Limitations, Numerical problems.

UNIT-IV

Accountancy: Book-keeping, Principles and Significance of Double Entry Bookkeeping, Accounting Concepts and Conventions, Accounting Cycle, Journalization, Ledger accounts, Trial Balance concept and preparation of Final Accounts with simple adjustments.

UNIT-V

Capital and Capital Budgeting: Capital and its Significance, Types of Capital, Estimation of Fixed and Working capital requirements, Methods and sources of raising finance. Capital Budgeting, Methods: Traditional and Discounted Cash Flow Methods - Numerical problems.

TEXT BOOKS:

1. Mehta P.L."Managerial Economics: Analysis, Problems and Cases", Sultan Chand & Son's Educational publishers, 2016.
2. Maheswari S.N. "Introduction to Accountancy", Vikas Publishing House, 12th Edition, 2018.

SUGGESTED READINGs:

1. Panday I.M. "Financial Management", 11th edition, Vikas Publishing House, 2016.
2. Varshney and K L Maheswari, Managerial Economics, Sultan Chand, 2014.
3. M. Kasi Reddy and S. Saraswathi, Managerial Economics and Financial Accounting, Prentice Hall of India Pvt Ltd, 2007.
4. A. R. Aryasri, Managerial Economics and Financial Analysis, McGraw-Hill, 2018.

22BT E11

ENVIRONMENTAL BIOTECHNOLOGY

(Professional Elective-III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: The course aims

1. To provide theoretical concepts and comprehensive knowledge of bioremediation methods.
2. To provide knowledge on metal leaching and non-conventional fuel production.
3. To impart theoretical basics on various methods used in the treatment of wastewater.
4. To provide knowledge on the degradation of Xenobiotic compounds.
5. To update the students with the available information on biotechnological applications in hazardous waste management.

COURSE OUTCOMES: At the end of the course, students will be able to

1. Describe the process of bioremediation in detail.
2. Explain the use of Microorganisms for metal leaching and biofuel generation.
3. Illustrate different methods of wastewater treatment and green energy generation.
4. Categorize different types of wastes and their degradation methods.
5. Evaluate various biotechnological applications for hazardous waste management.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2		2	3	3		2	3		3	2	2
CO2	2	2	2		2	2	2		2	3		3	2	2
CO3	2	3	2		2	3	3		3	3		3	2	2
CO4	2	2	2		3	3	3	2	3	3		2	2	2
CO5	2	2	2		3	3	3	2	3	3		2	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Bioremediation: Introduction to bioremediation and its types- In situ, Ex-situ, Intrinsic and Extrinsic Bioremediation; Constraints and priorities of Bioremediation, Bio stimulation of naturally occurring microbial activities Bio-augmentation; Solid-phase bioremediation- Land farming, composting, Bio pile; Phytoremediation techniques, Slurry/Liquid phase bioremediation, Bio restoration

UNIT-II

Metal Biotechnology and Biofuels: Bioleaching- Types, mechanisms and advantages of microbial leaching; Biosorption and Microbial transformation; Microorganisms and their role in energy requirements of mankind; Production of non-conventional fuels: Methane (Biogas), biohydrogen, bioethanol and Algal biofuels; Application of isolated enzymes versus whole cell systems for remediation and biofuels generation- Microbial Fuel Cells

UNIT-III

Biological Waste Water Treatment: Sources of wastewater and its types, General composition of wastewater; Biological processes for domestic and industrial waste water treatment; Aerobic systems – Activated sludge process, trickling filters, Rotating biological contractors (RBC), Fluidized bed (and biofilm) reactor; Anaerobic biological treatment-Contact digesters, Packed column reactors, UASB,

Other advanced bioreactor configurations

UNIT-IV

Degradation of Xenobiotic Compounds: Xenobiotics and Recalcitrant-Definition, Sources and examples; Co- metabolism; Biodegradation of Xenobiotics present in Environment-Degradative plasmids; Oil Pollution and Bioremediation of Contaminated soils; Biological Detoxification-Cyanide, Toxic Organics and Phenols.

UNIT-V

Hazardous Waste Management: Introduction to general Solid and Hazardous Waste Management-landfills, recycling and processing of organic residues; minimal national standards for waste/wastewater release into the environment; Biotechnological applications to hazardous waste management; Global Environmental problems and Biotechnological approaches for management; Nuclear waste generation and treatment.

TEXT BOOKS:

1. Alan Scragg "Environmental Biotechnology", 2nd edition, Oxford End Press, 2005.
2. Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd., 2007.

SUGGESTED READINGs:

1. Environmental Biotechnology By Priv.-Doz. Dr.Hans-Joachim Jördening, Prof.Dr. Josef Winter, Wiley-VCH Verlag GmbH & Co.KGaA.2005.
2. Stanier R. Y., Ingram J.L., Wheelis M.L., Painter R.R., General Microbiology, McMillan Publications,2009.

22BTE12

PHARMACEUTICAL BIOTECHNOLOGY

(Professional Elective -III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To understand the origin, scope, and importance of pharmaceutical biotechnology.
2. To learn ADME properties of drugs, pharmacokinetics, pharmacodynamics, and drug delivery systems.
3. To understand the materials and formulations of pharmaceuticals.
4. To learn the collection, processing, and storage of blood and plasma substitutes
5. To gain knowledge about pharmaceutical products and their use in the treatment of infectious diseases.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Summarize the fundamentals of biopharmaceuticals.
2. Explain the ADME properties of drugs, pharmacokinetics, pharmacodynamics, and drug delivery systems.
3. Outline the different manufacturing procedures of drugs.
4. Discuss the blood and plasma substitutes.
5. Describe the therapeutic activity of drugs used for treating diseases

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2		3	3	3	3	3	3		3	3	2
CO2	2	3	2		3	3	3	2	3	3		3	3	3
CO3	2	2	2		2	3	3	2	3	3		3	3	3
CO4	2	2	2		2	3	3		3	3		3	3	3
CO5	2	2	2		2	3	3	2	3	3		3	3	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Fundamentals of Biopharmaceuticals: Pharmaceutical Biotechnology: Definition, Scope, and Importance. Human protein replacements, Biosimilar (insulin analog), Therapeutic agents for human diseases: Tissue Plasminogen activator, Interferon, Recombinant vaccines, Clinical trials and Regulations (Basic), History and development of Pharmacovigilance.

UNIT-II

Biopharmaceutics and Pharmacokinetics: ADME properties- Physiochemical properties of Drug Absorption, Distribution, metabolism (Biotransformation), bioavailability, and Excretion. Pharmacokinetics and Pharmacodynamics. Basic considerations: Drug receptors, Drug interactions, Surgical supplies, Oral, Parenteral, Transdermal, Ophthalmic, Intravaginal, and Intrauterine Drug Delivery systems.

UNIT-III

The Drug Manufacturing Practices: Good manufacturing practices and facilities for drug production. Types of Tablets and capsules. Materials and Formulations for Manufacture of Tablets, Capsules. Excipients and its ideal properties, Parenteral solutions, Oral liquids, Emulsions, Ointments, Suppositories,

Aerosols.

UNIT-IV

Blood and Plasma Substitutes: Collection, processing, and storage of whole human blood, concentrated human RBC, dried human plasma, Human plasma protein fraction, Dried human serum, Human fibrinogen, Human thrombin, Human Normal Immunoglobulin, Plasma substitutes- Ideal requirements, PVP, Dextran 40, control of Blood products, Transfusion products, Blood and Plasma based bioproducts, Blood based and plasma-based Biomarkers.

UNIT-V

Pharmaceutical Products: Fundamentals of Therapeutic categories such as Analgesics, Antipyretic, Anti-inflammatory drugs, Anesthetics, Antacids, Alkaloids, Glycosides, Anti-neoclassic drugs, Biologicals (Immunizing agents and allergenic extracts), Anti-histamines, Electrolytes, and Diuretics, Chemotherapy of Tuberculosis and Urinary tract infections.

TEXT BOOKS:

1. Purohit SS, Kakrani HN, and Saluja AK., "Pharmaceutical Biotechnology", Student Edition Jodhpur, 2003.
2. Brahmankar, D.M., Sunil, B. Jaiswals - Biopharmaceutics & Pharmacokinetics a Treatise, 2nd edition, M.K. Jain Publication, Delhi,2009.
3. Cooper and Guns, "Pharmaceutics", CBS publishers, 1989.

SUGGESTED READING:

1. David B Troy and Paul Beringer, "Remington's: The Science and Practice of Pharmacy", Vol 1 and 2, Lippincott Williams & Wilkins Publications, 2006.
2. Tripathi, K.D. "Essentials of Medical pharmacology", Jaypee Brothers Medical Publishers 6th Edition, John Wiley, New.

22BTE13

GENOME EDITING

(Professional Elective -III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To learn Genome editing and its tools for genome engineering
2. To understand the genome editing strategy and target site
3. To know the genome editing tools applications in plant, animals and industry
4. To understand the emergent challenges for CRISPR technologies

COURSE OUTCOMES: At the end of the course, students will be able to

1. Outline the Genome editing and its tools for genome engineering
2. Describe the genome editing strategy and target site
3. Explain the Genome editing in Plants for crop improvement
4. Discuss the Genome editing in animals and for human welfare
5. Summarize the application genome editing and emergent challenges for CRISPR technologies

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
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CO2	2	2			2	3	3		2	2		2	2	2
CO3	2	2			2	3	3		2	2		2	2	2
CO4	2	2			2	3	3		2	2		2	2	2
CO5	2	2	1		2	3	3	2	2	2		2	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Genome Editing and its tools: Overview of traditional methods: homologues recombination for gene knockout. RNAi system, Cre-LoxP and Flp-FRT systems. Engineered enzyme systems: Zinc finger nucleases (ZFNs), transcription-activator-like effector nucleases (TALEN), mega nucleases and the clustered regularly interspaced short palindromic repeats (CRISPR/Cas9) system.

UNIT-II

Genome editing strategy and target site: Gene Knockout with single site targeting, Gene Knockout with double sit targeting, Gene Knockout via sequence insertion and the problem of noncoding RNAs, Inserting or correcting mutations, inserting a gene or other DNA Sequence. Design of sgRNA. Multiplex Automated Genomic Engineering (MAGE).

UNIT-III

Genome editing in Plants for crop improvement: The history of targeted mutations in plants. Use of ZFNs and TALENs as early tools for genome editing. Discovery of CRISPR-Cas system and its applications. GM plants, Recent innovations in the technology and case studies where CRISPRC as has been used for plant improvement. Regulatory approaches for genome edited crops.

UNIT-IV

Genome editing in Animals: Therapeutic Genome editing – Ex Vivo therapeutic genome and in vivo therapeutic genome editing, creating chromosome rearrangement, Study gene function with stem cells, Transgenic animals, Endogenous gene labeling, targeted transgene addition,

UNIT-V

Genome Editing Applications: Genome editing of Algal species by CRISPR Cas9 for Biofuel production, genome editing its role in bioremediation; Development and use of CRISPR in Industrial applications, Emergent challenges for CRISPR: Ethics, Biosafety and risk of targeted gene editing, Biosecurity, Patenting CRISPR Technologies and products, regulator issues with CRISPR products.

TEXT BOOKS:

1. CRISPR Gene Editing, Methods and Protocols, Editors: Luo, Yonglun (Ed.)
2. Genome Editing and Engineering, From TALENs, ZFNs and CRISPRs to Molecular Surgery. Edited by Krishnarao Appasani.

