1.1.3. Average percentage of courses having focus on employability/ entrepreneurship/ skill development during the last five years.

Year of offering: 2016-17
Batch- 2015-19 (3rd semester)

Program: Biotechnology		
Course Title: Microbiology		**Course Code: 15EBTC201**
L-T-P: 4-0-0	**Credits: 4.0**	**Contact Hours: 04 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 03 Hours**	

Unit I

1. Introduction

The scope of Microbiology, Historical Foundations, Taxonomy and classification of microorganisms, prokaryotic and eukaryotic cells, Eubacteria and Archaebacteria, study of different types of microorganisms: bacteria, yeasts, viruses, fungi, protozoa (structure, classification, modes of reproduction & growth). Role of microbes in agriculture, public health and industry, common diseases caused by microorganisms.

05 Hours

2. Functional anatomy of Prokaryotic and Eukaryotic cells:

Size, shape and arrangement of bacterial cells, structures external to cell wall, cell wall and structures internal to cell wall including endospores. Structure and functions of eukaryotic cell. Genome structure in prokaryotic and Eukaryotic cells, Genotype & Phenotype, Genetic transfer and recombination (Transformation, Conjugation & Transduction), Genes and evolution.

07 Hours

3. Microscopic Examination

Bright-field Microscopy, Dark-field Microscopy, Phase-contrast Microscopy, Fluorescence Microscopy and Electron Microscopy. Preparation of specimen for light and electron microscopy, Advances in scanned probe microscopy. **04 Hours**

4. Microbial Growth

The requirements for growth, Culture media, Effect of different factors on growth, Growth of bacterial culture: bacterial division, generation time, phases of growth. Measurement of growth: Direct and Indirect methods. **04 Hours**

Unit II

5. Microbial Techniques

Pure culture techniques (streak plate, spread plate, pour plate), Staining techniques (simple and differential staining techniques), Enumeration techniques (Direct Microscopic Count, plating techniques, membrane filtration, Electronic enumeration, etc). Characterization: Biochemical tests

and 16S rRNA homology studies. **10 Hours**

6. Microbial Metabolism

Catabolic and Anabolic reactions, Enzymes, Energy production, Carbohydrate catabolism: Glycolysis, Alternatives to Glycolysis, Cellular respiration, Lipid and Protein catabolism, Photosynthesis: Light dependent and light independent reactions. Metabolic diversity among microorganisms: autotrophs and heterotrophs. Metabolic pathways of energy use: Polysaccharide biosynthesis, lipid biosynthesis, amino acid and protein biosynthesis. The integration of metabolism.

Energy production: Principles of bioenergetics, Respiratory chain, Energy production by aerobic process, Energy production by anaerobic process, Energy production by photosynthesis, Mechanism of ATP synthesis. Utilization of Energy and Biosynthesis: Utilization of energy for biosynthetic and non-biosynthetic processes.

Bacterial genetics: Bacterial recombination (Transformation, Conjugation & Transduction)**.** Genome structure in prokaryotic and Eukaryotic cells. Population Genetics and Pedigree Analysis.

10 Hours

Unit III

7. Control & Preservation of Microorganisms

Control of microorganisms by physical methods (heat, filtration, radiation). Control of microorganisms by chemical methods (phenols, alcohols, halogens, dyes, detergents, heavy metals, etc), Common preservation techniques for microbes. **05 Hours**

8. Applied and Industrial Microbiology

Food Microbiology, role of microorganisms in food production, Industrial Microbiology: Introduction to Fermenter & fermentation processes, Media for industrial application, Industrial Products: amino acids, vitamins, enzymes, pharmaceuticals, organic acids (discussion of case study), r-DNA technology & therapeutic products from microbes. Biosynthetic pathways and Introduction to Metabolic Engineering.

Industrial Microbiology:Introduction to Fermenter & fermentation processes, Media for industrial application. Production of amino acids, antibiotics, organic acids & vitamins from microorganisms, Microbes as sources of proteins, enzymes from microbes. r-DNA technology & therapeutic products from microbes. **05 Hours**

Text Books:

1 Chan & Pelzar, Microbiology, Publisher: Tata McGraw Hill 5th Edition 2008.

2 Tortora, Microbiology: An Introduction, Publisher: Pearson Education, 8th Edition, 2004

Reference Books:

1. Stanier Ingraham & Wheeler, General Microbiology, Pub: Mac Millan 5th edition. 2007.

2. Heritage, Introductory Microbiology Pub: Cambridge, 1st edition, 2007

Program: Biotechnology		
Course Title: Biochemistry		**Course Code: 15EBTC202**
L-T-P: 4-0-0	**Credits: 4.0**	**Contact Hours: 04 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 03 Hours**	

Unit I

1. Biochemical Foundation & Biomolecules

Chemical Bonding- Ionic bond, covalent bond, Hydrogen bond, Van der waals forces, hydrophobic interactions, coordinate bond with examples. Nomenclature of organic compounds with examples. Stereochemistry of carbon compounds. Types of chemical reactions, Solution chemistry. Biochemical calculations, The pH scale, measurement of pH, pH meter, pKa values Buffers and their properties, biological buffer systems. **04 Hours**

2. Lipids

Definition and classification of lipid – simple, compound and derived lipids. Structure, classification and properties of fatty acids , Essential and non-essential fatty acid with physiological importance. Structure and physiogical functions of phospholipids, Sphingolipids, cerebrosides and gangliosides. Steroids- Structure and functions of cholesterol and its derivatives. Eicosanoids, lipoproteins and terpenes. Vitamins-classifications and functions.

