With effect from the Academic Year 2023-24

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	3	-	-	3	40	60	3
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	22 CE M01	Environmental Science	2	-	-	2	-	50	Non-credit
	PRACTICALS								
8	22CSC36	Data Structures Using Python Lab	-	-	2	3	50	50	1
9	22BTC08	Biochemistry Lab	-	-	2	3	50	50	1
10	22BTC09	Microbiology Lab	-	-	2	3	50	50	1
11	22BTC10	MOOCs/Internship - I	3-4 weeks / 90hrs			-	-	50	2
Total			**20**	**-**	**6**		**390**	**610**	**23**
Clock hours per week: 26									

L: Lecture **D: Drawing** **CIE - Continuous Internal Evaluation**

T: Tutorial **P: Practical /Project Seminar/Dissertation** **SEE - Semester End Examination**

22CSC35

DATA STRUCTURES USING PYTHON

(Common to BioTech, Chemical, Civil and Mechanical Engineerig)

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

Course Objectives: The objectives of this course are 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: On Successful completion of the course, students 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.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

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

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/
4. https://www.cs.usfca.edu/~galles/visualization/Algorithms
5. 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:

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 ingraphical 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:

At the end of the course, students are able to

1. To analyze, interpret and solve the problems encountered in the preparation of material and energy balances of different bioprocesses.
2. To analyze and present experimental data in the form of graphs.
3. To calculate Material balances for unit operations and unit processes involved in Biotechnology.
4. To calculate enthalpy changes associated during various bioprocesses.
5. To predict growth kinetics and analyze reaction kinetics for biological systems.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	2	2	2	0	0	2	0	0	3	3
CO2	2	2	1	2	2	2	2	0	0	3	0	0	2	3
CO3	2	2	1	2	2	2	2	0	0	2	0	0	2	1
CO4	2	2	1	2	2	2	2	0	0	2	0	0	2	1
CO5	2	2	1	2	2	2	2	0	0	2	0	0	2	3

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, W i l e y .
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-HillEducation, 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:

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:

By the end of the course, students 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.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	0	0	0	2	2	0	0	2	0	2	2	2
CO2	2	1	0	0	0	2	2	0	0	2	0	2	2	2
CO3	2	1	0	0	0	2	2	0	0	2	0	2	2	2
CO4	2	1	0	0	0	2	2	0	0	2	0	2	2	2
CO5	2	1	0	0	0	2	2	0	0	2	0	2	2	2

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:

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:

By the end of the course, students 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 haveon ecosystems
5. Illustrate the mechanisms for the propagation of infectious diseases caused by the microorganism

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	0	0	1	1	2	1	3	0	1	0	3	2	2
CO2	1	0	0	1	2	2	1	0	1	1	0	3	3	3
CO3	1	1	0	1	1	2	1	1	1	0	0	3	3	3
CO4	1	0	0	0	1	2	0	0	1	1	0	3	3	3
CO5	1	0	0	2	2	2	0	1	1	1	0	3	3	3

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:

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:

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.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	0	0	1	1	2	1	3	0	1	0	3	2	3
CO2	1	1	0	1	1	2	1	0	1	1	0	3	2	3
CO3	1	1	0	1	1	2	1	1	1	0	0	3	1	3
CO4	1	0	0	0	1	2	0	0	1	1	0	3	2	3
CO5	1	0	0	2	2	2	0	1	1	1	0	3	3	3

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:

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:

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

1. Explain 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.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	0	0	1	0	2	1	1	1	1	1	1	1	1
CO2	2	0	0	1	1	0	1	1	0	1	1	1	2	2
CO3	1	1	0	1	0	0	1	1	1	0	1	1	2	2
CO4	1	0	1	0	0	2	1	1	1	1	1	1	2	2
CO5	2	1	1	1	2	0	1	0	1	1	1	1	2	2

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 ofX- 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.

22 CE M01

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: The objectives of the course is to make the student

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: At the end of the course, student is 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.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	-	-	-	-	-	3	-	-	-	-	1	-	1
2	1	-	-	-	-	-	2	1	-	-	-	1	-	1
3	1	-	-	-	-	-	2	1	-	-	-	1	-	1
4	1	-	-	-	-	1	2	1	-	-	-	1	-	1
5	1	-	-	-	-	1	2	1	-	-	-	1	-	1
Average	1	-	-	-	-	1	2.2	1	-	-	-	1	-	1

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

CourseObjectives: The objectives of this course are

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

CourseOutcomes: On Successful completion of the course, students 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. Applypatternmatching algorithms for real time problems.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

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

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. DefineSingleLinkedListADT: Insertions, Deletions, Display, Detection of Loops,
6. Define DoublyLinkedListADT and perform all standard operations.
7. Define StackandQueueADTs and implement standard operations
8. Applications of Stacksand Queues.
9. Implementation of BinarySearchTree: Insertion, Deletion, Traversal
10. Implementation of Graphtraversal techniques.
11. Implementation of Hashing.