SUGGESTED READING:

1. Progress in Molecular Biology and Translational Science Vol 149-Genome Editing in Plants. Edited by Donald P. Weeks and Bing Yang. Academic Press.
2. Precision Medicine, CRISPR, and Genome Engineering, Moving from Association to Biology and Therapeutics, Editors: Tsang, Stephen H. (Ed.). Springer

22BTE14

BIOMATERIALS
(Professional Elective–III)

Instruction	3LHoursperweek
Duration of SEE	3Hours
SEE	60Marks
CIE	40Marks
Credits	3

COURSE OBJECTIVES: Students are made to understand the following concepts during their course of time:

1. To learn the types and trends of Biomaterials.
2. To recognize the procedures for manufacturing of Metallic Biomaterials.
3. To be aware of the types of ceramic Biomaterials.
4. To elaborate the detailed features of polymer and composite Biomaterials.
5. To learn the applications of Biomaterials.

COURSE OUTCOMES: By the end of the course, the students are able to

1. Explain the types and properties of Biomaterials.
2. Compare the techniques for manufacture of metallic Biomaterials and their use in health care industry.
3. Outline the physiological properties and various techniques for the manufacture of ceramic biomaterials.
4. Illustrate the preparation of polymer and composite Biomaterials.
5. Apply the different types of Biomaterials in the health industry.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2				3	3	2	2	2		3	2	2
CO2	2	2				3	3	3	2	2		3	2	2
CO3	2	2				3	3	3	2	2		3	2	2
CO4	2	2				3	3	3	2	2		3	2	2
CO5	2	2				3	3	3	2	2		3	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Biomaterials: Introduction and importance of biomaterials; Types of biomaterials: metallic, ceramic, polymeric and composite biomaterials; Future trends in biomaterials.

UNIT-II

Metallic Biomaterials: Properties of metallic biomaterials; Stainless steels; CoCr alloys; Ti alloys; Corrosion of metallic implants; Manufacturing of implants. Case study for manufacturing of Cardiac implants, Dental implant and their biocompatibility and hemocompatibility.

UNIT-III

Ceramic Biomaterials: Properties of ceramic biomaterials; Classification according to physiological response of ceramic biomaterials: bioinert, bioactive and bioresorbable ceramics; Deterioration of ceramics; Bio ceramic manufacturing techniques (ex; Manufacturing of orthopedic implants and their biocompatibility and hemocompatibility.

UNIT-IV

Polymeric and composite biomaterials: Polymerization and basic structure; Polymers used as biomaterials; Properties of polymeric and composite biomaterials; Sterilization; Surface modifications for

improving biocompatibility; Surface-protein interactions.

UNIT-V

Applications of Biomaterials: Applications of biomaterials in tissue engineering; Drug delivery; Biosensing; Diagnostics.

TEXT BOOKS:

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E An Introduction to Materials in Medicine, (Elsevier Academic Press, ISBN: 0-12-582463-7), 2002.
2. J.B. Park and J.D. Bronzino. Biomaterials: Principles and Applications. CRC Press. 2002. ISBN: 0849314917
3. K.C. Dee, D.A. Puleo and R. Bizios. An Introduction to Tissue-Biomaterial Interactions. Wiley 2002. ISBN: 0-471-25394-4.

SUGGESTED READING:

1. T.S. Hin (Ed.) Engineering Materials for Biomedical Applications. World Scientific. 2004. ISBN 981-256-061-0
2. B. Rolando (Ed.) Integrated Biomaterials Science. Springer. 2002. ISBN: 0-306-46678-3.

22BTE15

GENOMICS AND PROTEOMICS
(Professional Elective -III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. The student is made to understand the fundamentals of genome
2. Students are made to understand DNA sequencing and various DNA sequencing methods.
3. Students are enlightened about the construction and screening of cDNA libraries.
4. Students are enlightened about the current methods existing in the field of genomics.
5. Students are made to understand the basics of proteomics, tools for proteomics, and protein modifications

COURSE OUTCOMES: At the end of the course, the students are able to

1. Describe genomes, types of genomes, and the advanced techniques used for analyzing the genome.
2. Explain the methods of functional genomics.
3. Discuss the various sequencing technologies in genomics.
4. Describe the tools used for the characterization of proteins
5. Explain personalized medicines and their uptake, action, and metabolism.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2	2			2	2	2	2	2	2		3	3	
CO2	2	2			2	2	2	2	2	2		3	3	
CO3	2	2			2	2	2	2	2	2		3	3	
CO4	2	2			2	2	2	2	2	2		3	3	
CO5	2	2							2	2		2	2	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Structural Genomics: Overview of Genome - Types, analysis of genomes; comparative homologies; evolutionary changes; Genetic analysis: Linkage mapping and analysis, High-resolution chromosome maps, Physical mapping, Hybrid mapping strategies, Sequence-specific tags (SST), Sequence tagged sites (STS), FISH.

UNIT-II

Functional Genomics: Gene disruption and methods; DNA microarray and its applications; Serial analysis of gene expression (SAGE); Genome-wide association studies; Chip-Seq; RNA-Seq; Metagenomics.

UNIT-III

Next Generation Sequencing: Next generation sequencing - importance; Different sequencer platforms available; Methods of Sequencing; File formats; Data generation tools; Pre-processing of data and analysis; Introduction to rRNA sequencing and Single-cell sequencing

UNIT-IV

Proteomics: Protein arrays: basic principles. Computational methods for identification of polypeptides from mass spectrometry. Protein arrays: bioinformatics-based tools for analysis of proteomics data (Tools

available at ExPASy Proteomics server); databases (such as Inter Pro) and analysis tools. Protein-protein interactions: databases such as DIP, PPI server and tools for analysis of protein-protein interactions

UNIT-V

Metabolomics And Pharmacogenomics: Metabolomics - Basics; Pharmacogenomics - Basics, Diseased genes and their identification; Drug uptake and metabolism; Drug targets; Designer medicine; Genomics perspective of bioterrorism; Ethical and legal implications.

TEXT BOOKS:

1. Sahai S, "Genomics and Proteomics-Functional and Computational Aspects", Plenum Publications, 1999.
2. Rastogi SC, Mendiratta N, Rastogi P, "Bioinformatics-Methods and Application, Genomics, Proteomics, and drug discovery", 2nd edition, Prentice Hall of India, New Delhi, 2003.
3. Hunt SP, Levessy FJ, "Functional genomics" Oxford University Press, UK, 2000.

SUGGESTED READING:

1. Lieber DC, "Introduction to Proteomics, Tools for the new biology", Humana Press, UK, 2000.
2. Cendric Gondro, "Primer to Analysis of Genomic Data Using R", Springer, 2015.

22EGO02

GENDER SENSITIZATION
(Open Elective – II)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: No specific prerequisite is required.

COURSE OBJECTIVES: This course will introduce the students to:

1. Sensibility regarding issues of gender in contemporary India.
2. A critical perspective on the socialization of men and women.
3. Popular debates on the politics and economics of work while helping them reflect critically on gender violence.

COURSE OUTCOMES: After successful completion of the course the students will be able to:

1. Understand the difference between "Sex" and "Gender" and be able to explain socially constructed theories of identity.
2. Recognize shifting definitions of "Man" and "Women" in relation to evolving notions of "Masculinity" and "Femininity".
3. Appreciate women's contributions to society historically, culturally and politically.
4. Analyze the contemporary system of privilege and oppressions, with special attention to the ways in which gender intersects with race, class, sexuality, ethnicity, ability, religion, and nationality.
5. Demonstrate an understanding of personal life, the workplace, the community and active civic engagement through classroom learning.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1			1			2	2	1	1			1	1	1
CO2			1			2	2	1	1			1	1	1
CO3			1			2	2	2	2	1	1	1		
CO4			1			3	3	2	2	1	1	1	2	1
CO5			1			2	2	2	3	1	1	1	2	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Understanding Gender: Gender: Why Should We Study It? (*Towards a World of Equals*: Unit -1)
Socialization: Making Women, Making Men (*Towards a World of Equals*: Unit -2)
Introduction. Preparing for Womanhood. Growing up Male. First lessons in Caste. Different Masculinities.

UNIT-II

Gender and Biology: Missing Women: Sex Selection and Its Consequences (*Towards a World of Equals*: Unit -4) Declining Sex Ratio. Demographic Consequences.
Gender Spectrum: Beyond the Binary (*Towards a World of Equals*: Unit -10)
Two or Many? Struggles with Discrimination.

UNIT-III

Gender and Labour: Housework: the Invisible Labour (*Towards a World of Equals*: Unit -3) "My Mother doesn't Work." "Share the Load."

Women's Work: Its Politics and Economics (*Towards a World of Equals*: Unit -7)

Fact and Fiction. Unrecognized and Unaccounted work. Additional Reading: Wages and Conditions of Work.

UNIT-IV

Issues of Violence

Sexual Harassment: Say No! (*Towards a World of Equals*: Unit -6)

Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment- Further Reading: "*Chupulu".*

Domestic Violence: Speaking Out (*Towards a World of Equals*: Unit -8)

Is Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Additional Reading: New Forums for Justice.

Thinking about Sexual Violence (*Towards a World of Equals*: Unit -11)

Blaming the Victim-"I Fought for my Life…." - Additional Reading: The Caste Face of Violence.

UNIT-V

Gender: Co - Existence

Just Relationships: Being Together as Equals (*Towards a World of Equals*: Unit -12)

Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers. Additional Reading: Rosa Parks-The Brave Heart.

TEXTBOOK:

1. A. Suneetha, Uma Bhrugubanda, Duggirala Vasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu"Towards a World of Equals: A Bilingual Textbook on Gender"**,** Telugu Akademi, Hyderabad, 2015.

SUGGESTED READING:

1. Menon, Nivedita. "Seeing like a Feminist", Zubaan-Penguin Books, New Delhi, 2012.
2. Abdulali Sohaila, "I Fought For My Life…and Won", Available online at: http://www.thealternative.in/lifestyle/i-fought-for-my-lifeand-won-sohaila-abdulal/

WEB RESOURCES:

1. https://aifs.gov.au/publications/gender-equality-and-violence-against-women/introduction
2. https://theconversation.com/achieving-gender-equality-in-india

Note: Since it is an Interdisciplinary Course, Resource Persons can be drawn from the fields of English Literature or Sociology or Political Science or any other qualified faculty who has expertise in this field from engineering departments.

22MEO02

3D PRINTING
(Open Elective – II)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Nil

COURSE OBJECTIVES: This course aims to

1. Make students understand the basic concept of digital manufacturing.
2. Teach different processes involved in digital fabrication of products.
3. Demonstrate the STL file generation and manipulations.
4. Demonstrate various post processing techniques.
5. Demonstrate the applications of RP in different fields of engineering

COURSE OUTCOMES: Upon completion of this course, students will be able to

1. Understand the concept of 3D printing processes, advantages, and limitations.
2. Evaluate real-life scenarios and recommend the appropriate 3D printing technology.
3. Analyze various pre-processing and post processing techniques.
4. Identify components and construct basic 3D printer.
5. Explain current and emerging 3D printing technologies in diversified applications

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2	1	1		3	1	1	2		2	1	2		1
CO2	2	2	3	2	2	3	3	2	2	2	2	2		1
CO3	2	1	1	2	2	2	2	2	1	1	1	1		1
CO4	2	2	2	1	2	1	1	2	2	2	2	2		2
CO5	2	1	2	1	1	2	2	2		1		1	2	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to 3D Printing: Introduction to 3D printing, evolution, distinction between 3D printing and CNC machining. Design considerations: Materials, size, resolution, mass customization, additive vs. subtractive manufacturing, its advantages and limitations

UNIT-II

Photopolymerization processes: Photo polymerization, Stereolithography Apparatus (SLA), Applications, advantages and disadvantages.

Powder bed fusion processes: Introduction, Selective laser Sintering (SLS), Materials, Applications, advantages and disadvantages.

Extrusion based systems: Fused deposition modeling (FDM), principles, Materials, Process Benefits and Drawbacks.

