With effect from the Academic Year 2021-22

CHAITANYA BHARATHI INSTITUTE OFTECHNOLOGY (A)

Department of Bio-Technology

Scheme of Instructions for III Semester of B. Tech Bio-Technology as per AICTE Model Curriculum 2021-22

B. Tech (Bio-Technology)

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	20CSC34	OOPS using Python	2	1	-	3	40	60	3
2	20BTC04	Biochemistry	3	-	-	3	40	60	3
3	20BTC05	Microbiology	3	-	-	3	40	60	3
4	20BTC06	Thermodynamics for Biotechnologists	3	-	-	3	40	60	3
5	20BTC07	Cell and Molecular Biology	3	-	-	3	40	60	3
6	20BTC08	Genetics	3	-	-	3	40	60	3
7	20EGM01	Indian Constitution and Fundamental Principles	2	-	-	2	-	50	Non credit
	PRACTICALS								
8	20CSC35	OOPS using Python Lab	-	-	2	3	50	50	1
9	20BTC09	Biochemistry Lab	-	-	2	3	50	50	1
10	20BTC10	Microbiology Lab			2	3	50	50	1
11	20BTI01	MOOCs/Training/ Internship I	3-4 weeks/90 hrs				50		2
Total			**19**	**1**	**6**	**29**	**440**	**560**	**23**
Clock Hours Per Week-26									

L: Lecture T: Tutorial P: Practical

CIE – Continuous Internal Evaluation SEE – Semester End Examination

20CSC34

OOPS Using Python

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

Course Objectives:

The objectives of this course are

1. Describe the principles of Object-Oriented Programming.
2. Enable the students to solve problems using OOPs features.
3. Debugging in programs and files.
4. Use of library modules to develop applications.

Course Outcomes:

On Successful completion of the course students will be able to:

1. Demonstrate the concepts of Object-Oriented Programming languages to solve problems.
2. Apply the constructs like selection, repetition, functions and packages to modularize the programs.
3. Design and build applications with classes/modules.
4. Find and rectify coding errors in a program to assess and improve performance.
5. Develop packages for solving simple real-world problems.
6. Analyze and use appropriate library software to create mathematical software.

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	1	1					2					
CO2		3		1	2	2	2	3	3				3	3
CO3	3	2	1	3	3	2	2		3		3		3	
CO4	3	1	3	3	3			2	3	3	3	2	3	3
CO5	3	2	2	2										

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Object Oriented Programming: Introduction to Programming Languages, Features of Object-Oriented Programming, Merits and Demerits of OOPs

Basics of Python Programming: Features of Python, Variables, Identifiers, Data types, Input/ Output operations, Operators and Expressions, Operations on Strings, Type Conversion.

UNIT-II

Decision Control Statement: Selection/Conditional Branching, Loop Control Structures, Nested Loops. **Functions and Modules**: Uses of functions, Function definition, function call, Variable scope and Lifetime, Recursion, Lambda functions, map, reduce and filter built-in functions, Recursive Functions, Modules, Packages.

UNIT-III

Classes and Objects: Introduction, Classes and Objects, _init method, Class variables, and Object variables, Public and Private Data members, calling methods from other methods, garbage collection, class methods, staticmethods.

UNIT-IV

Inheritance: Introduction, Inheriting classes, Polymorphism and method overloading, Composition or Containership, Abstract classes and inheritance.

Operator Overloading: Introduction, Implementation of Operator Overloading, Overriding.

File Handling: File types, opening and closing files, reading and writing files, file positions, Regular Expression.

UNIT -V

Error and Exception Handling: Introduction to errors and exceptions, Handling Exceptions, Plotting Graphs in Python (Use of Matplotlib).

Suggested Reading:

1. Reema Thareja "Python Programming", Oxford Press, 2017.
2. Mike McGrath "Python in easy steps: Makes Programming Fun", Kindle Edition, 2017.

References:

1. Guido van Rossum and Fred L. Drake Jr, An Introduction to Python – Revised and updated for Python3.2, Network Theory Ltd.
2. https://anandology.com/python-practice-book/ object_oriented_programming.html
3. http://python-textbok.readthedocs.io/en/1.0/ Object_Oriented_Programming.html
4. http://www.tutorialspoint.com/python/python_classes_objects.html
5. https://docs.python.org/3/

20BTC04

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

Course outcomes:

By the end of the course students will be able to

1. Identify different biomolecule's structure 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.

Texts Books:

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

Suggested Reading:

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.

20BTC05

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 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 propagation infectious diseases caused by microorganisms

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	3	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: Principles of microbial ecology, nutrient acquisition, microbial competition and antagonism, environments and micro environments, Association of microbes with eukaryotes, Rumen micro flora, Aquatic habitats: Marine and fresh water; terrestrial habitats; key nutrient cycles: Carbon, Nitrogen and Sulphur.