TextBook:

1. NarasimhaKarumanchi,"DataStructuresandAlgorithmicThinkingWithPython",CareerMonkPublications, 2016
2. Jake VanderPlas, Python Data Science Handbook, OReilly, 2017

SuggestedReading:

1. MichaelT.Goodrich,RobertoTamassia,MichaelH.Goldwasser,“DataStructureandAlgorithms in Python”, Wiley, 2013.
2. KennethA.Lambert,"FundamentalsofPython:DataStructures",CengageLearning,2018.
3. Narasimha Karumanchi, “Data Structures and Algorithms for GATE”, CareerMonk

Publications,2011.
4. Wes McKinney, “Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython”,2nd Ed, OReilly, 2018

WebResources:

1. https://www.geeksforgeeks.org/data-structures/
2. https://www.coursera.org/specializations/data-structures-algorithms3.
3. https://nptel.ac.in/courses/106/106/106106182/
4. https://www.cs.usfca.edu/~galles/visualization/Algorithms

22BTC08

BIOCHEMISTRY LAB

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

Course Objectives:

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

Course Outcomes:

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

1. Apply the laboratory safety and standard operating procedures and prepare the solutions and biological buffers.
2. Estimate and analyze carbohydrates by different methods.
3. Estimate and analyze amino acids and proteins by different methods.
4. Estimate and analyze lipids and compare the acid value, Saponification value, and iodine valve of various lipids**.**
5. Estimate and analyze nucleic acids.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	2	2	1	0	3	2	1	3	2	3
CO2	1	1	1	2	2	2	2	0	3	2	0	3	1	3
CO3	2	1	1	2	2	2	2	0	3	2	1	3	1	3
CO4	1	2	2	2	1	3	2	0	3	2	1	3	2	3
CO5	1	1	1	2	2	2	2	0	3	2	1	3	1	3

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

Course Objectives:

Students during their course of time are made 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:

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

1. Examine the microbial cell structures using of Bright Field microscope
2. Demonstrate sterilization of equipment and various types of media
3. Prepare the basic culture media for the growth of microorganisms
4. Demonstrate the isolation of pure microbial culture from soil and water
5. Predict the nomenclature of microorganisms based on their metabolic activity

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	0	2	2	1	0	3	1	1	3	2	2
CO2	1	0	1	0	2	2	2	0	3	2	0	3	3	3
CO3	2	1	1	0	2	2	1	0	3	2	1	3	3	3
CO4	1	2	2	0	1	2	2	0	3	2	1	3	3	3
CO5	1	1	1	0	2	2	2	0	3	2	1	3	3	3

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.

22BTC10

MOOCS/INTERNSHIP – I

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	22BTC11	Fermentation Technology	3	-	-	3	40	60	3
3	22BTC12	Immunology & Immunotechnology	3	-	-	3	40	60	3
4	22BTC13	Instrumental Methods in Biotechnology	3	-	-	3	40	60	3
5	22BTC14	Thermodynamics for Biotechnologists	3	-	-	3	40	60	3
6	22BTC15	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	22BTC16	Fermentation Technology Lab	-	-	2	2	50	50	1
9	22BTC17	Immunology Lab	-	-	2	2	50	50	1
10	22BTC18	Instrumentation Lab	-	-	2	2	50	50	1
Total			**20**	**1**	**6**	**-**	**390**	**560**	**22**
Clock hours per week: 27									

L: Lecture **D: Drawing** **CIE - Continuous Internal Evaluation**

T: Tutorial **P: Practical /Project Seminar/Dissertation** **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. Solve the higher order linear differential equations.
2. Solve Linear and Non-linear Partial differential equations.
3. Determine the analytic functions.
4. Expand functions by using Taylor's and Laurent's series and Complex integrals by using Cauchy Theorems.
5. Solve Non-Linear algebraic and transcendental equations.

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", 43rd Edition, Khanna Publishers, 2015.
2. R.K JAIN and S.R.K IYENGER, "Advance engineering mathematics", 3rd edition, Narosa publications, 2007.
3. Narayan Shanti and Mittal P.K. ,"Differential Calculus", 30th edition, S Chand publishers, 2005.

Suggested Reading:

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

CO-PO & PSO Correlation Articulation Matrix-:

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

1 - Slightly; 2 - Moderately; 3 – Substantially

22BTC11

FERMENTATION TECHNOLOGY

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

Course Objectives:

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:

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

1. Apply the knowledge of fermentation processes and aseptic transfer of spore suspension in bioprocess industries.
2. Understand control 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.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	0	0	2	3	0	0	1	0	3	2	2
CO2	2	2	1	3	3	0	3	0	3	1	0	3	2	2
CO3	2	2	0	1	1	0	0	0	0	0	0	3	2	2
CO4	2	2	0	1	0	0	0	3	0	0	0	3	2	2
CO5	2	2	2	1	0	2	3	0	2	1	0	3	2	2

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, K_La values; Other Factorsaffecting 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.