Laminated Object Manufacturing (LOM), Principles, Materials, Process Benefits and Drawbacks.

Material Jetting AM Processes: Evolution of Printing as an Additive Manufacturing Process, Materials, Process Benefits and Drawbacks, Applications of Material Jetting Process

UNIT-III

Pre processing in AM: Modeling and viewing 3D scanning; Model preparation – STL conversion, STL

error diagnostics, STL file Repairs, generic solution, slicing, newly proposed file formats.
Post processing in AM: Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non thermal and thermal techniques.

UNIT-IV
Construction of basic 3D printer: Construction of 3D printing machine – axes, linear motion guide ways, ball screws, motors, bearings, encoders, process chamber, safety interlocks, sensors.

UNIT-V
Applications of AM: Application in construction and architectural engineering, aerospace industry, automotive industry, jewelry industry, coin industry, medical and bioengineering applications: planning and simulation of complex surgery, forensic science.

TEXT BOOKS:

1. Gibson, DW. Rosen and B. Stucker; Additive manufacturing methodologies: Rapid prototyping to direct digital manufacturing, Springer, 2010.
2. Chee Kai Chua, Kah Fai Leong, 3D printing and additive manufacturing: principles and application, 4th edition of rapid prototyping, World scientific publishing company, 2014.
3. P.K. Venuvinod, Rapid prototyping – Laser based and other technologies, Kluwer, 2004.

SUGGESTED READING:

1. Jacob, Paul, Rapid tooling: Technologies and industrial applications, Taylor & Francis Group, 2000.
2. Alain Bernard, Georges Taillandier, Additive Manufacturing, Wiley, 2014

22EEO04

WASTE MANAGEMENT
(Open Elective – II)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: None.

COURSE OBJECTIVES: This course aims to:
1. Imbibe the concept of effective utilization of any scrap
2. Become familiar with the processes of all disciplines of engineering.
3. Learn the technique of connectivity from waste to utility.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Categorize the waste based on the physical and chemical properties.
2. Explain the Hazardous Waste Management and Treatment process.
3. Illustrate the Environmental Risk Assessment, methods, mitigation and control.
4. Interpret the Biological Treatment of Solid and Hazardous Waste.
5. Identify the waste disposal options, describe the design and construction, Operation, Monitoring, Closure of Landfills.

CO-PO Articulation Matrix

PO/PSO CO	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
CO1	2	1	2			2	2					1	2	1
CO2	2	1	2			2	2					1	2	1
CO3	2	1	3			2	2					1	3	1
CO4	2	3	3			2	2					1	3	2
CO5	2	3	3			2	2					1	2	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Waste Management and Municipal Solid Waste Management: Classification of waste: Agro based, Forest residue, Industrial waste, e-Waste, Municipal Solid Waste Management: Fundamentals Sources, composition, Generation rates, Collection of waste, Separation, Transfer and Transport of waste, Treatment and Disposal options.

UNIT-II

Hazardous Waste Management and Treatment: Hazardous Waste Identification and Classification, Hazardous Waste Management: Generation, Storage and collection, Transfer and transport, Processing, Disposal, Hazardous Waste Treatment: Physical and Chemical treatment, Thermal treatment, Biological treatment, Pollution Prevention and Waste Minimisation, Hazardous Wastes Management in India.

UNIT-III

Environmental Risk Assessment: Defining risk and environmental risk, Parameters for toxicity quantification, Types of exposure, Biomagnifications, Effects of exposure to toxic chemicals, Risk analysis and Risk matrix, Methods of risk assessment, Mitigation and control of the risk, Case studies.

UNIT-IV

Biological Treatment: Solid and Hazardous Waste Composting, Bioreactors, Anaerobic decomposition of solid waste, Principles of biodegradation of toxic waste, Inhibition, Co-Metabolism, Oxidative and Reductive processes, Slurry phase Bioreactor, In-situ-remediation.

UNIT-V

Waste Disposal: Key Issues in Waste Disposal, Disposal Options and Selection Criteria: Disposal options, Selection criteria, Sanitary Landfill: Principle, Landfill processes, Landfill Gas Emission: Composition and properties, Hazards, Migration, Control, Leachate Formation: Composition and properties. Leach ate migration, Control, Treatment, Environmental Effects of Landfill, Landfill Operation Issues, Design and construction, Operation, Monitoring, Closure of Landfills-Landfill Remediation, National and International Waste Management programs.

TEXT BOOKS:

1. John Pichtel, Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. La Grega, M.D. Buckingham, P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994
3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997.

SUGGESTED READING:

1. Basics of Solid and Hazardous Waste Mgmt. Tech. by Kanti L. Shah 1999, Prentice Hall.
2. Solid and Hazardous Waste Management 2007 by S.C. Bhatia Atlantic Publishers & Dist.

22CAO03

FOUNDATIONS OF DEEP LEARNING

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Calculus, Probability and Statistics, Python Programming, Machine Learning.

COURSE OBJECTIVES:

1. Provide students with a foundational understanding of the history of deep learning, key concepts, and early neural network models.
2. Equip students with the skills to design and optimize feed forward neural networks using various gradient descent methods and optimization algorithms.
3. Develop students' competence in applying principal component analysis, singular value decomposition, and different types of auto encoders for data representation and regularization.
4. Enable students to design, implement, and apply convolutional neural networks (CNNs) for image and data processing tasks.
5. Enhance students' ability to design and apply recurrent neural networks (RNNs) and attention mechanisms for complex sequence modeling tasks.

COURSE OUTCOMES:

1. Demonstrate a comprehensive understanding of deep learning history, key milestones, and foundational concepts.
2. Design, develop, and optimize feed forward neural networks and understand their representation power.
3. Apply principal component analysis, singular value decomposition, and various auto encoder models for data analysis and dimensionality reduction.
4. Develop and implement convolutional neural networks (CNNs) using modern architectures and techniques.
5. Design and utilize recurrent neural networks (RNNs) and advanced attention mechanisms for sequential data processing.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	3	1											1	
CO2	3	2	3	2	2	2	2		1		1	1	1	
CO3	3	3	2	2	3	1	1				1	1	1	
CO4	3	3	3	3	3	2	2		1		1	1	1	
CO5	3	2	2	3	3	2	2	1	1	1	1	1	1	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent.

UNIT-II

Feed forward Neural Networks, Representation Power of Feed forward Neural Networks Feed Forward Neural Networks, Back propagation Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Eigenvalues and eigenvectors, Eigenvalue Decomposition, Basis

UNIT-III

Principal Component Analysis and its interpretations, Singular Value Decomposition Auto encoders and relation to PCA, Regularization in auto encoders, Denoising auto encoders, Sparse auto encoders, Contractive,autoencoders

Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout

UNIT-IV

Convolutional Neural Network: The Convolution Operation, Motivation, Pooling, Convolution and Pooling, Batch Normalization.

Pre-trained models: LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet.

UNIT-V

Recurrent Neural Networks, Vanishing and Exploding Gradients, GRU, LSTMs. Encoder Decoder Models, Attention Mechanism, Attention over images.

TEXT BOOKS:

1. Goodfellow. I., Bengio. Y. and Courville. A., "Deep Learning ", MIT Press, 2016.
2. Rothman, Denis, "Transformers for Natural Language Processing: Build innovative deep neural network architectures for NLP with Python, PyTorch, TensorFlow, BERT, RoBERTa, and more", Packt Publishing Ltd, 2021.
3. Ganguly Kuntal, "Learning generative adversarial networks: next-generation deep learning simplified", Packt Publishing, 2017

SUGGESTED READING:

1. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995. ISBN: 9780198538646.
2. Bishop, Christopher M. Pattern Recognition and Machine Learning. Springer, 2006. ISBN 978-0-387-31073-2
3. Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY: Wiley-Interscience, 2000. ISBN: 9780471056690.
4. Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
5. Richard Hartley, Andrew Zisserman, Multiple View Geometry in Computer Vision, 2004. David Marr, Vision, 1982.

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc18_cs41/
2. https://onlinecourses.nptel.ac.in/noc22_cs22/
3. https://onlinecourses.nptel.ac.in/noc19_cs85

22BT C32

ANIMAL BIOTECHNOLOGY LAB

Instruction	3 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES:

1. Students are expected to understand the sterility and aseptic conditions necessary for animal cell culture.
2. Students will learn various steps involved in the maintenance and culture of animal cells.
3. Students will know about measurement of cell viability & cytotoxicity and cell death.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Demonstrate aseptic culture techniques and preparation of animal cell culture media. (Expt. 1, 3, 4)
2. Identify and enumerate animal cells by using microscopic techniques. (Expt. 2, 8)
3. Apply animal cell culture techniques to the establishment of primary culture. (Expt. 5, 6, 7)
4. Evaluate cell viability and cytotoxicity of animal cell culture. (Expt. 9, 10)
5. Perform the maintenance and preservation of animal cells. (Expt.11, 12, 13)

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2		3	2	2	2	3	2	3		3	2	3
CO2	2	2		2	2	2	2	3	2	3		3	3	3
CO3	2	2		3	2	2	2	3	2	3		3	2	3
CO4	2	2		2	2	2	2	3	2	3		3	3	3
CO5	2	2		3	2	2	2	3	2	3		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

Atleast 10 experiments to be conducted from the following list of experiments".

List of Experiments

1. Maintaining sterility and aseptic techniques within the animal biotechnology lab.
2. Microscopic visualization of Human Buccal Epithelial cells. (structured enquiry)
3. Separation of serum from whole blood.
4. Preparation of cell culture growth media
5. Primary culture of chicken embryo fibroblast culture.
6. Isolation of Hepatocytes from Chicken liver cells
7. Enumeration and counting of animal cells using a Haemocytometer.
8. Staining and microscopic visualization of adherent animal cells.
9. Evaluation of cell viability/cytotoxicity in animal cells.
10. Cell viability of cells using trypan blue dye. (Open ended experiment)
11. Trypsinization or subculture of the adherent cell line.
12. Cryopreservation of animal cells
13. Monitoring and trouble shooting of microbial contamination in animal biotechnology lab. (Open ended experiment)

TEXT BOOKS:

1. Ian Freshney, R., "Culture of Animal Cells: A manual of basic technique and specialized applications" Seventh edition, John Wiley and Sons, 2016.
2. John Masters, "Animal Cell culture: A practical approach" OUP Oxford, 2000.
3. Gupta P.K., "Biotechnology and Genomics" Rastogi Publications, 1st edition, 6th reprint, 2013

22BTC33

PROJECT PART-I

Instruction	4P Hours per week
CIE	50 Marks
Credits	2

COURSE OBJECTIVES:

1. To enable the student take up investigative study in the broad field of Engineering / Technology, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a supervisor.
2. To provide a good initiation for the student(s) towards R&D.