05 Hours

3. Amino acids and Proteins

Definition, Classification and properties of amino acids, reactions, rare amino acids, essential and nonessential amino acids with physiogical importance. Peptides - Definition of peptide bond, Structure and function of Peptides and biological significance. Proteins - Classification, physico-chemical properties, structure- primary, secondary, tertiary and quaternary proteins, Secondary structures: Alpha hélix, Beta sheets, coils and turns, Helix to coil transition & zipper model., Fibrous proteins, structure of collagen. Ramachandran plot. Methodology related to isolation, purification and characterization of proteins, polypeptide sequencing- Edman degradation, Chemical synthesis of Peptides.

07 Hours

4. Nucleic acids

Structure and properties of purines, pyrimidines, nucleosides and nucleotides. Nucleic acids- Structure of DNA, RNA -Types, structure and properties, prokaryotic versus eukaryotic organisms. Genetic code. **04 Hours**

Unit II

4. Carbohydrates

Classification, basic chemical structure and properties of monosaccharides, Disaccharides, Sugar derivatives, deoxy sugars, amino sugars, and sugar acids, phosphorylated sugars, structure and properties of polysaccharides, Homopolysaccharides, Heteropolysaccharides - Peptidoglycan, Glycosaminoglycans, Glycoconjugates, Glycobiology . Biological importance of carbohydrates.

06 Hours

5. Carbohydrate metabolsim:

Glycolysis, Glycolysis in aerobic and in anaerobic conditions. Energy yield of glycolysis, phosphorylation at the substrate level. Regulation of glycolysis- metabolic and hormonal. Fates of pyruvate.Glycogen - structure, synthesis and degradation. Regulation of glycogen metabolism. Gluconeogenesis, Pentose phosphate pathway. Significane of pentose phosphate pathway and

regulation.Production of Acetyl-CoA, Reactions of Citric acid cycle, Anaplerotic reactions, regulation of citric acid cycle. Glyoxylate cycle.Structure of Mitochondria, Electon carriers, Electon transport chain, ATP synthesis, energetics of electon transfer, shuttle systems and regulation of Oxidative phosphorylation. Disorders of carbohydrate metabolism. Production of microbial polysaccharides; industrial application of exopolysaccharides; Medical applications of exopolysaccharides. **14 Hours**

Unit III

6. Photosynthesis and Phytochemistry

Photo pigments, Photo systems I & II, Cyclic and Non-cyclic Photophosphorylation. Calvin Cycle (C_3), and balance sheet, C_4 pathway. Bacterial photosynthesis. Exploitation of nature for product development and applications, Medicinal plants, plants secondary metabolites and endophytes.

05 Hours

8. Biological Membranes And Transport Mechanism

Composition and functions of biological membranes – Proteins, Carbohydrates, Glycoproteins and glycolipids. Models of Plasma membrane, Membrane transport - Passive transport, Osmosis and Active transport. Cytoskeleton – Microtubules, Microtubular organelles. Endomembrane systems – Endoplasmic reticulum, Golgi complex and Protein secretion Ion permeability and membrane potential, Cell signaling – devices, autocrine, paracrine and endocrine models, receptors –hormones, enzymes, ion channel, G-protein coupled receptors.

05 Hours

Text Books:

1. David L. Nelson, Michael M. Cox.Lehninger principles of biochemistry.McMillan –worth, third edition, 2003.
2. Lubert Stryer, Jeremy.M.Berg and John L Tymoczko, Biochemistry fifth edition,Freeman and Company.2002.

Reference Books:

1. Voet D. & Voet J, Biochemistry. John wielly and sons. 2nd edition2002.
2. G.Zubay, Biochemistry, Welsey Publ.1983.
3. Laurence A. Moran, Raymond S. Ochs, J. David Rawn, and K. Gray Scrimgeour. Principles of biochemistry. Third edition,Prentice Hall.2002.

Course Title: Bioprocess Calculations		Course Code: 15EBTF201
L-T-P: 4-0-0	Credits: 4	Contact Hours: 04 Hours/Week
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hours: 50	Examination Duration: 03 Hours	

Unit I

1.Units and dimensions

Introduction to Fundamental and derived Units. FPS, MKS, CGS and SI system. Conversion from one system to another system with examples. **04 Hours**.

2.Basics of chemical calculation

Introduction, concept of mole, Atomic mass and molar mass, composition of mixtures of solids, liquids and gaseous. Ideal gas law, Amagats law and Dalton's law. Varification of Vol %=Mol %. Physical properties of solution, normality, morality and molality. Solving problems for normality, morality and molality. **08 Hours**

3.Material balances without chemical reaction

General material balance equation, simplification for steady state without chemical reaction. Material balances of unsteady-state operation. Problems on mixing of streams, Distillation, Drying, Absorption, evaporation, Filtration, Extraction & Crystallization. **08 Hours**

Unit II

4.Material balances with chemical reaction

Introduction, Concept of limiting, excess reactant and inerts. Conversion, yield and selectivity. Fuels and combustion-Definition of ultimate and proximate analysis of coal, air fuel ratio calculation. Problems. **10 Hours**

5.Energy Balance

General steady state energy balance Equation.Thermopysics-Enthalpy, Heat

capacities of solids, liquids and gases. Heat capacities of mixture, Thermo chemistry-

Heat of combustion, formation and reaction. Effect of temperature on heat of reaction. Definition and significances of NCV and GCV and problems. **10 Hours**