22BTC12

IMMUNOLOGY AND IMMUNOTECHNOLOGY

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

Course Objectives:

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:

At the end of the course, students 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. Explain 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.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	2	2	2	2	1	1	1	0	3	2	3
CO2	2	1	1	2	2	3	2	3	0	2	0	3	1	3
CO3	1	1	1	1	2	3	2	3	0	1	0	3	1	3
CO4	1	2	1	2	3	3	2	3	2	2	2	3	2	2
CO5	3	2	1	2	3	3	2	3	3	2	2	3	1	2

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 nonpeptide 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, immunoelectrophoresis, RIA, ELISA, western blotting, immunofluorescence, FACS.

Textbooks:

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.

22BTC13

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:

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

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:

By the end of the course, students 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.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	2	2	2	2	1	1	1	0	3	2	3
CO2	2	1	1	2	2	3	2	1	0	1	0	3	1	3
CO3	0	0	1	1	2	2	0	2	0	1	0	3	1	3
CO4	1	1	1	1	2	3	2	3	2	1	2	3	2	2
CO5	3	2	1	2	3	2	2	3	3	2	2	3	1	2

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 Biomoleculesand cell organelles: centrifugation; basic principles of sedimentation, sedimentation coefficient, SvedbergUnit; 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 subcellularorganelles 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 KInternational 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 PvtLtd (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.

22BTC14

THERMODYNAMICS FOR BIOTECHNOLOGISTS

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

Course Objectives:

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:

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

1. Calculate heat and work effects for closed systems and cyclic processes.
2. Understand the volumetric properties of fluids.
3. Determine the coefficient of performance of heat engines and heat pump
4. Predict the oxygen consumption and heat evolution for aerobic cultures
5. Calculate equilibrium conversions and yields for single reactions.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	2	2	2	0	0	2	0	3	3	3
CO2	2	2	1	2	2	2	2	0	0	3	0	3	2	3
CO3	2	2	1	2	2	2	2	0	0	2	1	3	2	1
CO4	2	2	1	2	2	2	2	0	0	2	1	3	2	1
CO5	2	2	1	2	2	2	2	0	0	2	0	3	2	3

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.

22BTC15
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:

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:

At the end of the course, the students are 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 sensorysystems.
5. Discuss the anatomical structures and the physiological functions of the reproductive system and the physiology of the blood

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	0	1	1	1	2	2	1	1	1	0	2	1	1
CO2	1	0	1	0	1	2	2	1	1	1	0	2	1	1
CO3	1	0	1	1	1	2	2	1	1	2	0	1	1	1
CO4	1	0	1	1	1	2	2	1	1	2	0	2	1	1
CO5	0	0	1	1	1	2	2	1	1	2	0	1	1	1

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 andPhysiology" 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

(BE/B.Tech - Common to all branches)

Instruction	2 L Hours per week
Duration of Semester End Examination	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
CO 1	-	-	1	-	-	1	1	1	1	-	-	-	-	--
CO 2	-	-	2	-	-	3	2	2	1	-	-	-	3	1
CO 3	-	-	1	-	-	1	1	-	-	-	-	-	-	-
CO 4	-	-	1	-	-	1	1	-	-	-	-	-	2	-
CO 5	-	-	2	-	-	3	2	1	1	-	-	-	2	1

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.

Online Resources:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

Text Books

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

Suggested Reading

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

Online Resources:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

22BTC16

FERMENTATION TECHNOLOGY LAB

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

Course Objectives:

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

Course Outcomes:

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

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

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	0	3	0	2	2	2	3	3	0	2	2	2
CO2	2	3	0	3	0	2	2	2	3	3	0	2	2	2
CO3	2	3	2	3	3	2	2	2	3	3	0	2	2	2
CO4	2	3	2	3	0	2	2	2	3	3	0	2	2	2
CO5	2	3	0	3	0	2	2	2	3	3	0	2	2	2

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

22BTC17

IMMUNOLOGY LAB

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

Course Objectives:

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:

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

1. Classify the blood groups, cells, and predict the diseases.
2. Demonstrate bacterial agglutination reactions
3. Measure the concentration of antigens and serotypes by using precipitation reactions.
4. Interpret the concentration of the analytes using electrophoretic techniques.
5. Analyze the importance of ELISA techniques.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

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

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.

22BTC18

INSTRUMENTATION LAB

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

Course Objectives:

With the help of this course, Students are expected 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:

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

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

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	2	3	3	2	3	2	2	1	3	3	3
CO2	1	2	0	2	3	2	2	3	3	1	1	3	3	3
CO3	1	2	1	2	3	2	2	3	2	2	1	3	3	3
CO4	1	1	2	2	3	3	2	3	1	1	1	3	3	3
CO5	2	1	1	2	3	2	2	3	1	1	2	3	3	3

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.