COURSE OUTCOMES: Upon completion of this course, students will be able to:

1. Survey and carry out a study of published literature on the assigned topic;
2. Work out a preliminary Approach to the Problem relating to the assigned topic;
3. Conduct preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility;
4. Prepare a Written Report on the Study conducted for Presentation to the Department;
5. Present a Final Seminar, as oral Presentation before a departmental Committee.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	3	2	1	1				1	1	2	2	2	3	2
CO2	2	2	1	3	3	2	2		3	1	2	3	3	2
CO3	3	3		2	2			1				1	3	3
CO4	1	2		1		2	2	2	1	2	2	3	3	2
CO5		1	1	2		2	2	1	2	3	2	3	3	2

1 - Slightly, 2 - Moderately, 3 - Substantially

Guidelines for the award of Marks: Max. Marks: 50

Evaluation by	Max. Marks	Evaluation Criteria / Parameter
Supervisor	20	Project Status / Review
	5	Report
Department Committee	5	Relevance of the Topic
	5	PPT Preparation
	5	Presentation
	5	Question and Answers
	5	Report Preparation

GUIDELINES:

These guidelines assure consistency in the quality and components of the project to be taken in VIIth Semester within the Department and they are segregated into 3 sections

A) Section 1 describes guidelines and procedures for allotment, submission, and acceptance of the project

1. Students will be allotted a faculty supervisor based on their topic/ area of interest.
2. There will be a maximum of 3 students attached to each of the staff for each research project
3. Students are encouraged to select a topic that has scope to be continued as a major project in the VIIIth Semester

4. Tentative area of research, title and objectives along with novelty statement have to be surveyed with proper discussion and guidance of internal guide
5. All the above mentioned should be finalized in consultation with the faculty supervisor
6. Care should be taken that no two project problems should be the same. Care should be taken that the problem should not be the same as done in the department over the last three years
7. No change in project or group after the department research committee and HoD finalize the list
8. Softbound project reports (3 Nos) duly certified by the internal guide, DRC and the HOD should be submitted at the time of final review
9. The students should record the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. Students shall be ready to show the diary to the internal guide or DRC or HoD at any point of time.
10. Responsibilities of students include
    a. Schedule meetings as needed with the guide, or others as needed.
    b. Meet the deadlines as specified in the departmental curriculum.
    c. Submit working drafts to the project guide during the writing process.
    d. The student is responsible for making all arrangements for the preparation of the report

B) Section 2 provides an overview of the structure and content of the project report and minimal formatting requirements for the preparation of the report.

1. The report consists of three general sections: The preliminary pages, text, and references.
    - ✓ Title page (mention the guide's name – both internal and external also)
    - ✓ Certificates (INTERNAL AND EXTERNAL)
    - ✓ Declaration
    - ✓ Acknowledgements
    - ✓ Contents
    - ✓ Abbreviations
    - ✓ List of Tables
    - ✓ List of Figures
    - ✓ Abstract (in 250 words) and Keywords
    - ✓ Novelty statement
    - ✓ Aim and objectives
    - ✓ Introduction
    - ✓ Review of literature
    - ✓ Materials and Methods (if any)
    - ✓ Results and Discussion (if any)
    - ✓ Expected Conclusions (200 words)
    - ✓ References
    - ✓ Appendix (if any)
    - ✓ Published research papers (if any)
2. The report should be written in Times New Roman (12 size), 1.5 or double spacing, headings and side headings in bold, well defined margins, pagination, etc.
3. Students are instructed to prepare a comprehensive PowerPoint presentation with all findings to present before DRC during the final review

C) Section 3 suggests the time schedule.

Students should attend all the reviews and follow the deadlines as per the almanac will be allotted with a faculty supervisor

Suggested schedule:

Starting Date	Day 1 (As per almanac)
Literature review / survey	End of 4 Weeks
Tentative aim and objectives	End of 8 Weeks
Process Manuscript submission	End of 10 Weeks
Material and microbes procurement (if any)	End of 12 Weeks

Results and Analysis (if any)	End of 14 Weeks
Approval of printout draft and Manuscript	End of 16 Weeks
Submission of bound copies	Last Day (As per almanac)

The project would be evaluated on a regular basis by the DRC by conducting periodical reviews and marks will be awarded following the rubrics

The students have to fill out the checklist provided by the DRC in order to evaluate the project's feasibility to be carried out in the department

FEASIBILITY CHECKLIST

S. No	Detail	Response
1	Tentative title of the project	
2	Tentative objectives	
3	Novelty statement/Gaps identified	
4	No. of papers referred to identify the gaps and frame the objectives	
5	No. of days required for literature survey	
6	Time required to complete the project in 8^{th} semester	
7	Chemicals/Materials required for the project	
8	Equipment/Software required	
9	If equipment/software is not available, identification of any alternatives	
10	Microorganisms required	
11	Planning to do a project internally/external	
12	If external, the topic should be related to the ones in 8^{th} semester	
13	Expertise available in CBIT	
14	Any ethical approvals required (animal/human testing)	

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

In line with the AICTE Model Curriculum with effect from AY 2025-26

B. Tech BIOTECHNOLOGY

SEMESTER-VIII

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours Per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
	THEORY								
1	22BTEXX	Professional Elective –IV	3	-	-	3	40	60	3
2	22BTEXX	Professional Elective –V	3	-	-	3	40	60	3
3		Open Elective–III	3	-	-	3	40	60	3
	PRACTICALS								
4	22BTC34	Technical Seminar	-	-	2	-	50	-	1
5	22BTC35	Project Part - II	-	-	8	-	100	100	4
Total			**9**	**0**	**10**	**9**	**270**	**280**	**14**
Clock hours per week:16									

L: Lecture T: Tutorial P: Practical

CIE – Continuous Internal Evaluation SEE - Semester End Examination

22BTEXX	**Professional Elective – IV**
22BTE16	Food Biotechnology
22BTE17	Cancer Biology
22BTE18	Stem Cell Technology
22BTE19	Nanobiotechnology
22BTE20	Rational Drug Discovery

22BTEXX	**Professional Elective – V**
22BTE21	Process Dynamics and Control for Biotechnologists
22BTE22	Immunodiagnostics
22BTE23	Tissue Engineering
22BTE24	Biosimilar Technology
22BTE25	Molecular Modeling and Drug Design

	Open Elective - III
22EGO03	Indian Traditional Knowledge
22MEO06	Principles of Entrepreneurship and startups
22CIO03	Fundamentals of Blockchain Technology
22ADO01	Industry 5.0: Applications of AI

22BTE16

FOOD BIOTECHNOLOGY
(Professional Elective -IV)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. Student is made to understand the importance of food biotechnology and its nutritive value.
2. Students are taught the types of food available in the nature and its consumption value.
3. Students made to understand the food spoilage.
4. Students are enlightened about the importance of food processing.
5. Students are made aware of chemical and physical methods of food processing.

COURSE OUTCOMES: At the end of the course the students are able to

1. Apply the fundamentals of food biotechnology to their real-life situation
2. Differentiate types of food and explain their nutritive value
3. Examine the types of pathogens and their effect on food
4. Demonstrate the physical and chemical methods of food processing.
5. Apply the techniques to preserve the food material to avoid food spoilage.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2				3	3	3	2	3		3	3	2
CO2	2	2				3	3	3	2	3		3	3	2
CO3	2	2				3	3	3	2	3		3	3	2
CO4	2	2				3	3	3	2	3		3	3	2
CO5	3	2				3	3	3	2	3		3	3	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction To Food Biotechnology: Introduction to scope and importance of food biotechnology, Nutritive value of the food; Shelf life of food. Water relationships in foods: water activity and its relevance to deteriorative processes in foods (chemical, enzymatic, physical and microbial changes). Lipids of biological importance like cholesterol and phospholipids. Food Pigments &Flavoring Agents: Importance, types and sources

UNIT-II

Food Products: Introduction to Probiotics, Nutraceuticals and GM foods; Processing and post-harvest technology of various food products (High Fructose Corn syrup, Single Cell Protein and Bakery Products, Milk Products). Fermented food: origin, scope and development, sauerkraut, yoghurt, cheese, miso, tempeh.

UNIT-III

Food Spoilage And Food Microbiology: Shelf life of food. Microbes found in raw materials and foods that are detrimental to quality, Factors that influence the development of microbes in food, Food spoilage by bacterial agents (Clostridium, Salmonella, Vibrio and Shigella), Non-bacterial agents (Protozoa, Algae, Fungi and Viruses)

UNIT-IV

Food Processing Applications: Principles and methods of food processing (freezing, heating, dehydration, canning, additives, fermentation, irradiation, extrusion cooking, dielectric heating). Enzymes and chemicals used in food processing for flavor development; Processing of meat, fisheries, vegetables, and dairy products. Food adulteration and food safety.

UNIT-V

Food Preservation: Application of sugar and salt, antimicrobial agents, biological agents, non-ionizing and ionizing radiations in preservation of foods. Basic concepts in thermal destruction of microorganisms D, Z, F values. Blanching, Pasteurization and Sterilization of foods. Controlled and Modified atmosphere storage of foods. Intelligent packaging concept.

TEXT BOOKS:

1. Roger Angold, Gordon Beech & Taggart, Food Biotechnology1st edition, Cambridge End Press, 1989.
2. Frazier, William, C. Westhoff, Dennisc, Food Microbiology, 2nd Edition TATA Mcgraw Hill Publishers, 1989.

SUGGESTED READING:

1. Ashok Pandey, Biotechnology: Food Fermentation, Asia Tech Publishers Inc, New Delhi, 1999.
2. J.M. Jay, M.J. Loessner and D.A. Golden, Modern food microbiology, 7th edition, Springer, 2006.
3. Romeo T. Toledo, Fundamentals of Food Process Engineering, 3rd edition, Springer, February, 2007.

22BTE17

CANCER BIOLOGY
(Professional Elective -IV)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To understand the fundamentals of cancer biology.
2. To know the importance of physical and chemical carcinogens and their effects on cell cycle.
3. To learn the Molecular aspects of cell cycle control.
4. To learn the theories of metastasis, diagnosis and treatment of cancer.
5. To understand the principles of cancer pharmacology

COURSE OUTCOMES: At the end of the course the students are able to

1. Summarize the etiology of cancer.
2. Explain the principles and mode of action of physical and chemical carcinogens.
3. Discuss the molecular genetics of cancer.
4. Outline the cancer metastasis, diagnosis and different forms of therapy
5. Describe the principles of cancer pharmacology.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	3					2	2	3	3	2		3	3	3
CO2	3					2	2	3	3	2		3	3	3
CO3	3					2	2	3	3	2		3	3	3
CO4	3	2			2	2	2	3	2	2		3	3	2
CO5	3	2			2	2	2	3	3	2		3	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Fundamentals of Cancer Biology: Introduction to cancer, origin and classification of different cancers, Hall marks of cancer, Cell cycle control, Regulation of the cell cycle by cyclins, cyclin-dependent kinases, cdk inhibitor. Two-Hit Hypothesis, Tumor suppressor genes. Case studies for carcinoma ex: breast cancer and stomach cancer, Diet and cancer.

UNIT-II

Principles of Carcinogenesis: Classical theory of Carcinogenesis, Types of Carcinogenesis, Chemical Carcinogenesis, Metabolism of Carcinogenesis, Laboratory chemicals induces carcinogenesis, Targets of Chemical Carcinogenesis, Principles of Physical Carcinogenesis, Ionizing radiation and UV radiation mechanism of Carcinogenesis.

UNIT-III

Principles of Molecular Cell Biology of Cancer: Retroviruses and Oncogenes, Activation of proto-oncogenes to oncogenes. Identification of Oncogenes, Growth factor and Growth factor receptors (RTK's) that are oncogenes, signaling pathways in cancer (MAPK, WNT pathway).

UNIT-IV

Cancer Metastasis and Diagnosis: Seed & Soil theory, heterogeneity of metastatic phenotype, Metastatic

cascade, clinical significance of invasion: angiogenesis and EMT, Three-step theory of invasion (Basement Membrane disruption, role of Proteinases in tumor invasion and tumor cell locomotion), cancer stem cells. Diagnosis of cancers, Advances in Cancer detection (Biomarkers technology and nanotechnology).

UNIT-V

Principles of Cancer Therapy: Different forms therapy- conventional therapy-Chemotherapy, Radiation therapy and immunotherapy, Advances in Cancer therapy – personalized, targeted therapies and Thermo therapy. Classification of antineoplastic drugs, inter individual differences in response to anticancer drugs, mechanisms of anticancer drug resistance, mechanism of gene silencing (antisense, ribozymes, RNAi) and chemoprevention studies.