Unit III

6a .Stoichiometry of microbial growth and product formation kinetics

Introduction and definition of various yield coefficients. Elemental balances and Degree of reduction. Problems. **05Hours**

6b .Stoichiometry of microbial growth and product formation kinetics

Introduction and Basic cell kinetic models, Strutured,unstructured and mixed growth kinetic models **05 Hours**

Text Books:

1. B.I Bhatt and S.M.Vora, Stoichiometry,Tata McGraw Hill publications,4th edn,2007.
2. David Himmelblau, Basic principles and calculation in chemical engineering, Pearson Education Limited,6th edn,2005

Reference Books:

1) Hougen, Watson and Rigatz, Chemical Process principles Pati-I , CBS Publishers & Distributors,2nd edn,2004.
2) J E Bailey and D F Ollis, Biochemical engineering Fundamentals, Mc Grew Hill Publication, 2nd edn,1986.

Program: Biotechnology		
Course Title: Heat and Mass Transfer		**Course Code: 15EBTF202**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1. Basics of mass transfer

Introduction to Mass Transfer, Classification of mass transfer operations, Diffusion, Fick's law of diffusion, Vapour Liquid Equilibrium (Txy & xy plots),Raoult's law, Relative volatility and its importance. Prediction of VLE data for binary mixture (Ideal system).

05 Hours

2. Distillation

Types of distillation: simple distillation, flash vaporization, Multi stage tray tower distillation, Packed tower distillation & steam distillation.

Determination of theoretical stages in multistage tray tower distillation column: Construction of equilibrium curve, Equations for operating lines of rectifying section & stripping section, Equation for feed line(q-line).Concept of Reflux ratio, Types of Refluxes: Total reflux, Minimum reflux & Optimum reflux. Conceptual numerical Problems on determination of number of theoretical stages.

10 Hours

Unit II

3. Drying

Importance of Drying, Terminologies and definitions, Drying rate curves under constant drying conditions, Drying Equipments: Tray dryer, Freeze dryer, spray dryer etc. **04 Hours**

4. Extraction

Introduction, Liquid-Liquid & Solid-Liquid Extraction Principles, selection of solvents. Phase Diagrams, Extraction equipments: Fixed bed, moving bed leaching, mixer and settler Extractor.

04 Hours

5. Adsorption: Concept of Adsorption, Types of Adsorption, Adsorption Isotherms, Applications of Adsorption. **02 Hours**

6. Heat transfer: Introduction, Modes of heat transfer: conduction, convection and radiation. Conduction: Fourior's law of heat conduction, Thermal conductivity. Steady state heat conduction through unilayer and multilayer plain wall, Unilayer & multilayer Cylindrical pipe. Conceptual problems. **05 Hours**

Unit III

7. Convective heat transfer & Heat transfer equipments:

Forced and natural convection, individual and overall heat transfer coefficient, Correlation for h and U for the flow in circular tubes and annulus. Concept of Log Mean Temperature Difference

(LMTD). Typical heat transfer equipments: Double pipe heat exchanger, Shell and tube heat exchanger. (Line diagram and operation). **05 Hours**

8. Condensation & Boiling:

Condensation: Drop wise & Film wise condensation. Boiling: Phenomenon, different regimes of Boiling (descriptive only). Insulation, Critical thickness of Insulation. **05 Hours**

Text Books:

1. McCabe W. L. and Smith J. C, Unit operations of chemical engineering, Pub: McGraw-Hill, 7th edition, 2005.
2. C. J. Geankoplis, Transport Processes and unit operations, Prentice Hall of India, 4th edition, 2004

Reference Books:

1. George Granger Brown, Unit Operations, Pub: CBS Publishers &Distributors,1st Edition, 2004.
2. Alan S Foust, Principles of Unit operations, Pub: John Wiley & Sons, 2nd edition, 1980

Program: Biotechnology		
Course Title: Microbiology Lab		**Course Code: 15EBTP201**
L-T-P: 0-0-1	**Credits:1.0**	**Contact Hours: 2Hrs/week**
CIE Marks: 80	**SEE Marks: 20**	**Total Marks: 100**
Teaching Hours: 24	**Examination Duration: 03 Hours**	

List of Experiments:

1. Laboratory safety precautions, cleaning & storage practices, culture disposal practices.
2. Study of Laboratory equipments: Microscope, Autoclave, Laminar Air Flow Bench, Hot Air Oven, Bacteriological Incubator and Freeze Drier. SOP and Calibration.
3. Media preparation: Nutrient broth/Agar, Mac-Conkey's medium and Potato-Dextrose broth/Agar.
4. Pure culture techniques: Streak plate Method, Spread plate Method, Pour plate Method.
5. Enumeration techniques: Plate Count Method, Direct Microscopic Count.
6. Simple and Differential Staining Techniques (Gram staining technique).
7. Hanging drop technique for motility and Endospore staining.
8. Study of bacterial growth curve.
9. Sterilization by Filtration.
10. Antibiotic susceptibility testing for bacteria.
11. Identification of Unknown fungi.
12. Open ended-experiment.

Note: There shall be ONE Open-Ended Experiment
Text Books/Reference Books: 1. Microbiology: A Lab Manual Seventh Edition by Cappuccino J G and Sherman N 2012 Pearson education Inc, 2012 (ISBN 978-81-317-1437-9). 2. Lab Ref by Jaine Roskams IK International, 2004.