UNIT-V

Microbiology and Human health: Microorganisms related to 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)

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 Reading:

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.

20BTC06

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 the knowledge about thermodynamic principles to solve practical problems.
2. The course also gives an insight about the concepts of Solution Thermodynamics.
3. The aim of the course is 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 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 volumetric properties of fluids.
3. Determine the coefficient of performance of heat engines andheat pump
4. Predict the oxygen consumption and heat evolution for aerobic cultures
5. Calculate equilibrium conversions and yields for single reactions.

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	0	3	3	3
CO2	2	2	1	2	2	3	3	2	3	3	0	3	2	3
CO3	2	2	1	2	2	3	3	2	3	3	0	3	2	1
CO4	2	2	1	2	2	3	3	2	3	3	0	3	2	1
CO5	2	2	1	2	2	3	3	2	3	3	0	3	2	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction To Thermodynamics: System Definition and Classification of system – closed and open system based on 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 calculationof 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 binary mixture. Chemical Reaction Equilibria: Equilibrium criteria for homogenous chemical reactions. Standard Gibbs energy change of reaction, **Reaction co-ordinate** –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 EngineeringThermodynamics", 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 andSons, 2006.
2. Stanley I. Sandler, "Chemical and Engineering Thermodynamics", 3rd Edition, Wiley, 1999.
3. K.V.Narayanan," ATextbookofChemicalEngineeringThermodynamics",PHILearningPvt.Ltd, 2004.

20BTC07

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. Student is made to understand the basics of cell biology i.e., concept of cellular organelles and their functions.
2. Students are taught the structure of cytoskeleton, and how it maintains the cell structure integrity.
3. 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 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 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
CO2	2	2			2	2	2		2			3	3	3
CO3	2	2			2	2	2	1	2			3	3	3
CO4	2	2			2				2			3	3	3
CO5	2	2			2			1	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 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 membrane – passive diffusion, facilitated diffusion, osmosis, active transport (Na+ /K+ Pump), cotransport; uniport, antiport, symport. Cell cycle: Different phases of cell cycle; check points of cell cycle; Regulation of cell cycle - cyclins and cyclin dependent kinases, cell-cell junctions and Apoptosis.

UNIT III

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

UNIT-IV

Mechanism of Transcription: Structure of promoters- RNA polymerases of 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 t-RNA, r-RNA, m-RNA splicing; 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 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 E. 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", 2ndedition, Narosa Publication, 2007.

Suggested Reading:

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

20BTC08

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 understand the basics concepts of genetics and inheritance of characteristics.
2. To impart knowledge of structure of chromosome, aberrations, mutations and its causes.
3. To enlighten about consequences of linkage, crossing over, sex determination and sex liked disorders.
4. To provide an insight of 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 organization of genes due to linkage and crossing over mechanism.
4. Categorize sex determination, the chromosomal basis of genetic disorders and sex-linked genes
5. Predict maternal inheritance and genotypic frequencies in a population.

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	1	2	2	0	0	0	2	2	1	2
CO2	2	2	2	1	1	2	2	2	1	0	2	2	2	2
CO3	2	3	2	2	1	2	2	0	0	0	2	2	2	3
CO4	2	3	2	3	1	3	3	1	0	0	2	2	2	3
CO5	3	3	2	2	1	3	3	0	0	2	2	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, 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, significance of Crossing over. Two point and three-point test cross. Interference. Tetrad analysis.

UNIT-IV

Sex Determination, Sex Linked and Genetic Disorders: Sex chromosomes, sex determination mechanism Chromosomal: XX-XY, XX-XO, ZZ-ZW; Geneic balance theory, Environmental, Hormonal and molecular basis. Y chromosome in melandrium. Gynandromorphs. Dosage compensation: Maryleon's hypothesis; Inhertance 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 – inheritance of mitochondrial and chloroplast genes, maternal inheritance (CMS, Mirabilus 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. Snustad, D.Peter, Simmons Michael, "Principles of Genetics" 6th edition, John Wiley& Sons publication, 12.
2. Singh, B.D. "Genetics - 3rd edition", Kalyani Publications, 2004.
3. Gardner, E. J., Simmons, M. J., Snustad, D. P. and Snustad, "Principles of Genetics", 8th Edition, John Wileyand Sons, Inc. 2008.

Suggested Reading:

1. Verma PS, Agrawal VK, "Cell Biology, Genetics, Molecular Biology, Evolution and Ecology". 9thedition, S. Chand & Company Ltd., New Delhi, 2014.
2. Gupta PK, "Genetics", 4th Rev Edition (2nd Reprint) Rastogi Publications, 2011.

20EGM01

INDIAN CONSTITUTION AND FUNDAMENTAL PRINCIPLES

(BE/BTech III/IV Semester - Common to all branches)

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	50 Marks
Credits	0

Course Objectives

The course will introduce the students to:

1. History of Indian Constitution and how it reflects the social, political and economic perspectives of the Indian society.
2. Fundamental Rights and Duties, administration of the Union Government and Legislature and Judiciary.
3. Various Organs of Governance and Local Administration.