TEXT BOOKS:

1. Introduction to cell and Molecular biology of cancer, Franks and Teich, Oxford medical Publications, 2002.
2. Introduction to Cancer Biology, Robin Hesketh, Cambridge University Press, 2012.
3. King, Roger J B, Robins, Mike W, "Cancer Biology", 3rdedition, Prentice Hall, USA. 2003.
4. Molecular Biology of Cancer. Lauren Pecorina, 4th edition. Oxford University Press – 2016

SUGGESTED READING:

1. Robert A. Weinberg, "The Biology of Cancer", 5th edition, Garland Science. 2013.
2. Fiona Macdonald, Christopher Ford, Alan Casson, "Molecular Biology of Cancer", 2nd Edition, Taylor & Francis, 2004.Molecular biology of the cell. Bruce Alberts, 6th Edition.
3. Textbook readings; primary literature; in-class discussion. The Molecular Biology of Cancer: A Bridge from Bench to Bedside. Stella Pelengaris, Mike Khan -2nd Edition – 2013.

22BTE18

STEM CELL TECHNOLOGY
(Professional Elective–IV)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

To impart knowledge of wide-ranging topics related to stem cells and regenerative biology, including a brief history of the field, research on animal models of regeneration, tissue engineering, social and ethical issues related to stem cell research.

COURSE OUTCOMES: At the end of the course, the students are able to

1. Describe the Stem cells properties and their niche
2. Identify the cell cycle checkpoints, development and epigenetic control
3. Explain the Stem cell types, regeneration and its storage
4. Discuss the Isolation, differentiation and visualization of Stem Cells
5. Outline the application of stem cells for the treatment of various disease

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2					3	3		2	3		2	2	2
CO2	2					3	3		2	3		2	2	2
CO3	2					3	3		2	3		2	2	2
CO4	2					3	3		2	3		2	2	2
CO5	2		2			3	3	2	2	3		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Stem Cells and its Niche: Principles and properties of stem cells, types of stem cells, comparison of embryonic and adult stem cells. Introduction to stem cell niches in the gut epithelium, bone marrow, epidermis, testis and neural tissues.

UNIT-II

Cell Cycle and Development: Cell cycle regulators and checkpoints, cell fusion, differentiation of stem cells and their role in self-renewal.

Epigenetic Control: DNA-methylation and histone modifications, genomic imprinting, telomerase regulation, X-chromosome inactivation, reprogramming of cells, induced pluripotent stem cells and their therapeutic applications.

UNIT-III

Types and Regeneration: Stem cells derived from amniotic fluid, extraembryonic membrane, germ cells, hematopoietic organs, neurons and kidney, cord blood transplantation, donor selection, HLA matching, patient selection, peripheral blood and bone marrow transplantation, bone marrow and cord blood collection procedures and cryopreservation and their applications.

UNIT-IV

Experimental Methods: Isolation and differentiation of human adult stem cells, embryonic stem cells and

mouse stem cells, stem cell techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging.

UNIT-V

Applications: Stem cells applications in cancer, diabetes, heart disease, muscular dystrophy, regeneration of epidermis; stem cell regulations, debate, social and ethical concerns, Organ farming.

TEXT BOOKSs:

1. Hematopoietic Stem Cell Transplantation by Treleaven, J., first edition 2009.
2. Essentials of Stem Cell Biology by Lanza, R., second Edition, 2009 Academic Press.

SUGGESTED READINGs:

1. Molecular Cell Biology by Lodish et al., sixth Ed., W.H. Freeman & Co. 2008.
2. Stem Cells: From Bench to Bedside by Bongso and Ariff.

22BTE19

NANOBIOTECHNOLOGY
(Professional Elective -IV)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To introduce the concept of nanotechnology and nano-size
2. To gain knowledge on the synthesis and characterization of nanomaterials
3. To have awareness about different types of Nanostructures
4. To get familiarize with applications of nanobiotechnology in different fields

COURSE OUTCOMES:

1. Discuss the multidisciplinary nature of nanotechnology and nanoscale paradigm in terms of properties at the nano scale dimension.
2. Describe different methods used for the synthesis and characterization of nanomaterials.
3. Interpret various types of nanostructures.
4. Summarize general applications of nanobiotechnology.
5. Outline the current applications of nanobiotechnology.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2					3	3		2	3		2	2	2
CO2	2					3	3		2	3		2	2	2
CO3	2					3	3		2	3		2	2	2
CO4	2					3	3		2	3		2	2	2
CO5	2		2			3	3	2	2	3		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction and Significance of Nano Domain: Nanotechnology - A Historical Perspective, definition of nanoscale with special suggested reading to biosystems, scope and future prospects of Nanotechnology, Nanobiotechnology and Bionanotechnology, Opportunities and Challenges in Bionanotechnology; Limitations of micron size, need for nano-size-surface volume ratio significance, significance and key feasstures of nano-size, comparison of particle behaviour at nano-size to Macro Size: Gold and Titania, advantages of scaling down-nano-size.

UNIT-II

Synthesis and Characterization of Nanomaterials: Synthesis of Nanomaterials - Top-down and bottom up approaches with examples, physical, chemical and biological methods, characterization of nanomaterials-Optical (UV-Visible/fluorescence), X-ray diffraction, Imaging and size - (Electron Microscopy- SEM, TEM), Atomic force microscopy, Scanning tunneling microscopy, Spectroscopy- NMR, Raman FT-IR and Plasma Resonance

.

UNIT-III

Nanostructures: Smart materials, nanoscale biostructures, carbon nanotubes, nanowires, nanoflakes, nanoshells, quantum dots, dendrimers, micelles, nanosomes, liposomes, virosomes, polymersomes.

UNIT-IV

General Applications of Nanobiotechnology: Application of nanotechnology in medical diagnosis, drug discovery, drug development, drug delivery, Photodynamic Therapy.

UNIT-V

Current applications of Nanobiotechnology: Application of nanotechnology in Protein Engineering, Tissue Engineering, Agriculture, Environment, food processing, Nanotechnology and Nanoparticles: Clinical, Ethical, and Regulatory Issues.

TEXT BOOKS

1. Christof M. Niemeyer and Chad A. Mirkin, "Nanobiotechnology: Concepts, Applications and Perspectives" Wiley Publishers, April 2004.
2. Mark Ratner and Daniel Ratner, "Nanotechnology: A Gentle Introduction to Next Big Idea", Low Price edition, Third Impression, Pearson Education.

SUGGESTED READING

1. David S Goodsell, "Bionanotechnology", John Wiley & Sons, 2004.
2. DebasisBagchi, ManashiBagchi, Hiroyoshi Moriyama, Fereidoon Shahidi, "Bio-Nanotechnology: A Revolution in Food, Biomedical and Health Sciences" Wiley -Blackwell, 2013.
3. Elisabeth S P, Aravind P, "Bionanotechnology", Morgan & Claypool publishers, 2007.

22BTE20

RATIONAL DRUG DISCOVERY
(Professional Elective-IV)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. The student is made to understand the fundamentals of molecular modeling and drug discovery
2. Students are made to understand quantum Mechanics and molecular mechanism
3. Students are enlightened about molecular dynamics simulation methods.
4. Students are enlightened about the methods for Molecular Docking and lead optimization, ADMET properties of the drug.
5. Students are made to understand the basics of Pharmacophore and QSAR

COURSE OUTCOMES: At the end of the course, the students are able to

1. Describe drug discovery process, CADD, molecular modeling etc.
2. Explain the quantum Mechanics and molecular mechanism.
3. Identify various molecular dynamics simulation methods.
4. Discuss the methods for Molecular Docking and lead optimization, ADMET properties of the drug.
5. Summarize about the Pharmacophore and QSAR.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2	2			2	2	2	2	2	2		2	3	
CO2	2	1			2			2	2	2		2	2	
CO3	2	2	2		2	2	2	2	2	2		3	3	
CO4	2	2	2		2	2	2	2	2	2		3	3	
CO5	2	2			2	2	2	2	2	2		2	2	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Molecular Modeling in Drug Discovery: Drug discovery process, Role of Bioinformatics in drug design, Methods of computer-aided drug design, ligand design methods, drug design approaches, Target identification and validation, lead optimization and validation, Structure and ligand based drug design, modeling of target-small molecule interactions, Molecular simulations. Protein Modeling.

UNIT-II

Quantum Mechanics and Molecular Mechanics: Features of molecular mechanics force fields; Bond structure and bending angles–electrostatic, van der Waals and non–bonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Application of energy minimization.

UNIT-III

Molecular Dynamics simulation methods: Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time–dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation and application.

UNIT-IV

Molecular Docking and lead optimization: Molecular Docking; Types of Molecular Docking, docking algorithms and programs, Structure-based methods to identify lead compounds; de novo ligand design; Applications of 3D Databases Searching and virtual Screening; Strategy for target identification and Validation, lead identification, optimization and validation. Combinatorial chemistry and library design, virtual screening, drug likeness and compound filtering, Absorption, distribution, metabolism, excretion and toxicity (ADMET) property prediction, computer-based tools for drug design.

UNIT-V

Pharmacophore and QSAR: Pharmacophore derivation, 3D pharmacophore prediction and application in drug discovery; QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principal Components Analysis in the QSAR equations.

TEXT BOOKS

1. Computational methods in drug design Fred E. Cohen, Walter Hamilton Moos Publisher: ESCOM Science, 1993.
2. Molecular Modelling for Beginners - Alan Hinchliffe Publisher: John Wiley & Sons Inc, 2008. ISBN: 978-0470513149.
3. Combinatorial Library Design and Evaluation: Principles, Software, Tools, Applications in Drug Discovery – Arup Ghose, Vellarkad Viswanadhan Publisher: CRC Press, 2001. ISBN: 0-8247-0487-8.

SUGGESTED READING

1. Molecular Modeling Basics - Jan H. Jensen Publisher: CRC Press, 2010. ISBN 978- 1420075267.
2. 3D QSAR in Drug Design: Recent Advances – Hugo Kubinyi, GerdFolkers, Yvonne C. Martin Publisher: Springer Science & Business Media. ISBN: 0-306-46858-1.
3. Computational Chemistry and Molecular Modeling - K. I. Ramachandran, Gopakumar Deepa, Krishnan Namboori Publisher: Springer – Verlag Berlin Heidelberg. ISBN: 978 3540773023.

22BTE21

PROCESS DYNAMICS & CONTROL FOR BIOTECHNOLOGISTS
(Professional Elective–V)

Instruction	3LHoursperweek
Duration of SEE	3Hours
SEE	60Marks
CIE	40Marks
Credits	3

COURSE OBJECTIVES:

1. The course aims at providing dynamics of system process, flow, level and temperature etc.
2. The course aims at incorporating concepts of the response of first order systems for non-interacting and interacting systems.
3. The course aims at providing knowledge on the design of control systems for open and close loop control.
4. The course aims at inculcating concepts of the control of pH of process and biochemical reactions.

COURSE OUTCOMES:

Upon completing the syllabus, the students will be able to

1. Use the knowledge of Process dynamics to control level, temperature, flow variable etc. in bioprocess industries.
2. Devise a simple feedback control strategy for a bioprocess
3. Incorporate the knowledge of closed loop and open loop tuning methods to fine tune the control parameters.
4. Use the knowledge of control valve sizing in the design of control valve system in bioprocess units.
5. Apply the knowledge of process control to regulate the pH of bioreactors.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2	2		2	1					1	1	2	2	2
CO2	3	3	1	1	2		2			2	1	2	2	2
CO3	2	2		2	1	2	1				1	3	2	3
CO4	2	1	1	1	1		2				1	2	2	2
CO5	2	2	1	1	2		1		1	2	1	3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Process Dynamics: Laplace transform of simple functions, transforms of derivatives, solutions of differential equations, inversion by partial fractions, Partial fractions. Process variables, Dynamics of simple processes – Flow, level, Temperature, Pressure and Concentration; Transfer function – Properties, response of simple processes for Step, Impulse and Sinusoidal Forcing functions. Concept of Time Constant, Linearization, Response of first order systems in series - Non-interacting and Interacting systems.