Program: Biotechnology		
Course Title: Biochemistry Lab		**Course Code: 15EBTP202**
L-T-P: 0-0-1	**Credits:1.0**	**Contact Hours: 02 Hours/week**
CIE Marks: 80	**SEE Marks: 20**	**Total Marks:100**
Teaching Hours: 24	**Examination Duration: 03 Hours**	

List of Experiments

1. Biochemical Measurements: Molarity, Normality, Molality, Moles, weight/volume measurements, percent solution, concentration Units. pH measurements and Buffer preparation, SOP's, Instrument calibrations.
2. Qualitative analysis of carbohydrates and Lipids
3. Qualitative analysis of amino acids and proteins.
4. Estimation of Reducing sugar by Folin – Wu method.
5. Estimation of Reducing sugar by Nelson –Somogyi/DNS method.
6. Estimation of Amino acids by ninhydrin method.
7. Estimation of Proteins by Lowry's method.
8. Estimation of Inorganic Phosphate by Fiske-Subbarao method.
9. Estimation of Urea by DAMO method
10. Estimation of DNA by Diphenylamine method.
11. Estimation of RNA by Orcinol method.

Text Books/ Reference Books:

1. David Plummer An introduction to Practical biochemistry.Third edition,McGraw-Hill,1987.
2. Sadasivam S and Manickam A.,Biochemical methods.Second edition,New Age International,2005.

Year of offering: 2016-17
Batch- 2015-19 (4th semester)

Program: Biotechnology		
Course Title: Immunology		**Course Code: 15EBTC203**
L-T-P: 3-0-0	**Credits: 03**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1. Immune system

History and Scope of Immunology and Immune system, Classification of Immune system, Types of Immune responses, Molecules ,Cells and Organs of Immune system and Anatomy of immune response

06 Hours

2. Humoral Immunity

Overview of Humoral immunity, B- Lymphocytes – Development and their activation, Antibody response, Structure and functions of Immunoglobulins, Classes and sub-classes of immunoglobulins, genetic control of antibody production, Monoclonal and Polyclonal antibodies, Production of Monoclonal antibodies and quality screening processes in large scale monoclonal antibody production

05 Hours

3. Cell Mediated Immunity

Overview of cell mediated immunity and its significance, T-Lymphocytes – Development, Types and their activation, Major Histocompatibility (MHC) Complex, Antigen Presenting Cells (APC) and antigen processing and presentation, Mechanism of Phagocytosis- Oxygen dependent and Oxygen independent

04 Hours

Unit II

4. Regulation of Immune response and Immune tolerance

Immune response – Nature and necessity of its regulation, Complement System- Types, activation and types and their biological applications, Cytokines – types and their role in immune response, Immune Tolerance and their types, Hypersensitivity reactions – Types and Treatments **05 Hours**

5. Immunological disorders

Auto immune disorders – Features, important types and Experimental models of auto immune diseases Immunodeficiency Disorders – Types and features **04 Hours**

6. Transplantation immunology

Transplantation antigens – Types and functions, Types of Transplantations, Immunological basis of Graft rejection, Role of HLA in graft rejection, Tumor specific antigens, Tissue typing, Immune suppression and immune suppressive drugs

06 Hours

Unit III

7. Molecular Immunology

Vaccines – Types and their development, Production of Recombinant DNA vaccines, Application of PCR technology to produce antibodies, Immune Therapy with genetically engineered antibodies, Catalytic antibodies, immunotherapeutic applications of hematopoietic stem cells, Purification and preparation of antigens in vaccine development and Immunoinformatics.

06 Hours

8. Immunodiagnosis

Immunization and Antiserum, Antigen-Antibody interactions – Precipitation reactions and Agglutination reactions Immunoelectrophoresis and Immunoflurescence assay, Principle and applications of ELISA and RIA and Western blotting analysis.

04 Hours

Text Books:

1. Immunology – J. Kuby, WH Freeman and Company, New York (2003)
2. Immunology and Immunotechnology by Pandian (2003)

Reference Books:

1. Instant notes in Immunology by P.M. Ladyard, Bios Scientific Publishers Ltd (2000)
2. Essential Immunology by Roitt I, Blackwell scientific publications, (1991)

Program: Biotechnology		
Course Title: Enzyme Technology & Metabolism		**Course Code: 15EBTC204**
L-T-P: 4-0-0	**Credits: 04**	**Contact Hours: 04 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 03 Hours**	

Unit I

1. Enzyme Purification and characterization

History, nomenclature, classification of enzymes, sources of enzymes, properties of enzyme, strategies for isolation and purification and characterization of enzyme, theories and mechanism of enzyme action with examples.

08 Hours

2. Enzyme catalysis and enzymatic techniques

Types of specificities, Enzyme catalysis -Acid base catalysis, covalent catalysis, metal ion catalysis, Enzyme assay, Enzyme and isoenzyme measurement methods with examples, Methods for investigating the kinetics of Enzyme catalyzed reactions, Standardization and optimization methods, stability and activity of enzymes

06 Hours

3. Allosteric enzymes and Enzyme Inhibitions.

Kinetics of single substrate reactions, Michaelis–Menten plots, Lineweaver–Burk plot, Enzyme inhibition-reversible, competitive, uncompetitive and non-competative inhibitions and kinetics allosteric and irreversible inhibition. Multi-substrate reactions-ordered mechanisms, random mechanisms, Ping-pong mechanism. Allosteric enzymes - The Monad - Changeux - Wyman model (MCW) and The Koshland - Nemethy - Filmer (KNF) model, regulation of enzymes: Allosteric, Feed back regulation and covalent regulation

06 Hours

Unit II

4. Lipid Metabolism

Fatty acid oxidation, biosynthesis of fatty acids, Ketone bodies, cholesterol biosynthesis, steroid, harmones. Regulation. Enivronmental and Industrial Significance of lipid metabolsim. Oleaginous microorganisms and their principal lipids; Production of microbial lipids; Modification of lipids for commercial application; Extracellular microbial lipids and biosurfactants.