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

1. Understand the making of the Indian Constitution, its features and know the importance of Directive Principles of State Policy.
2. Identify the difference between Right to Equality and Right to Freedom and acquires the legal status of Fundamental Duties.
3. Analyze the structuring of the Indian Union, distribution of powers between the Union and the States, and the role and position of President in Union Government.
4. Distinguish between the Lok Sabha and Rajya Sabha in law making while appreciating the importance of Judiciary in interpretation of law.
5. Differentiate between the Municipalities and Panchayats in their structure and functions.
6. Apply the knowledge of Indian Constitution to real-life or professional situation for better civic society

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	2	1					
CO2		2	1			3	3	1	1				3	1
CO3		1	1			1	1	1						
CO4						1	1						2	
CO5													2	1
CO6		2	2	2		3	3	2	1					

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Constitution of India: Constitutional history-Govt of India Act 1909, 1919 and 1935, Constitution making and salient features. Directive Principles of State Policy - Its importance and implementation.

UNIT-II

Scheme of the Fundamental Rights & Duties: The Fundamental Rights - To Equality, to certain Freedom under Article 19, to Life and Personal Liberty Under Article 21. Fundamental Duties - the legal status.

UNIT-III

Union Government and its Administration - Structure of the Indian Union: Federalism, distribution of legislative and financial powers between the Union and the States.
Parliamentary form of government in India: Executive-President's role, power and position.

UNIT-IV

Legislature and Judiciary: Central Legislature-Powers and Functions of Lok Sabha and Rajya Sabha.
Judiciary: Supreme Court-Functions, Judicial Review and Judicial Activism.

UNIT-V

Local Self Government - District's Administration Head (Collector): Role and Importance. Municipalities & Municipal Corporations: Introduction, Chairperson/Mayor, Commissioner and Role of Elected Representatives. Panchayati Raj: Introduction, Zilla Panchayat, Chairperson, CEO, Elected Officials and their roles. Block/Mandal level: Organizational Hierarchy (Different departments). Village level: Role of Elected and Officials.

Text Books:

1. **Indian Government & Politics**, Ed Prof V Ravindra Sastry, Telugu Academy, 2nd edition, 2018.
2. **Indian Constitution at Work,** NCERT, first edition 2006, Reprinted- January 2020.

Suggested Reading:

1. **The Constitution of India**, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, **Framing of Indian Constitution**, 1st Edition, 2015.
3. M. P. Jain, **Indian Constitution Law**, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu**, Introduction to the Constitution of India**, Lexis Nexis, 2015.

20CSC35

OOPS USING PYTHON LAB

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

Course Objectives: The objectives of this course are

1. Identification and installation of required software to work with Python.
2. Program development using OOPs concepts.
3. Handling of errors in program code.
4. Use of library modules to develop applications.

Course Outcomes: On Successful completion of the course, student will be able to

1. Inspect and identify suitable programming environment to work with Python.
2. Choose appropriate control constructs, data structures to build the solutions.
3. Develop the solutions with modular approach using functions, packages to enhance the code efficiency.
4. Analyze and debug the programs to verify and validate code.
5. Demonstrate use of STLs and modules to build applications.
6. Determine the requirements of real-world problems and use appropriate modules to develop solutions.

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
CO2	1	2		1										
CO3	1	2	1	1										
CO4	1	2		1										
CO5	1	3	1	2										

1 - Slightly, 2 - Moderately, 3 - Substantially

Lab experiments:

1. Installation of any Object-Oriented Programming Language and IDE.
2. Simple scripts to demonstrate the use of basic data types and operators.
3. Simple scripts to demonstrate the use of control structures.
4. Functions and Lambda function and parameter passing.
5. Experimentation with Modules.
6. Implementation of classes with attributes and methods.
7. Demonstration of inheritance.
8. Experiments on Overloading.
9. Experimentation of Files and Regular Expressions.
10. Building code to demonstrate Exceptions and built-in tools.
11. Demonstration of Plotting graphs.

Text Book:

1. ReemaThareja "Python Programming", Oxford Press, 2017.

Suggested Reading and References:

1. https://vknight.org/cfm/labsheets/04-object-oriented-programming/
2. http://learning-python.com/class/Workbook/x-exercises.htm
3. https://inst.eecs.berkeley.edu/~cs61a/fa14/lab/lab06/#inheritance
4. https://anandology.com/python-practice-book/ object_oriented_programming.html
5. http://stanfordpython.com/
6. https://docs.python.org/3/