UNIT-II

Control Actions and Controllers: Controller and Control system – measuring device and final control elements, Open and Closed loop control, Negative and Positive feedback control, Servo and Regulatory problems. Ideal transfer functions –Control valve, Controllers, Proportional, Integral, and derivative actions – PI. PD and PID controls. Block diagram- Development of block diagram, overall Transfer function for single loop system, overall transfer function for change in set point and load, transportation lag.

UNIT-III

Optimum Controller settings: Controller Tuning – Evaluation criteria with l/4th decay ratio, Criteria for good control- IAE. ISE, ITAE. Controller Tuning – Ziegler –Nicholas and Cohen Coon methods. Continuous cycling method, Control of processes with a time delay.

UNIT-IV

Final Control Element: I/P Converter– pneumatic, electric and hydraulic actuators. Control valves – Construction, valve sizing, valve characteristics, valve positioner. Control of Globe, Butterfly and Diaphragm valves.

UNIT-V

Advanced Control Strategies: Brief description of Cascade control. Feed forward control, Ratio control, with a simple example. Dynamics and Control of pH of a process and Biochemical reactor.

TEXT BOOKS:

1. Donald R. Coughanowr , Process Systems Analysis and Control, 2nd ed., McGraw HillInc.,1991.
2. George Stephanpoulos,"Chemical process control", Pearson Prentice Hall, 1984.
3. Seborg, Edgar, Mellichamp, Doyle, "Process Dynamics and Control", 3rd edition John Weily and Sons, 2010.
4. Harriott P, "Process control", Tata McGraw-Hill publishing Co., New Delhi, Reprint 1991.

SUGGESTED READING:

1. Patranabis D, Principles of Process Control, Tata McGraw-Hill publishing Co., New Delhi, Reprint1997.
2. Eckman D.P., Automatic process control, Wiley Eastern Ltd., New Delhi, 1993.

22BTE22

IMMUNODIAGNOSTICS
(Professional Elective -V)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To learn the basic principles, procedures, and applications of immunodiagnostic tests.
2. To understand the principles and applications of immunodiagnostic tests.
3. To learn the steps involved in the production, diagnosis, and applications of monoclonal antibodies.
4. To learn the development of prophylactic agents such as vaccines.
5. To learn the novel methods used for immunodiagnostics.

COURSE OUTCOMES: At the end of the course, students will be able to

1. Outline the principle, importance, scope, classification of immunodiagnostic tests and antigen-antibody reaction
2. Explain the principles and application of immunodiagnostics tests for diagnosing various diseases
3. Discuss the production of monoclonal antibodies for diagnosis, treatment, and prevention of disease.
4. Describe various methods used for vaccine development.
5. Summarize the various novel techniques used in immunodiagnostics.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	3	2				2	2	2	2	2		3	3	2
CO2	2	2				3	3	2	2	2		3	3	2
CO3	2	2				3	3	2	2	2		3	3	2
CO4	2	2				3	3	2	2	2		3	3	2
CO5	3	2				3	3	2	2	2		3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Immunodiagnostics: Principles of immunodiagnostic tests and their development; classification of immunodiagnostic tests; Immunodiagnostics importance and scope; the antigen-antibody reaction; Selection and preparation of reagents; Assay design; Antibody engineering; Catalytic antibodies.

UNIT-II

Immunodiagnostics Techniques: Immunodiagnostics techniques – Precipitation, Immunoelectrophoresis, Agglutination, RIA, ELISA, Fluoroimmunoassay, Luminescent immunoassay, Immunofluorescence, Cell separation techniques, Western blotting.

UNIT-III

Hybridoma Technology: Hybridoma technique - choice of host for immunization and myeloma cells, choice of immunogen, preparation of antigen for immunization, growth of myeloma cell lines, preparation of cells for fusion, cell fusion, selection and screening of hybridoma, purification and application (biochemical research, clinical diagnosis and treatment) of monoclonal antibodies.

UNIT-IV

Vaccines: Whole organism Vaccines; Subunit-vaccines - Herpes Simplex virus, Foot and Mouth disease; Peptide vaccines - Foot and Mouth disease, Malaria; Live recombinant vaccines- Cholera, Salmonella; Vector vaccines - directed against viruses and bacteria; Purified vaccines, Conjugate polysaccharide vaccines; DNA vaccines; Antifertility vaccines.

UNIT-V

Novel Techniques in Immunodiagnostics: Imaging as an Immunodiagnostic Tool; Multicolor Flow Cytometry; Immunoglobulin and Free-light Chain Detection; Methods for Autoantibody Detection; Immunodiagnostic of Allergy; Multiplex Analysis of Cytokines; Immuno monitoring of Clinical Trials; Immunological Assays Used in Vaccine Clinical Trials.

TEXT BOOKS:

1. Edwards R, "Immunodiagnostics: A practical approach" Oxford University Press, 1999.
2. Rastogi SC, "Immunodiagnostics Principles and Practice" New Age Publishers, 1996.

SUGGESTED READING:

1. Shepherd, P., Dean C., "Monoclonal Antibodies: A Practical Approach" Oxford University Press, 2000.
2. Jenni Punt, Sharon Stanford, Patricia Jones, Judith A Owen., "Kuby Immunology" 8th edition, Macmillan learning, 2018.
3. Ralph M Aloisi Lea, Principles of Immunology and Immunodiagnostics, Lea & Febiger, 1988.

22BTE23

TISSUE ENGINEERING
(Professional Elective -V)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To provide fundamental principles and elements of tissue engineering.
2. To get an insight into the roles of cells, tissue organization, and matrix in tissue engineering.
3. To learn the tissue culture techniques and scale-up designs.
4. To learn the different biomaterials used for the fabrication of scaffolds.
5. To gain knowledge about the therapeutic applications of tissue engineering.

COURSE OUTCOMES: At the end of the course, students will be able to

1. Outline the concepts of tissue engineering, ethical issues, and future prospects
2. Illustrate the molecular mechanisms at the tissue level and in cell-matrix in tissue engineering.
3. Identify in vitro culturing techniques and scale-up designs.
4. Classify the compatible biomaterials used for the fabrication of scaffolds in Tissue engineering.
5. Summarize the therapeutic applications of tissue engineering.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2	2			2	2	2	3	2	2		2	2	2
CO2	2				2				2	2		2	3	3
CO3	2	2			3	2	2	3	2	2		2	3	3
CO4	2	2			2	2	2	2	2	2		2	3	3
CO5	2	2			2	2	2	2	2	2		2	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Tissue Engineering: Basic definition of Tissue engineering; origin and history of Tissue Engineering, an overview of its basic steps and its applications; General scientific issues, Ethical issues; Current challenges and future prospective.

UNIT-II

Cells and Tissue Organization: Cells-cell growth and death; cell differentiation; Cells in tissues and organs. Cell to cell interactions; cell adhesion molecules (CAM) Organization of cells into higher ordered structures-Mesenchymal cells; EMT, Molecular mechanisms and control of EMT process. Tissues-Vascularity; angiogenesis; wound healing Extracellular matrix (ECM) –components.

UNIT-III

Biomaterials of Tissue Engineering: Biomaterials Properties, Types of Biomaterials, Biological polymers; Synthetic polymers; a hybrid of synthetic and biological polymers; Scaffolds, 3D scaffolds, Scaffold fabrication conventional techniques: Solvent casting, porogen leaching, freeze drying, electro spinning and 3D bio-printing.

UNIT-IV

Functional Tissue Engineering: Cell and tissue culture- media; culture initiation; transformation and immortalization; validation; differentiation; maintenance of cells in vitro; cryopreservation. Stem cells in tissue engineering Bioreactors for tissue engineering- Bioreactor design requirements; Spinner flask

bioreactors. Rotating-wall bioreactors, Compression bioreactors, Strain bioreactors, Hydrostatic pressure bioreactors, Flow perfusion bioreactors and combined bioreactors.

UNIT-V

Applications of Tissue Engineering: Tissue replacement –crucial factors, Skin tissue engineering, Bone tissue engineering; Cardiac tissue engineering; Neural tissue engineering; Vascular tissue engineering; Lab on chip/Organ on chip technology.

TEXT BOOKS:

1. Robert.P.Lanza, Robert Langer & Vacanti, Principles of tissue engineering. Academic Press. 4th edition 2014.
2. B. Palsson, J.A. Hubbell, R. Plonsey & J.D. Bronzino. Tissue engineering. CRC Taylor & Francis press 2003.
3. B. Palsson & S.N. Bhatia. Tissue engineering. Pearson Education India Education Services Pvt. Ltd. 2016.

SUGGESTED READING:

1. Atala O.P &Lanza.L, Methods of tissue engineering. Woodhead Publishing Ltd. Cambridge. UK. 2009.

22BTE24

BIOSIMILAR TECHNOLOGY
(Professional Elective -V)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. Student is made to understand about the design and development of different kinds of biologics, biomimetics, and biosimilars.
2. Students are taught about different biotechnological applications of biologics, biomimetics, and biosimilars.
3. Students are made to study the regulatory framework about the biosimilars.

COURSE OUTCOMES: At the end of the course the students are able to

1. Outline the biologics, biosimilars and super biologics.
2. Distinguish the various biosimilar drugs
3. Compare and contrast various biosimilar characterization methods.
4. Interpret various bioequivalence studies.
5. Analyze various case studies of biosimilar products of Indian companies

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	2	2			2	2	2	3	2	2		2	2	2
CO2	2				2				2	2		2	3	3
CO3	2	2			3	2	2	3	2	2		2	3	3
CO4	2	2			2	2	2	2	2	2		2	3	3
CO5	2	2			2	2	2	2	2	2		2	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Biopharma: Generics in Biopharma, definition of biologics, biosimilars, super biologics, differences between chemical generics and biosimilars, The developmental and regulatory challenges in biosimilar development, Prerequisites for Biosimilar development, Biosimilar market potential.

UNIT-II

Types of Biosimilar drugs: Peptides, proteins, antibodies, Enzymes, Vaccines, Nucleic acid-based therapies (DNA, RNA), Cell based therapies (including stem cells)

UNIT-III

Characterization methods: Aggregation- precipitation, floccule strength, precipitate aging and kinetics, adsorption of proteins and peptides on surfaces, effect of temperature on protein structure, hydration and thermal stability of proteins - solid powders, suspension on non-aqueous solvents, reversed micelles, aqueous solution of polyols, analytical and spectrophotometric characterization of proteins.

UNIT-IV

Bioequivalence studies: Immunogenicity and allergenicity of biosimilars; factors affecting immunogenicity - structural, post-translational modifications, formulations, impurities, manufacturing and formulation methods for biosimilars; types of bioequivalences (average, population, individual).

UNIT-V

Case studies: Indian companies working in this space & their product pipeline (Biocon, Intas, Dr Reddy's,

Reliance, Bharat Biotech, Lupin, Cipla, Sanofi etc); products -Insulin analog, Erythropoietin, growth hormone, granulocyte stimulating factors, interferons, streptokinase, monoclonal antibodies.

TEXT BOOKS:

1. Laszlo Endrenyi, Paul Declerck and Shein-Chung Chow, Biosimilar Drug Development, Drugs and Pharmaceutical Sciences, Vol 216, CRC Press.
2. Cheng Liu and K. John Morrow Jr., Biosimilars of Monoclonal Antibodies: A Practical Guide to Manufacturing, Preclinical and Clinical Development, Wiley, Dec 2016.