. **08 Hours**

5. Protein Metabolism

General reactions of amino acid metabolism, urea cycle, amino acid biosynthesis and degradation, regulation, Protein folding and assembly – protein folding pathways in prokaryotes and eucaryotes. Application of gene cloning in redirecting cellular metabolism for over-production of a few industrial products. Strategies for hyper production of primary and secondary metabolites such as enzymes, amino acids, anti-oxidants and antibiotics. Enivronmental and Industrial Significance of Amino acid metabolsim.

08 Hours

6. Nucleic acid Metabolism

Biosynthesis and degradation of purines and pyrimidines, uric acid production, regulation, metabolic disorders of nucleic acid metabolism. **04 Hours**

Unit III

7.Enzyme Immobilization

Techniques of enzyme immobilization; kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, applications of immobilized enzyme. Bioreactors for soluble and immobilized enzymes.

05 Hours

8.Industrial Applications and synzymes:
Enzymes used in detergents, use of proteases in food, leather and wool industries,uses of lactase in dairy industry, glucose oxidase and catalase in food industry. Enzymes in diagnostics, Biotransformations, Peptide Synthesis, synzymes, The design and construction of novel enzymes.

05 Hours

Text Books:

1. Lehninger principles of biochemistry, David L. Nelson, Michael M. Cox, Fourth edition.
2. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry-Trevor Palmer, 1st edition, East-West Press Pvt. Ltd. (2004).
3. Fundamentals of Enzymology –Nicholas .C. Price and Lewis Stevens, 3rd ed., Oxford University Press (1991).

Reference Books:

1. Biochemistry by Donald voet, & Judith G. Voet, 2nd Edition, Wiley.
2. Biotransformation in Organic Chemistry - Faber,4th edition,Springer,2000.
3. Enzymes in industry- production and applications- Aehle W, Wiley-VCH,2004

Program: Biotechnology		
Course Title: Cell and Molecular Biology		**Course Code: 15EBTC205**
L-T-P: 4-0-0	**Credits: 04**	**Contact Hours: 04 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 03 Hours**	

Unit I

1. Cell, Cell Division and Cell-Cycle

Prokaryotic and Eukaryotic cells. Structure and functions of membranes, cytoskeletal elements, cytoplasm, nucleus, endoplasmic reticulum, Golgi complex, mitochondria, chloroplast and vacuoles. Cell functions: Cell division, Cell Cycle and its regulation.

05 Hours

2. Molecular Biology and Nucleic Acids

Meaning and scope of molecular biology, Central Dogma and its updated view, Nucleic acids as genetic material, Structure and forms of nucleic acids, factors determine the structure of DNA – Denaturation and melting curves, Evidences for hydrogen bonds, hydrophobic interactions and effect of the ionic strength of a solution on the structure of DNA. Isolation and Purification of Nucleic acids – genomic DNA, Plasmid DNA and Total RNA, Quantification and storage of nucleic acids.

06 Hours

3. Organization of Genome or Genetic material

Genome: Viral genome, bacterial genome, Mitochondrial genome, Eukaryotic genome. Organization of Chromatin, Chromosomes: types and Gene organization in Prokaryotes and Eukaryotes.

04 Hours

4. Replication of DNA

An overview and Basic rules for DNA Replication, Enzymes and proteins of DNA Replication, DNA

Replication is Semi conservative, Origin of DNA Replication, Replicon and Replication fork, Unidirectional and Bidirectional replication of DNA, Mechanism of DNA replication in prokaryotes and in Eukaryotes. **05 Hours**

UNIT - II

5. Transcription

General features of Transcription process, Types of RNA molecules, Prokaryotic and eukaryotic RNA polymerases, Promoter structure and Mechanism of transcription in prokaryotes and eukaryotes, Post transcriptional modifications of mRNA, tRNA and rRNA, Transcription inhibitors **05 Hours**

6. Translation

Features of Genetic code and Wobble hypothesis, Overview of protein synthesis, Components required for protein synthesis, Mechanism of protein synthesis in prokaryotes and eukaryotes, Post-translational modifications and Protein targeting, Inhibitors in translation **04 Hours**

7. Regulation of Gene Expression in Prokaryotes and Eukaryotes.

Regulation of gene activity, Gene regulation in Prokaryotes: Constitutive, Inducible and repressible gene expression systems, Operon model for gene expression regulation in prokaryotes, Positive and Negative regulation of – Lac Operon – Regulation, Catabolic repression and Gratuitous inducers etc, Trp Operon and Gal Operon.