20BTC09

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 the 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 (Expt. 1, 2, 3 & 4).
2. Estimate and analyze carbohydrates by different methods (Expt. 5 & 6).
3. Estimate and analyze amino acids and proteins by different methods (Expt. 7, 8 & 9).
4. Estimate and analyze lipids and compare the acid value, Saponification value and iodine valve of various lipids (Expt. 10 & 11).
5. Estimate and analyze nucleic acids (Expt. 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	2	2	2	2	2	2		3	2	1	3	2	3
CO2	1	1	1	2	2	2	2		3	2		3	1	3
CO3	2	1	1	2	2	2	2		3	2	1	3	1	3
CO4	1	2	2	2	1	3	3		3	2	1	3	2	3
CO5	1	1	1	2	2	2	2		3	2	1	3	1	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 sugars from the given sample by DNS method
6. Estimation of Carbohydrates by Anthrone method
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 Diphenyl amine method
13. Estimation of RNA by Orcinol method

20BTC10

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 (Exp. 1, 2)
2. Demonstrate sterilization of equipment and various types 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 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		3	3		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 microorganism: (a) 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 the bacterial growth and study of 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 Reading:

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.

20BTI01

MOOCs/TRANING/INTERNSHIP -I

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. 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			2	2	2	3	3	2		3	3	3
CO5	2	2	2	1		2	2		3	3	2	3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

Schedule for the internship schedules will be given in a flexible manner according to the availability opportunities. The minimum and maximum requirement regarding Internship duration and credits is given in Table-1

Table 1: Internship Frame work

Schedule	Activities	Duration	Credits
Summer / Winter vacation (4^{th}/ 5^{th} Semester)	Industrial / Govt. /NGO / MSME/ Rural Internship/ Innovation/ Entrepreneurship/ NSQF level 3, 4,5	3-4 weeks or 90 hrs	2 Credits

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, Intern may be debarred for the remaining period of his/her internship. Daily diary needs to be submitted to Faculty Mentor at the end of Internship along with the attendance record and an evaluation sheet duly signed and stamped by the industry. Daily diary is evaluated on the basis of 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 (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, departmental reports shall be analyzed along with the internship Report

With effect from the Academic Year 2021-22

CHAITANYA BHARATHI INSTITUTE OFTECHNOLOGY (A)

Department of Bio-Technology

Scheme of Instructions for IV Semester of B. Tech Bio-Technology as per AICTE Model Curriculum 2021-22

B. Tech (Bio-Technology)

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	20MTC23	Engineering Mathematics for Biotechnologists	3	1		3	40	60	4
2	20BTC12	Bioprocess Engineering	3	-	-	3	40	60	3
3	20BTC13	Immunology & Immunotechnology	3	-	-	3	40	60	3
4	20BTC14	Instrumental Methods in Biotechnology	3	-	-	3	40	60	3
5		Professional Elective - 1	3	-	-	3	40	60	3
6	20EGM03	Universal Human Values-II: Understanding Harmony	3	-	-		40	60	3
7	20CEM01	Environmental Science	2	-	-	2	-	50	Non credit
PRACTICALS									
8	20BTC15	Bioprocess Engineering Lab	-	-	2	3	50	50	1
9	20BTC16	Immunology Lab	-	-	2	3	50	50	1
10	20BTC17	Instrumentation Lab	-	-	2	3	50	50	1
Total			**20**	**1**	**6**	**26**	**390**	**560**	**22**
Clock Hours Per Week –27									

L: Lecture T: Tutorial P: Practical

CIE – Continuous Internal Evaluation SEE – Semester End Examination

Professional Elective – 1	
20BTE01	Environmental Biotechnology
20BTE02	Process Dynamics and Control for Biotechnologists
20BTE03	Intellectual Property Rights and Bioethics
20BTE04	Enzyme technology
20BTE05	Industrial Biotechnology

20MTC23

ENGINEERING MATHEMATICS FOR BIOTECHNOLOGISTS
(For Bio-Technology)

Instruction	3L+1T Hours per Week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
Continuous Internal Evaluation	40 Marks
Credits:	4

Course Objectives: To learn

1. To discuss Mean value theorems
2. To learn the Laplace and Inverse Laplace transforms for solving engineering problems
3. To discuss vector line, surface and volume integrals
4. To discuss solution of higher order differential equations.
5. Solve algebraic and transcendental equations

Course Outcomes: On the successful completion of the course, the student shall be able to

1. Analyse the geometrical interpretation of Mean value theorems
2. Find Laplace transform and inverse Laplace transform and can solve Linear Differential equations.
3. Solve line, surface and volume integrals by Green's, Guass, Stoke's theorem
4. Solve the higher order linear differential equations.
5. Derive the solutions when system of equations has more than two unknowns and learn to reduce the instability of 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										1	1	
CO2	2	2										1	1	
CO3	2	2										1	1	
CO4	2	2										1	1	
CO5	2	2	2									1	1	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I: Differential Calculus

Rolle's Theorem, Lagranges Mean value theorem, Cauchy's mean value theorem (without proofs). Taylor's series and Maclaurin's series for single variable. Curvature, radius of curvature and Evolutes (Cartesian form only)

UNIT-II: Laplace Transform

Laplace Transform of standard functions, Linearity property, change of scale property. Shifting theorems, Laplace Transform of Periodic Function, Unit step function and Unit impulse function. Transforms of derivatives, Transforms of integrals, Multiplication by t^n and division by t. Inverse Laplace Transform properties, Inverse Laplace Transform by partial fractions and Convolution theorem, Applications of Laplace Transform (Solution of Linear Differential Equations).