SUGGESTED READING Material:

1. https://www.drugs.com/medical-answers/many-biosimilars-approved-unitedstates-3463281/

22BTE25

MOLECULAR MODELING & DRUG DESIGN

(Professional Elective -V)

Instruction	3L Periods per week
Duration of university Examination	3 Hours
University Examination	60 Marks
Sessional	40 Marks
Credits	3

COURSE OBJECTIVES:

1. Empirical force fields and Hydrogen bonding in different molecules.
2. Simulation methods to calculate Thermodynamic properties of molecules.
3. Molecular dynamics simulation of molecules by simple and continuous potential.
4. Practical aspects in setting and running the molecular dynamics simulation.
5. Montecarlo simulation method for rigid and flexible molecules.
6. QSAR between different protein-ligand interactions.

COURSE OUTCOMES: After completion of the course students gain knowledge in the following concepts:

1. Analyse the total energy of the molecule by using force field potentials and Molecular mechanics
2. Identify various computer simulation methods using Molecular modeling for drug discovery
3. Illustrate an ensemble of representative configurations under specific thermodynamic conditions for a complex macromolecular system by simulation.
4. Outline the strategies applied by Monte Carlo Simulation methods
5. Summarize the applications of Molecular Modeling and Drug Design.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2		2				2	2		2	2	
CO2	2	2	2		2				2	2		3	3	
CO3	2	2	2		2				2	2		3	3	
CO4	2	2	2		2				2	2		3	3	
CO5	2	2	2		2				2	2		2	3	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Empirical Force Fields and Molecular Mechanics: Introduction to Molecular Mechanics, Coordinate system, Molecular graphics, Force fields, Bond stretching, Angle bending, Torsions, out of plane bending motions, Electrostatic interactions, Van der Waals interactions, Effective pair potentials, Hydrogen bonding.

UNIT-II

Computer Simulation Methods: Calculation of Thermodynamic properties, Phase space, Practical aspects of computer simulation, Periodic boundary condition, Boundaries monitoring Equilibrium, Truncating the potential and minimum image convention, Long-range process, Analyzing results of simulation and estimating errors**.**

UNIT-III

Molecular Dynamics Simulation Methods: Molecular Dynamics using simple modules, Molecular Dynamics with continuous potentials: Finite difference methods and Predictor corrector integration method, Constraint Dynamics, Transport properties, Time-dependent properties, Molecular Dynamics at Constant

Temperature and Pressure.

UNIT-IV

Monte Carlo Simulation Methods: Metropolis methods, Importance of Hamiltonian equation, Monte Carlo simulation of Rigid and Flexible molecules, Monte Carlo simulation of Polymers: Lattice model & continuous polymer model, calculating chemical potential, Differences between Molecular dynamics & Monte Carlo simulation method.

UNIT-V

Applications Of Molecular Modeling And Drug Design: Production of Drugs in Pharmaceutical companies, CADD: Structure-Based Drug Design and Ligand Based Drug Design, Quantitative Structural Activity Relationship (QSAR) studies in Protein-Ligand interactions, Case studies of Alzheimer's disease, Tuberculosis, and Cancer, etc.

TEXT BOOKS:

1. Molecular modeling principles and Applications AR Leach, Longman, (1996).
2. Molecular Dynamics simulation -Elementary Methods- John Wiley and Sons, (1997).

SUGGESTED READING:

1. Protein Engineering - Moody PCE and AJ Wilkinson. IRL Press.
2. Introduction to protein structure by C. Brandon and J. Tooze, Garland, 2nd edition, (1998).
3. Essentials of Drug Designing V. Kothakar, Dhruv publications

22EGO03

INDIAN TRADITIONAL KNOWLEDGE
(Open Elective–III)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge of Indian Culture.

COURSE OBJECTIVES: This course aims to:
1. To get a knowledge in Indian Culture.
2. To know Indian Languages and Literature and the fine arts in India
3. To explore the Science and Scientists of Medieval and Modern India.

COURSE OUTCOMES: Upon completion of this course, students will be able to:
1. Understand philosophy of Indian culture.
2. Distinguish the Indian languages and literature.
3. Learn the philosophy of ancient, medieval, and modern India.
4. Acquire the information about the fine arts in India.
5. Know the contribution of scientists of different eras.

CO-PO/PSO Articulation Matrix

PO/PSO CO	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
CO1	1	1	2	1	1	2	2	3	2	2	1	2	1	1
CO2	1	1	2	1	1	2	2	3	2	2	1	2	2	1
CO3	1	1	2	1	1	2	2	3	2	2	1	2	1	1
CO4	1	1	2	1	1	2	2	3	2	2	1	2	1	1
CO5	1	3	2	1	1	2	2	3	2	2	2	3	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Culture and Civilization: Culture, Civilization and heritage, general characteristics of culture, importance of culture in human life, Cultural diversity, Aesthetics, Women seers, Indus culture, Indian Cuisine, Martial arts.

UNIT-II

Education System: Education in ancient, medieval and modern India, aims of education, subjects, Languages, Science and Scientists of ancient. Medieval and modern India. Concepts of Sciences in Indian Knowledge Systems.

UNIT-III

Linguistic Wealth: Indian languages and Literature: The role of Sanskrit, Morphology and brevity of Sanskrit, Concepts of NLP in IKS. Paleography, Fundamentals of Vedic Mathematics, Significance of scriptures to current society, Indian semantics and lexicography, Darshanas.

UNIT-IV

Art, Technology & Engineering: Sculpture, Painting and Handicrafts, Indian Music, Dance Drama and Theatre, introduction to Mayamatam, Iron and Steel technology, Use of metals in medicinal preparations.

UNIT-V

Science and Logic: Heliocentric system, Sulbasutras, Katapayadi, Engineering in Vedas, Adaptability of Sanskrit in Computer languages, Related commands Hindu calendar, 6 Pramanas in Indian logic, Scientific method applied to therapeutics, Fallacies, Tarka- Induction and deduction, Ayurvedic biology, Definition of health.

TEXT BOOKS:

1. B. Madhavan, Nagendra Pavana, Vinayak Rajat Bhat, "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning, June 2022.
2. Kapil Kapoor, "Text and Interpretation: The Indian Tradition", D K Print World Ltd., 2005.
3. Samskrita Bharati, "Science in Sanskrit", 2017.
4. Satya Prakash, "Founders of sciences in Ancient India", Govindram Hasanand, 1986.

SUGGESTED READING:

1. Brajendranath Seal**, "**The Positive Sciences of the Ancient Hindus", Motilal Banarasidass, 2016.
2. Kancha Ilaiah, "Turning the Pot, Tilling the Land: Dignity of Labour in Our Times", Navayana, 2019.
3. Balram Singh and others, "Science & Technology in Ancient Indian Texts", D.K. Print World Ltd, 1st edition, 2012.
4. Smt. Kalpama Paranjepe, "Ancient Indian insight and Modern Science"**,** Bhandarkar Oriental Research Institute, 1996.
5. Pradeep Parihar, "Vedic World and Ancient Science", World House Book Publishing, 2021.

22MEO06

PRINCIPLES OF ENTREPRENEURSHIP AND STARTUPS
(Open Elective–III)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Prerequisite: Nil

COURSE COURSE OBJECTIVES: This course aims to
1. Impart basic concepts and procedure of idea generation.
2. Familiarize the nature of industry and related opportunities and challenges.
3. Familiarize with elements of business plan and its procedure.
4. Learn the project management and its techniques.
5. Know the behavioral issues and time management.

COURSE OUTCOMES: Upon completion of this course, the students will be able to
1. Understand the concept and essence of entrepreneurship.
2. Identify business opportunities and nature of enterprise.
3. Analyze the feasibility of new business plan.
4. Apply project management techniques like PERT and CPM for effective planning and execution of projects.
5. Use behavioral, leadership and time management aspects in entrepreneurial journey.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	1		1	1	1	2	2	2	1	1	1	1		
CO2	1	1	1	1	1	2	2	2	2	2	3	1		
CO3	1	1	1	2	2	2	2	2	2	2	3	1		
CO4	2	1	1	2	2	2	2	2	1	2	3	1		
CO5	1		1	1	1			2	1	1	1	1		

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Entrepreneurship: Definition, Characteristics of an Entrepreneur, Functions of Entrepreneurs, Entrepreneur vs. Intrapreneur, First Generation Entrepreneur, Women Entrepreneurship, Ideas and their Sources, Conception and Evaluation of Ideas.

Behavioral Aspects of Entrepreneurs: Personality: Determinants, Attributes and Models, Leadership: Concepts and Models, Values and Attitudes, Motivation Aspects.

UNIT-II

Indian Industrial Environment: Competence, Opportunities and Challenges, Entrepreneurship and Economic Growth, Small Scale Industry in India, objectives, Linkage among Small, Medium and Heavy Industries, Types of Enterprises, Corporate Social Responsibility.

UNIT-III

Business Plan: Introduction, Elements of Business Plan and its salient features, Business Model Canvas, Technical Analysis, Profitability and Financial Analysis, Marketing Analysis, Feasibility Studies, Executive Summary.

UNIT-IV

Project Management: During construction phase, project organization, project planning and control using CPM, PERT techniques, human aspects of project management.

Time Management: Approaches of Time Management, their strengths and weaknesses. Time Management Matrix, Urgency Addiction.

UNIT-V

Startup: Definition, Startup Ecosystem, Startup Incubator, Need and Importance of Startups and Incubation Centers. Sources of Finance and Incentives for Startups. Innovation, Creativity, Intellectual Property in Entrepreneurial Journey. Business firm Registration Process in INDIA.

TEXT BOOKS:

1. Vasant Desai, "Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 1997.
2. Prasanna Chandra, "Project-Planning, Analysis, Selection, Implementation and Review", Tata Mcgraw- Hill Publishing Company Ltd, 1995.
3. S.S. Khanka, "Entrepreneurial Development", S. Chand & Co. Pvt. Ltd., New Delhi, 2015.

SUGGESTED READING:

1. Robert D. Hisrich, Michael P. Peters, "Entrepreneurship", 5th edition, Tata Mc Graw Hill Publishing Company. Ltd., 2005.
2. Stephen R. Covey and A. Roger Merrill, "First Things First", Simon and Schuster Publication, 1994.

22CIO03

FUNDAMENTALS OF BLOCKCHAIN TECHNOLOGY
(Open Elective – III)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To provide an understanding of blockchain benefits and limitations
2. To familiarize with decentralisation and cryptography
3. To explore theoretical foundations of bitcoin
4. To equip with the knowledge of smart contracts
5. To analyse real-world case studies and applications of blockchain technology across various industries.

COURSE OUTCOMES: By the end of this course, students should be able to:

1. Explain the fundamental concepts and principles of blockchain technology.
2. Describe the decentralisation and cryptographic primitives.
3. Understand bitcoin and its limitations
4. Analyse smart contracts and Ethereum blockchain
5. Evaluate the potential applications and impact of blockchain technology in different sectors.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	3	3	3	3	1							3	1	
CO2	3	3	3	3	1							3	1	
CO3	3	3	3	3	2							3	1	
CO4	3	3	3	3	2							3	1	
CO5	3	3	3	3	3							3	3	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Blockchain Technology: Blockchain 101: Distributed systems, History of blockchain, Introduction to blockchain, Types of blockchain, CAP theorem and blockchain, Benefits and limitations of blockchain.

UNIT-II

Decentralization and Cryptography: Decentralization using blockchain, Methods of decentralization, Routes to decentralization, Decentralized organizations. Cryptography and Technical Foundations: Cryptographic primitives, Asymmetric cryptography, Public and private keys

UNIT-III

Bitcoin and Alternative Coins: Bitcoin, Transactions, Blockchain, Bitcoin payments Alternative Coins. Theoretical foundations, Bitcoin limitations, Namecoin, Litecoin, Primecoin, Zcash

UNIT-IV

Smart Contracts and Ethereum 101: Smart Contracts: Definition, Ricardian contracts. Ethereum 101: Introduction, Ethereum blockchain, Elements of the Ethereum blockchain, Precompiled contracts.