Gene regulation in Eukaryotes, Regulation of Gene expression at Genome level, Transcriptional level –Acetylation of Histones, Chromatin remodeling, DNA Methylation, DNA elements, Transcription factors, Insulators, Regulatory proteins and Hormones. Gene regulation at Post transcriptional level – Splicing, RNA interference, Transport of mRNA and by regulating mRNA stability. **11 Hours**

Unit III

8. Mutations and DNA Repair

Mutation – Source of genetic variability, basic features of Mutation process, Molecular basis of Mutation, Conditional lethal mutations as a powerful tool for genetic studies and Ames test of Mutagenecity testing. DNA damage and different types of DNA repair systems and Human diseases. **05 Hours**

9. Polymerase Chain Reaction

Principle of polymerase chain reaction (PCR) - Components of PCR reaction and optimization of PCR -Gene specific primer and degenerate primer – Inverse PCR, Hot-start PCR, Loop mediated PCR -, Reverse transcription PCR and Real time PCR. Chemistry of primer synthesis. **05 Hours**

Text Books:

1. Fundamentals of Molecular Biology Ane's Student Edition. - Veer Bala Rastogi, Ane Books India, New Delhi (2008)
2. Instant Notes in Molecular Biology – P.C. Turner, Viva Series Publishing, New Delhi

Reference Books:

1. Principles of Genetics (IVth) Edition – Snustad and Simmons, Wiley Asia Student Edition (2006)

2. Molecular Biology (IInd) Edition –David Freifelder, Narosa Publishing House,(1990)

Program: Biotechnology		
Course Title: Momentum Transfer		**Course Code: 15EBTF203**
L-T-P: 3-0-0	**Credits: 03**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1. Basic concepts

Fluid definitions, shear stress, shear strain, Properties of fluids: specific weight, viscosity, Density, specific gravity, specific volume. Types of fluids; real fluid and ideal fluid, compressible fluid and incompressible fluid, Newtonian and non-Newtonian fluids. Types of fluid flow: steady flow, uniform flow, rotational flow, one dimensional flow, laminar flow and turbulent flow, Reynolds number, pressure measurements, Types of manometers, Hydrostatic equilibrium, Newton's law of viscosity, Screen Analysis.

03 Hours

2. Fluid flow

Basic equations of fluid flow: Mass balance, Continuity equation, Euler's equation, Bernoulli's equation, Application of Bernoulli's equation. Numericals on Bernoulli's equation and continuity equation, Laminar Flow through Circular Conduits, Hagen Poiseulle's equation, Boundary layer, development of boundary layer on a plate and in pipe. Boundary layer separation and wake formation, friction factor, friction factor chart, effect of roughness, minor loss and major loss, Losses due to sudden expansion, contraction and other fittings.

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06 Hours

3. Flow past immersed bodies

Drag, lift, Drag coefficient, drag coefficients of typical shapes, Pressure drop correlations, Kozney- Carman equation, Blake- plummer equation Ergun's Equation. Filtration, Filter media, Filter aids, Types of filters, cake filter, clarifying filter, cross flow filter,rate of filtration, Constant rate filtration, Constant pressure filtration, Specific cake resistance α and Filter media resistance R_m. Filtration equipment: principle and working of rotary drum filter, plate and frame filter, leaf Filter.

06 Hours

Unit II

4. Flow through stagnant fluids

Settling, Types of settling, Free settling, hindered settling, Terminal settling velocity, Stoke's law, Newton's law, Criterion for settling regime, Sedimentation, Batch sedimentation,

Rate of sedimentation, Kynch theory, Thickener, Determination of thickener area. Numericals on Settling and Sedimentation. Fluidization, conditions for fluidization, minimum fluidization velocity.

07 Hours

5. Fluid pumping and metering

Measurement of fluid flow rates, Constructional features and working principles of venturimeter, orificemeter, rotameter, pitot tube. Application of Bernoulli's equation to venturi meter and orificemeter, Flow rate calculations from the readings of venturi meter, orifice meter and pitot tube. Pumps, Classification and selection of Pumps, developed head, power requirement, suction lift and cavitation, NPSH, priming, constructional features and working principle of centrifugal pump, reciprocating pump, rotary pump, peristaltic pump, characteristic curves of a centrifugal pump. Numericals on flowmeters.

08 Hours

Unit III

6. Mixing

Mixing and Agitation: Necessity of mixing & agitation in industries, Principles of agitation Types of Impellers & propellers, Different flow patterns in mixing, prevention of swirling, draft tubes. Standard turbine design, Calculation of power requirement of mixing equipment, Mixing equipment of pastes & viscous material, Solid – Solid Mixing, Agitator selection. Mixing equipments: Change can mixers, Muller mixers, Ribbon blender, Double cone mixer, Twin shell blender, Internal Screw mixer, Jet mixer, Static mixer.

05 Hours

7. Dimensional Analysis:

Units and dimensions, Dimensionless number, Rayleigh and Buckingham π theorem. Problems on Rayleigh and Buckingham π theorem. Model and prototype. Similitude: Geometric, Kinematic and Dynamic. Numericals.

05 Hours

Text Books:

1. McCabe W. L. and Smith J. C, Unit operations of chemical engineering, Pub: McGraw-Hill, 7th edition, 2005.
2. C. J. Geankoplis, Transport Processes and unit operations, Pub: Prentice Hall of
   a. India, 4th edition, 2004

Reference Books:

1. John F. Douglas, Janusz M. Gasiorek, John A. Swaffield, Fluid Mechanics, Pub: Pearson education limited, 4th edition, 2007.
2. Alan S Foust, Principles of Unit operations, Pub: John Wiley & Sons, 2nd edition, 1980.