UNIT-III: Vector Integral Calculus:

Line integral, Surface integral and Volume integral. Green's theorem in the plane, verifications of Stoke's theorem (without proof) and Gauss's divergence theorem (without proof).

UNIT-IV: Differential Equations of Higher order

Solutions of higher order linear equations with constants coefficients, Method of variation of parameters, solution of Cauchy's homogeneous linear equation.

UNIT-V: Numerical Methods

Solutions of Algebraic and Transcendental Equations: Method of Bisection, RegulaeFalsi Method (method of false position) Secant Method, Newton Raphson Method. Solution for simultaneous equation –Gauss sidle method

Text Books:

1. B.S.Grewal, “Higher Engineering Mathematics”, 43rd Edition, Khanna Publishers, 2015.
2. A.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.
4. Dr B S Grewal “Numerical Methods in Engineering & Science” Khanna Publishers, 11th edition,2013

Suggested Reading:

1. Joseph Edwards, “Differential Calculus For Beginners”, Arihant publishers, 2016.
2. Erwin Kreyszig, “Advanced Engineering Mathematics”, 10th edition, Wiley publishers, 2015.
3. R.K. Jain, S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publications, 5thedition, 2016
4. Numerical Methods by S. S. Shastry

20BTC12

BIOPROCESS 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 at providing knowledge to students on scope and chronological development of fermentation technology.
2. To understand the types of fermentation process and design of fermentation.
3. To learn about the ancillaries of fermentor and its 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 fermentation processes and aseptic transfer of spore suspension in bioprocess industries.
2. Design fomenters and control process parameters, media formation in bioprocesses, solid state and slung processes.
3. Determine oxygen transfer ratio in aerobic fermentation used in fermentation industries.
4. Apply the knowledge of scale up and scale down technique in bio process industries and able to determine power requirements in bioreactors.
5. Apply knowledge of different bioreactor like air lift, fed batch, batch and continuous in bioreactors while evaluating their performances in bioprocesses industries.

CO-PO ARTICULATION MATRIX

6.

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	2	2	2	2	1	1	1	3	2
CO2	2	2	3	2	1	2	2	2	2	1	2	2	2	3
CO3	2	2	3	3	1	1	1	1	1	1	1	2	2	1
CO4	2	2	3	2	1	2	2	2	2	1	2	2	2	3
CO5	2	2	3	2	1	2	2	2	2	1	2	2	2	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

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

UNIT-II

Media Design: General requirements of fermentation processes, Basic design and construction of fermenter and ancillaries, Main parameters to be monitored and controlled in fermentation processes; 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 Factors affecting the values of mass transfer coefficients in fermentation vessels.

UNIT-IV

Cell Growth Kinetics: Batch Growth, Balanced Growth, Effect of Substrate Concentration, Monod Equation, Kinetics of Substrate Uptake in Cell Culture, Effect of Culture Conditions on Cell Kinetics Determining Cell Kinetic Parameters from Batch Data, Yields in Cell Culture, Batch and continuous sterilization kinetics, Effect of Maintenance on Yields, Kinetics of Cell Death

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, behavior of microbes in different reactors viz. air lift, 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. Bailey JE and Ollis DF, "Biochemical Engineering Fundamentals", 2nd edition, McGraw Hill, 1986.

SUGGESTED READING:

1. Shuler M and Kargi F, Bioprocess Engineering, Prentice Hall of India Pvt. Ltd., New Delhi,2002.
2. Harvey W. Blanch, Douglas S. Clark, "Biochemical Engineering" 1st edition, CRC, 1997.

20BTC13

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 Immune system.
2. Knowledge of structure of Antigen and antibody and the processing of Antigen
3. Importance of Antigen and Antibody interactions.
4. Students understand significance of complement system and hypersensitivity.
5. The immunological basics for diseases are taught to the students.

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 of antigen
3. Analyze the Immune system related underlying causes in Allergies, Asthma, and other hypersensitive reactions.
4. Acquainted with the diseases caused due to Immune system malfunctioning.
5. Explain the Immune system related medical complications in transplantation and Cancers.
6. Apply the principles of immunological techniques in 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
CO6	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, hematopoietic, cells of the immune system, Organs of immune system– primary (bone marrow and thymus) and secondary (lymph node, spleen, MALT, GALT), Pro inflammatory and anti-inflammatory cytokines.