UNIT-V

Alternative Blockchains: Blockchain-Outside of Currencies: Internet of Things, Government, Health, Finance, Media. **Case studies and real-world projects showcasing blockchain technology in various industries.**

TEXT BOOKS:

1. Imran Bashir, "Mastering Blockchain - Distributed ledgers, decentralization and smart contracts explained", Packt Publishing Ltd, Second Edition, 2018
2. Imran Bashir, "Mastering Blockchain - A technical reference guide to the inner workings of blockchain, from cryptography to DeFi and NFTs", Packt Publishing Ltd, Fourth Edition, 2023

SUGGESTED BOOKS:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction"
2. Daniel Drescher, "Blockchain Basics: A Non-Technical Introduction in 25 Steps", Apress, First Edition, 2017.

E-RESOURCES:

1. https://nptel.ac.in/courses/106/104/106104220/
2. https://nptel.ac.in/courses/106/105/106105184/

22ADO01

INDUSTRY 5.0: APPLICATIONS OF AI
(Open Elective)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To introduce Artificial Intelligence in detail from its basics to future applications and tools of Industry 5.0
2. To provide insights on technological advancements and focus on preparing students and researchers for Industry 5.0
3. To impart the importance of AI technologies in assistive technology
4. To discuss the available applications of AI for promoting early diagnosis of diseases
5. To understand the various AI technologies

COURSE OUTCOMES:

1. Summarize the evolution, current applications, and future challenges of artificial intelligence.
2. Evaluate the foundational elements and impacts of AI within machine learning paradigms.
3. Analyze AI's effectiveness in diagnosing diseases and enhancing assistive technology.
4. Design AI-driven solutions for modernizing and improving agricultural practices.
5. Assess AI's role in advancing radiotherapy techniques and ensuring quality assurance.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	3	3	3	3	1	2	2	1	2	1	2	3	2	
CO2	3	3	3	3	1	2	2	1	2	1	2	3	2	
CO3	3	3	3	3	1	2	2	1	2	1	2	3	2	
CO4	3	3	3	3	1	2	2	1	2	1	2	3	2	
CO5	3	3	3	3	1	2	2	1	2	1	2	3	2	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Artificial Intelligence Insight: Artificial Intelligence: What and Why, History of AI, What is AI?,The Basics, AI Environment, Challenges in AI, Current work in AI for environment, Customer Experience (CX) and the use of AI, Future of AI, Future challenges in AI

UNIT-II

Influence of AI in Machine Learning: Definition, What is Machine Learning, Importance of Machine Learning, Types of Machine Learning, Approaches of Machine Learning - Machine Learning Algorithm, Programming Languages, Frameworks, Databases, Deployment tools, Methodology for Model Building, Machine learning methods, Statistical Measures, Application areas of Machine Learning, Medical Machine

Learning, Influence of AI and ML in Clinical and Genomic Diagnostics.

UNIT-III

Artificial Intelligence in Healthcare sector & Assistive Technology (AT): AI in diagnosis of Genetic Diseases, Cancer, Diabetes, AI in Diagnosis of Syndrome, AI in diagnosis of Psychiatric Disorders, Depression, Alzheimer's Disease, Autism Spectrum Disorder, Anxiety, Parkinson's Disease, AI in other Diagnosis, Infectious, Lung and Brain Disease, Case studies on AI in systems Biology, AI technologies in Systems Biology towards Pharmacogenomics, AI in Systems Biology for Cancer Cure, Applications of AI for COVID-19 Pandemic, Transformative impact of AI on AT, AI experience and AT for disables people in India, AI Powered technology for an inclusive world .

UNIT-IV

Artificial Intelligence in Agriculture: Need of AI in Agriculture, Emerging Agricultural Technologies, Soil and water sensors, Weather Tracking, Satellite Imaging Agriculture, Automation Systems, RFID Technology, Potential Agricultural Domain for Modernization, AI transformation in Agricultural Scenarios.

UNIT-V

Artificial Intelligence in Radiotherapy: Importance of Artificial Intelligence in Radiotherapy , AI tools for automated treatment planning (ATP), Present ATP techniques, AI applications, Advancements and Research Guidance in ATP, AI challenges in ATP, AI in Intensity-modulated Radiotherapy (IMRT), AI for IMRT Dose Estimation, AI for IMRT Planning Support, AI for Modeling IMRT outcome and plan deliverability, AI for AUTO- Segmentation of OAR in IMRT, AI in Brachytherapy, AI in Radiotherapy Quality Assurance, Challenges associate with AI for Quality Assurance in RT, Future directions to improve AI-based Quality Assurance in RT, AI in Radiation Biology, AI in Radiation Protection/Safety, Motivations to develop AI-Based systems for Radiation Protection.

TEXTBOOK:

1. Kaliraj, P., & Devi, T. (Eds.). (2021). Artificial Intelligence Theory, Models, and Applications (1st ed.). CRC Press, Taylor & Francis Group, Boca Raton, ebook ISBN 9781032008097 Auerbach Publications. https://doi.org/10.1201/9781003175865

22BTC34

TECHNICAL SEMINAR

Instruction	2P Hours per week
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course aims to:

1. To introduce students to critical reading, understanding, summarizing, explaining and preparingreport on state-of-the-art topics in a broad area of his/her specialization.
2. Seminar topics may be chosen by the students with advice from the faculty members and thestudent shall read further relevant articles in the domain.
3. Documenting the seminar report in a prescribed format.

COURSE OUTCOMES: At the end of the course, students will be able to:

1. Study and review research papers of new field/areas and summarize them.
2. Identify promising new directions of various cutting edge technologies in Computer Science and Engineering
3. Impart skills to prepare detailed report describing the selected topic/area.
4. Acquire skills to write technical papers/articles for publication.
5. Effectively communicate by making an oral presentation before the evaluating committee.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2	2		2	2	3	3	3		3		2	2	3
CO2	2			2	2	3	3	3		2		2	2	2
CO3	2	2		2		3	3			3	1	2	2	2
CO4	2	1		3	3					3	1	3	2	2
CO5	2			3		3	4	3		2		2	2	3

1 - Slightly, 2 - Moderately, 3 - Substantially

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the topic
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Submit a one page synopsis of the seminar talk for display on the notice board.
2. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
3. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the department.

Seminars are to be scheduled **from 3rd week to the last week of the semester** and any change in schedule shall be discouraged. For the award of sessional marks students are **judged by three (3) faculty members** and are based on oral and written presentations as well as their involvement in the discussions during the oral presentation.

Guidelines for awarding Marks		
S. No.	Description	Max. Marks
1	Contents and Relevance	10
2	Presentation Skills	10
3	Preparation of Presentation slides	05
4	Question and Answers	05
5	Report in prescribed format	20

Note: Topic of the seminar shall preferably be from any peer reviewed recent journal publications.

22BTC35

PROJECT PART-II

Instruction	8P Hours per week
SEE	100 Marks
CIE	100 Marks
Credits	4

COURSE OBJECTIVES: This course aims to:

1. Enable the student to extend further the investigative study taken up, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry.
2. Provide a good training for the student(s) in R&D work and technical leadership.

COURSE OUTCOMES: Upon completion of this course, students will be able to:

1. Carry out In depth study of the topic assigned;
2. Review and finalize the Approach to the Problem relating to the assigned topic;
3. Prepare an Action Plan for conducting the investigation, including teamwork;
4. Present a Detailed Analysis/Modeling/Simulation/Design/Problem Solving/Experiment as needed and Develop a product/process, testing, results, conclusions and future directions;
5. Prepare a Dissertation in the standard format for being evaluated by the Department, paper for Conference presentation/ Publication in Journals, if possible and Present a Final Seminar before Departmental Committee.

CO-PO/PSO Articulation Matrix

PO/PSO / CO	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
CO1	2	2	2	2	2	2	2	2	2	2	2	3	3	3
CO2	3	2	3	2	3	3	3	3	2	2	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	2	2	2	2	2	2	2	2	2	3	2	2	2	2
CO5	3	3	3	3	3	3	3	2	3	3	3	3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

Guidelines for the award of marks in CIE: (Max. Marks: 100)

Evaluation by	Max. Marks	Evaluation Criteria / Parameter
Department Review Committee	10	Review 1
	15	Review 2
	25	Submission
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Report Preparation
	10	Analytical / Programming / Experimental Skills

Guidelines for awarding marks in SEE: (Max. Marks: 100)

Evaluation by	Max. Marks	Evaluation Criteria / Parameter
External and Internal Examiners together	20	PowerPoint Presentation
	40	Thesis Evaluation
	20	Quality of the project • Innovations • Applications • Live Research Projects • Scope for future study • Application to society
	20	Viva-Voce

PROJECT PART-II GUIDELINES:

These guidelines assure consistency in the quality and components of project within the Department and they are segregated into 3 sections

A) Section 1 describes guidelines and procedures for allotment, submission, and acceptance of the project

1. Students will be allotted a faculty supervisor based on their topic/ area of interest.
2. There will be a maximum of 3 students attached to each of the staff for each research project
3. Students are encouraged to continue the topic of Project Part I in their previous semester
4. The project problem statement and topic should be finalized in consultation with the faculty supervisor
5. Care should be taken that no two project problems should be the same. Care should be taken that the problem should not be the same as done in the department over the last three years
6. No change in project or group after the department research committee and HoD finalize the list
7. Hardbound project thesis (4 Nos) duly certified by internal guide, external guide (if any), DRC and the HOD should be submitted at the time of external viva-voce examination
8. The students should record the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. Students shall be ready to show the diary to the internal guide or DRC or HoD at any point of time.
9. Responsibilities of students include
    - Schedule meetings as needed with the guide, or others as needed.
    - Meet the deadlines as specified in the departmental curriculum.
    - Submit working drafts to the project guide during the writing process.
    - The student is responsible for making all arrangements for the preparation of the thesis

B) Section 2 provides an overview of the structure and content of the project thesis and minimal formatting requirements for preparation of the thesis.

1. The thesis consists of three general sections: The preliminary pages, text and references.
    - ✓ Title page (mention the guide's name - both internal and external also)
    - ✓ Certificates (INTERNAL AND EXTERNAL)
    - ✓ Declaration
    - ✓ Acknowledgements
    - ✓ Contents
    - ✓ Abbreviations
    - ✓ List of Tables
    - ✓ List of Figures
    - ✓ Graphical Abstract or comprehensive overview of work
    - ✓ Abstract (in 250 words) and Keywords

- ✓ Novelty statement
- ✓ Introduction
- ✓ Review of literature
- ✓ Materials and Methods
- ✓ Results and Discussion
- ✓ Conclusions(200 words)
- ✓ References
- ✓ Appendix (if any)
- ✓ Published research papers (if any)

2. The thesis should be written in Times New Roman (12 size), 1.5 or double spacing, headings and side headings in bold, well defined margins, pagination, etc.
3. Students are instructed to prepare a comprehensive PowerPoint presentation with all findings to present before the external examiner

C) Section 3 suggests the time schedule.

Students should attend all the reviews and follow the deadlines as per the almanac will be allotted with a faculty supervisor

Suggested schedule:

Starting Date	Day 1 (As per almanac)
Literature review/survey	End of 1 Weeks
Process Manuscript submission	End of 2 Weeks
Material and microbes procurement	End of 4 Weeks
Results and Analysis	End of 12 Weeks
Approval of printout draft and Manuscript	End of 15 Weeks
Submission of bound copies	Last Day (As per almanac)

The project would be evaluated on a regular basis by the DRC by conducting periodical reviews and marks will be awarded following the rubrics