Program: **Biotechnology**		
Course Title: Enzyme Technology Lab		**Course Code: 15EBTP204**
L-T-P: 0-0-1	**Credits:1.0**	**Contact Hours: 02 Hours/week**
CIE Marks:80	**SEE Marks: 20**	**Total Marks:100**
Teaching Hours: 24	**Examination Duration: 03 Hours**	

List of Experiments

1. Biochemical Measurements: Molarity, Normality, Molality, Moles, weight/volume measurements, percent solution, concentration Units. pH measurements and Buffer preparation, SOP's, Instrument calibrations.
2. Determination of activity of amylase enzyme
3. Estimation of protein content of amylase and specific activity
4. Effect of temperature on enzyme activity
5. Effect of pH on enzyme activity
6. Effect of substrate concentration on enzyme activity
7. Effect of enzyme concentration on enzyme activity
8. Effect of inhibitor on enzyme activity
9. Enzyme immobilization and kinetics of immobilized enzyme
10. Molecular weight determination by SDS PAGE
11. Staining the gel using CBB and silver staining

Text Books/ Reference Books:

1. Introduction to Practical biochemistry – David Plummer, McGraw-Hill Publishing Co,3rd edition,pp:332.
2. Biochemical methods- Sadasivam and Manickam(1996), New Age International Publishers, 2nd edition, pp256.
3. Experimental Biochemistry – A Student Companion by Beedu Shashidhar Rao and Vijay Deshpande.(2005) I.K International Pvt. Ltd,New Delhi. pp301

Program: **Biotechnology**		
Course Title: Cell and Molecular Biology Lab		**Course Code: 15EBTP205**
L-T-P: 0-0-1	**Credits: 1.0**	**Contact Hours: 02 Hours/Week**
CIE Marks: 80	**SEE Marks: 20**	**Total Marks: 100**
Teaching Hours: 24	**Examination Duration: 03 Hours**	

List of Experiments

1. Study of Cell and Molecular Biology laboratory equipments – Table top cooling Centrifuge,

UV – Visible Spectrophotometer, PCR machine and Gel Documentation system.

2. Staining and microscopic observation of plant/animal cells and chromosomes
3. Study of Mitosis and Meiosis Cell Divisions
4. Isolation of genomic DNA from Bacteria/ Plant/ Animal cells
5. UV Spectrophotometric analysis of DNA and RNA
6. Calculation of Tm value of DNA of isolated DNA sample
7. Agarose gel electrophoresis and gel elution of DNA.
8. Isolation and estimation of Plasmid DNA
9. Extraction of Total RNA from different biological sources

Text Books /Reference Books:

1. Cell and Molecular Biology – A Lab Manual K V Chaitanya PHI Learning Private Limited Delhi – 110092, 2013.
2. Molecular Cloning Volumes I, II and III – Sambrook J *et al* (2000) Cold Spring Harbour Laboratory Press, 2000

Program: Biotechnology		
Course Title: Momentum Transfer Lab		**Course Code: 15EBTP206**
L-T-P: 0-0-1	**Credits:1.0**	**Contact Hours: 02 Hours/Week**
CIE Marks: 80	**SEE Marks: 20**	**Total Marks: 100**
Teaching Hours: 24	**Examination Duration: 03 Hours**	

List of Experiments:

1. Verification of Bernoulli's Equation.
2. Pressure drop through packed bed. (Verification of Ergun's Equation).
3. Studies on sedimentation. (Verification of Kynch Theory, Thickener area calculation).
4. Verification of stoke's law
5. Studies on agitation
6. Constant pressure filtration using leaf filter
7. Study on flow meters (Characteristics of Rotameter, venturimeter etc).
8. Pressure drop correlations through circular pipes (Friction factor correlations).
9. Study of laminar flow characteristics
10. Sieve Analysis

Text Books:

1. McCabe W. L. and Smith J. C, Unit operations of chemical engineering, Pub: McGraw-Hill, 7th edition, 2005.
2. C. J. Geankoplis, Transport Processes and unit operations, Pub: Prentice Hall of India, 4th edition, 2004

Reference Books:

1. John F. Douglas, Janusz M. Gasiorek, John A. Swaffield, Fluid Mechanics, Pub: Pearson education limited, 4th edition, 2007.

2. Alan S Foust, Principles of Unit operations, Pub: John Wiley & Sons, 2nd edition,1980.

Year of offering: 2017-18
Batch- 2015-19 (5th semester)

Program: Biotechnology		
Course Title: Genetic Engineering and Applications		**Course Code: 15EBTC301**
L-T-P: 4-0-0	**Credits: 4.0**	**Contact Hours: 04 Hours/Week**

CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hours: 50	Examination Duration: 03 Hours	

Unit I

1. Basics of Recombinant DNA technology

Development and Scope of Recombinant DNA Technology and Genetic Engineering. Emergence and commercialization of Molecular Biotechnology. Gene Cloning: Introduction and Steps involved in gene cloning. Subcloning and its applications. Vectors in GE - biology, features, types, cloning & expression vectors.

06 Hours

2. Enzymes in Genetic Engineering

DNA modifying enzymes and necessity of DNA modification in gene cloning. Enzymes used for DNA modification. Restriction Endonucleases, classification & mode of action, Role and applications of different DNA modifying enzymes in gene cloning process - DNA Polymerases, Reverse Transcriptase, RNA Polymerase, Alkaline Phosphatases, Polynucleotide Kinase and DNA Ligases etc.

05 Hours

3. Molecular Cloning Strategies and Genetic Transformation

Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), Quantification on and storage of nucleic acids, Construction of cDNA library , Construction of Genomic library ,Screening and preservation of DNA libraries. DNA Cloning – Methods and applications. Genetic Transformation of prokaryotes and DNA Transfection in Eukaryotic hosts. Biological and Non-biological methods of gene transfer in hosts. Chloroplast transformation.