UNIT-II

Antigen and Antibody and its Structure and properties and processing and presentation of Antigen: Antigen – immunogenicity and antigen city, factors influencing immunogenicity, haptens and adjutants, 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 – 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); 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 – immunological basis of graft rejection, immunosuppressive therapy (general and specific), immune prophylaxis (attenuated, inactivated and DNA vaccines), immunology of cancer- tumor antigens, immune response to 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, IEP, RIA, ELISA, western blotting, immune fluorescence, FACS .

Text Books:

1. Judith A.Owen, Jenni Punt, Sharon A. Stanford,"KubyImmunology", 7th edition,W.H.Freeman,2013.
2. PeterJ. Delves, SeamusJ. Martin, DennisR. Burton, Ivan M. Roitt, "Roitt's Essential Immunology", 12th edition, John Wiley &Sons, 2011.

Suggested Reading:

1. Kenneth Murphy, "Janeway's Immunobiology", 8thedition, Garland Science, 2011.
2. Abdul K. Abbas, Andrew H. Lichtman, Shiv Pillai, "Cellular and Molecular Immunology, 7th edition", Elsevier Health Sciences, 2011.
3. Sunil Kumar Mohanty and K. Sai Leela, "Textbook of Immunology", 2ndedition, JP Medical Ltd, 2014.

20BTC14

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 Importance of microscopy
2. Types of Instruments used for isolation of Bimolecular and Sub cellular 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 purification of cellular products.
4. Illustrate various electrophoresis techniques in order 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 Bright field. Dark field, fluorescent and electron microscopy.

UNIT-II

Instruments For Isolation Techniques: Cell disruption by French press, Sonification, freeze thaw technique; use of liquid N2 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 preparation of density gradient- sucrose & cesium chloride; Isolation of sub cellular organelles and Biomolecules. Determination of molecular weight and purity of Biomolecules by analytical ultra-centrifugation.

UNIT-III

Separation Techniques: Partition coefficient, partition chromatography, counter current distribution, adsorption chromatography, Paper, TLC& GLC, adsorption media, solvent, continuous and gradient elution, fraction collection and detection of pure molecules. Methods based on size: Gel permeation chromatography, principle application- Molecular weight determination. Dialysis and its significance. Affinity chromatography, application & technique for purification of proteins and nucleic acids.

UNIT-IV

Charge Based Separation Techniques: Principle and application of Ion exchange chromatography, use of ion exchange- cation& anion exchangers, pH and salt gradients for elution of proteins, amino acids and nucleotides. Electrophoresis: Migration of charged molecules in electric field-moving boundary, paper, cellulose acetate, starch gel electrophoresis, SDS PAGE, Determination molecular weight, 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 BiotechnologyI K International Publishing House Pvt. Ltd (2012 Edition)
2. Keith Wilson and John Walker, "Principles and Techniques of Biochemistry and MolecularBiology", 6thEdition, 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 toSpectroscopy, Cengage Learning India Private Limited (2015 Edition)
3. GW Ewing, "Instrumental Methods of Chemical Analysis", 4thedition, McGraw Hill, 1985.
4. Hobert H Willard D.L.Merritt and J.R.J.A.Dean, "Instrumental Methods of Analysis", CBSpublishers & Distributors, 1992.
5. Skoog DA, "Fundamentals of Analytical Chemistry", Thomson Brooks/Cole, 2004.

20BTE01

ENVIRONMENTAL 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:

The courseaims

1. To provide theoretical concepts and a comprehensive knowledge on bioremediation methods.
2. To provide knowledge on metal leaching and non-conventional fuels production.
3. To impart theoretical basics on various methods used in treatment of wastewater.
4. To provide knowledge on 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 biofuels generation.
3. Illustrate different methods of waste water 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	3	2	1	1	1	1	1	2	1	1	1	2	1	1
CO2	3	1	1	1	3	3	3	3	1	3	1	3	2	1
CO3	3	2	2	1	2	2	2	2	1	2	1	3	1	1
CO4	2	3	3	3	3	2	2	1	2	3	2	3	3	1
CO5	3	3	3	3	3	2	2	2	3	1	1	1	2	2

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 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.

20BTE02

PROCESS DYNAMICS & CONTROL FOR BIOTECHNOLOGISTS
(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. The course aims at providing dynamics of system process, flow, level and temperature etc.
2. The course aims at incorporating with concepts of response of first order system for non-interacting and interacting systems.
3. The course aims at providing knowledge the design of control system for open and close loopcontrol.
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. inbioprocess industries.
2. Devise 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		2				2	2		2	2	2
CO2	3	3	2		2	2	2		2	2		2	2	2
CO3	2	2	2		1	2	2		2	2		3	2	3
CO4	2	1	2		2	2	2		2	2		2	2	2
CO5	2	2	2		2	2	2		2	3		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, over all 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 Hill Inc.,1991.
2. George Stephanpoulos,"Chemical process control",Pearson PrenticeHall,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, Reprint1991.

Suggested Reading:

1. Patranabis D, Principles of Process Control by 2nd ed., Tata McGraw-Hill publishing Co., New Delhi, Reprint1997.
2. Eckman D.P., Automatic process control, Wiley Eastern Ltd., New Delhi, 1993.

20BTE03

INTELLECTUAL PROPERTY RIGHTSANDBIOETHICS
(Professional Elective-I)

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

Course Objective:
This course is intended to impact awareness on intellectual property rights and various regulatory issues related toIPR

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, trade mark, 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/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	3	3	3	2	1	1	3	2	2
CO2	1	1	1	1	1	3	3	2	1	0	2	2	2	2
CO3	1	1	1	1	1	3	3	2	1	0	2	2	2	2
CO4	1	1	1	1	1	3	3	2	1	0	2	2	2	2
CO5	1	1	1	1	1	3	3	2	1	0	2	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, Cengage learning,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)

References:

1. M.M. S. Karki, Intellectual Property Rights: Basic Concepts, Atlantic Publishers, 2009.
2. Neeraj Pandey & Khushdeep Dharni, Intellectual Property Rights, Phi Learning Pvt. Ltd.
3. AjitParulekar 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.

20BTE04

ENZYME TECHNOLOGY
(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 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. Explain the kinetics of enzyme action and inhibition.
4. Compare various enzyme immobilization techniques and analyze the mass transfer effects inimmobilized enzyme systems.
5. Outline 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 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 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; Design of enzyme electrodes and their application as biosensors in industry, health care and environment.

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 Pvt Ltd, 2009.
2. Voet and Voet J.G, "Biochemistry", 4nd edition, John C. Wiley and Sons, 2010.

20BTE05

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 about the production of enzymes
4. To make the student understand about the biotechnologically important products like recombinant proteins, vaccines etc.
5. To make the student understand about 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. Manipulate the ideas for the production of microbial metabolites
3. Apply the concept of biosynthesizing enzymes and other important products
4. Explain the methodologies behind production of modern products like recombinant vaccines and monoclonal antibodies in industries
5. Apply the concept to produce commercially important

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	3	2
CO2	3	2	3	2		2	2		2	2	2	2	2	3
CO3	3	2	3	2						2		2	2	1
CO4	3	2	3	2		2	2		2	2	2	2	2	3
CO5	3	2	3	2		2	2		2	2	2	2	2	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Industrial Bioprocess: Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of upstream and downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation

UNIT-II

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

UNIT-III

Production of Enzymes and Other Products: Production of industrial enzymes (proteases & amylases), Production of biopesticide, Biofertilizers, Bio preservative (Nisin), biopolymers (Xanthan gum & PHB), Cheese, Beer, SCP, Biodiesel

UNIT-IV

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

UNIT-V

Production of Beverages: Production of beverages, beer, wine, microbes in baking - production of Baker's Yeast, Production of fermented milk products

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 Pvt Ltd, 2009.
2. Voet and Voet J.G, "Biochemistry", 4nd edition, John C.Wiley and Sons, 2010.

20EGMO3

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY
(B.E/B.Tech II/III Year -Common to all Branches)

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

Introduction

This course discusses the role of human values in one's family, in society and in nature. In the Induction Program, students would get an initial exposure to human values through Universal Human Values–I. This exposure is to be augmented by this compulsory full semester foundation course.

Course Objectives

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in human being, family, society and nature/existence.
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Course Outcomes

By the end of the course,

1. Students are expected to become more aware of themselves, and their surroundings (family, society, nature)
2. They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. They would have better critical ability.
4. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

The course has 28 lectures and 14 practice sessions:

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					
CO2			1			1	1		1		1	1		
CO3					1	1	1			1				
CO4														
CO5				1					1	1	1	1		

1 - Slightly, 2 - Moderately, 3 - Substantially

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

- Purpose and motivation for the course, recapitulation from Universal Human Values-I
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
- Continuous Happiness and Prosperity- A look at basic Human Aspirations
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority

- Understanding Happiness and Prosperity correctly- A critical appraisal of the current Scenario
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

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

Unit 2: Understanding Harmony in the Human Being - Harmony in Myself

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

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

Unit 3: Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship

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

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

Unit 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

- Understanding the harmony in the Nature
- Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self-regulation in nature
- Understanding Existence as Co-existence of mutually interacting units in all - pervasive space
- Holistic perception of harmony at all levels of existence.

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

Unit 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

- Natural acceptance of human values
- Definitiveness of Ethical Human Conduct
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems
- Strategy for transition from the present state to Universal Human Order:
  a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers

b. At the level of society: as mutually enriching institutions and organizations

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

Mode of Conduct (L-T-P-C 2-1-0-3)

- Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them. Tutorial hours are to be used for practice sessions.
- While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.
- In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self- exploration.
- Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.
- Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practicals are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignments and/or activities are included.
- The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

Assessment:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self- assessment, peer assessment etc. will be used in evaluation.

Example:
Assessment by faculty mentor: 10 marks
Self-assessment/Assessment by peers: 10 M
Socially relevant project/Group Activities/Assignments: 20 marks
Semester End Examination: 60 marks
The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

Text Books

The Text Book

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1 The teacher's manual
2. R R Gaur, R Asthana, G P Bagaria, "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books

1. A Nagaraj Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amar kantak, 1999.
2. N. Tripathi, "Human Values", New Age Intl. Publishers, New Delhi, 2004.
3. Cecile Andrews, Slow is Beautiful
4. Gandhi - Romain Rolland (English)
5. Dharampal, "Rediscovering India"
6. E. FSchumacher. "Small is Beautiful"
7. J. C. Kumarappa "Economy of Permanence"
8. Pandit Sunderlal "Bharat Mein Angreji Raj"
9. Mohandas Karamchand Gandhi "The Story of My Experiments with Truth"
10. 10.Mohandas K. Gandhi, "Hind Swaraj or Indian Home Rule"
11. Maulana Abdul Kalam Azad, India Wins Freedom -
12. Vivekananda - Romain Rolland (English)
13. The Story of Stuff (Book)

20CEM01

ENVIRONMENTAL SCIENCE

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

Course Objectives:

To enable the student

1. Identify environmental problems arising due to over utilization of natural resources and understand the importance of use of renewable energy sources
2. Become aware about the importance of eco system and interlinking of food chain.
3. Identify the importance of biodiversity in maintaining ecological balance.
4. Learn about various attributes of pollution management and waste management practices.
5. Contribute for capacity building of nation for arresting and/or managing environmental disasters.

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 affects of over utilization.
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/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				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

20BTC15

BIOPROCESS ENGINEERING LAB

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

Course Objectives:
To provide the hands-on training to students to practically see the integrated bioprocess operations right from the beginning 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 fermentation process (Expt. 1, 5, & 6).
2. Analyze the difference between batch and fed batch processes (Expt. 2, & 8).
3. Demonstrate the preparation of media and its optimization using statistical techniques (Expt. 7).
4. Estimate the growth kinetics of microorganisms (Expt. 3, 4, & 9).
5. Determine the mass transfer coefficient in fermentation (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	1	1	1	2	3	3	3	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	3	3	2	3	2	3	2	3
CO4	1	1	2	2	3	3	3	3	2	1	1	3	1	3
CO5	2	1	1	2	3	2	2	3	1	2	2	3	1	3

1 - Slightly, 2 - Moderately, 3 - Substantially

List of Experiments:

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

20BTC16

IMMUNOLOGY LAB

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

Course Objectives:

A student identifies significance of blood grouping.

1. The applications of Antigen-antibody agglutination are demonstrated.
2. The applications of Antigen-antibody Precipitation are demonstrated.
3. Students learn about diagnostic kits based on immunology.
4. Students learn to interpret results.

Course Outcomes:

At the end of the course students will be able to

1. Demonstrate how Antigens and Antibody interact(Exp 1)
2. Identify agglutination and precipitation reactions.(Exp2,3,4,5,6&7)
3. Interprets the results based on the results of the antigen-antibody interaction.(Exp10)
4. Analyze the importance of different Immunological techniques developed.(Exp11)
5. Outline the importance of blood group matching in blood transfusions and other cases are practically demonstrated.(Exp1)
6. Differentiate the B-cells and T-cells(Exp12)

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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

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List of Experiments:

1. ABO Blood Grouping and Identification of Rh typing
2. Rocket immune electrophoresis
3. Ouchterlony Double Diffusion for Antigen Antibody Patterns (ODD)
4. Immuno-electrophoresis (IEP)
5. Radial Immune Diffusion test (RID)
6. Widal test
7. VDRL tests
8. Total and Differential count of RBC & WBC by Micropipette method
9. Erythrocyte sedimentation rate
10. Enzyme Linked Immuno sorbent Assay (ELISA) for Antigen capture and Antibody capture.
11. Estimation of Immunoglobulins by Precipitation with Saturated Ammonium Sulphate.

12. Isolation and microscopic visualization of T cells and B cells.

Lab Manual:

1. Arti Nigam and 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, J.P.Medical Ltd, 2013.

20BTC17

INSTRUMENTATION LAB

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

Course Objectives:

With 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 (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 UV-Visible spectrophotometer, Conductivity meter, Nephelometer, and flame photometer (Exp. 5,6,7,11,12, 13)
5. Justify their results on separation of biomolecules by differential centrifugation methods (Exp. 14, 15)

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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	2	2	3		2		3	3	3
CO5	2	2	1	2	3	2	2	3		2		3	3	3

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List of Experiments

1. The calibration of pH meter and measurement of pH for different solutions
2. Estimation of Ascorbic acid by colorimetric assay
3. Estimation of unknown samples by using 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 Nephlometer
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.