09 Hours

Unit II

4. Selection, Screening and Analysis of Recombinants

Introduction to screening and analysis of recombinants. Genetic selection and screening methods - Selectable Marker genes, Reporter genes. Screening using Nucleic acid hybridization methods - Preparation of probes for hybridization experiments and different blotting techniques. Screening by PCR based methods. Screening by Immunological methods and Analysis of cloned genes.

07 Hours

5. Production of Proteins from Cloned Genes

Introduction to recombinant gene expression, scope and applications of recombinant gene expression. Special vectors for expression of foreign genes in E coli. General problems with the production of recombinant protein in E coli. Production of recombinant proteins by Eukaryotic cells.

07 Hours

6. Directed Mutagenesis and Protein Engineering

Oligonucleotide – Directed Mutagenesis with M13 DNA, Plasmid DNA, PCR Amplification etc. Protein Engineering – Meaning and Scope, Protein Engineering for adding disulphide bonds, increasing enzymatic activity, decreasing protease sensitivity, modifying protein specificity, Increasing enzyme stability and specificity etc.

06 Hours

Unit III

7. Genetic Engineering and Microbial Biotechnology

Genetic manipulation of Microorganisms – Introduction and scope. Applications of Recombinant Microorganism – Production of recombinant therapeutic proteins, Production of Antibiotics, Combating Human diseases, Microbial pesticides, Efficient utilization of Carbohydrates and Bioremediation or Environmental cleanup.

05 Hours

8. Plant and Animal Transgenic Technology and Applications.

Applications of Transgenic Plant Technology – Development of Insect resistant plants, Herbicide resistant plants, Pathogens resistant plants, and Abiotic stress tolerant plants. Plants as Bioreactors for large scale production. Applications of Animal cloning and Transgenic technology - Cloning in Domestic animals. Applications of Transgenic Animals - as research models, and as bioreactors for large scale production of substances for Human welfare.

05 Hours

Text Books

1. Genetic Engineering by Smitha Rastogi and Neelam Pathak, Oxford University Press, USA (2009)
2. Molecular Biotechnology – Principles and applications of Recombinant DNA by Bernard r Glick and Jack J Pasternak, ASM Press, American Society for Microbiology, Washington DC 2003

Reference Books

1. Gene Cloning and DNA Analysis by T A Brown. Wiley-Blackwell (2010)
2. An Introduction to Genetic Engineering – Third Edn By Desmond S T Nicholl, Cambridge University Press, Singapore 2008.

Program: Biotechnology		
Course Title: Bioinformatics		**Course Code: 15EBTC302**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit - I

1.Database

Introduction, meaning of databases, types of databases, Primary Database: NCBI, Genbank, DDBJ, EMBL. File formats, Secondary Database: PROSITE, PIR, UNIPROT, BLOCKS, Pfam, specialized databases: KEGG, OMIM. Structure Database: PDB, MMBD, CATH, SCOP & structure visualization tools. **6 Hours**

2.Pairwise Sequence Alignment

Meaning and significance of Sequence alignment, Pairwise sequence alignment, Global alignment, Local Alignment, overview of methods, Methods & Algorithms-dot matrix, dynamic programming, substitution matrices, gap penalties, FASTA, BLAST PSI-BLAST & PHI-BLAST.

6 Hours

3.Multiple Sequence Alignment

Meaning of Multiple Sequence Alignment, Global Multiple Sequence Alignment: Progressive Alignment methods, Iterative methods, Local Multiple sequence Alignment, Significance of Multiple Sequence Alignment, Multiple Sequence Alignment editors. Motifs and Patterns, PROSITE.

4 Hours

Unit - II

4.Molecular Phylogenetics

Meaning of phylogenetic analysis, Meaning & significance of evolutionary trees, Rooted and unrooted trees, Elements of phylogenetic Models, Phylogenetic Data Analysis, Distance based methods: Neighbor Joining (NJ) method, Fitch-Margoliash (FM) method, Minimum Evolution (ME) method, Character based methods:Maximum parsimony, Maximum Likelihood; Tree Evaluation methods, Phylogenetic Softwares: PHYLIP & PAUP.

6 Hours

5.Gene Prediction

Prokaryote and Eukaryote gene prediction, promoter site prediction. Gene Prediction tools-GRAIL, GENSCAN & GENEPARSER.

4 Hours

6.Protein Prediction

Protein structures: Secondary structure :Alpha helix, beta Sheets, phi & psi angles, Ramachandran plots. Protein Secondary Structure Prediction, Tertiary Structure Predictions: Homology modeling, conformational analysis and forces that determine protein structure, Protein Structure Comparison.

6 Hours

Unit - III

7.In-silico Drug Designing-I

Introduction to traditional drug designing, Introduction in-silico drug designing approach, Methodology for in-silico drug designing, different tools used for drug designing, molecular Modeling, Energy minimization methods.

4 Hours

8.In-silico Drug Designing-II

Identification of ligands, Lipinski's rule, Process of Docking, Quantitative structure-activity relationship (QSAR), Physical and Chemical basis of receptor ligand interactions.

4 Hours

Text Books

1. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd, Wiley-Inte, 2005
2. David Mount, Bioinformatics: Sequence and Genome Analysis , 2nd, Cold Sprin, 2004

Reference Books

1. P. Rastogi, N. Mendiritta, S. C. Rastogi, Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, 4th, Prentice-H, 2013.
2. Anand Solomon K, Molecular Modelling and Drug Design , 1st, MJP Publis, 2015
3. Richard Durbin, Sean R. Eddy, Anders Krogh, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, 1st, Cambridge , 1998

Program: Biotechnology		
Course Title: Reaction Engineering		**Course Code: 15EBTC303**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 50**
CIE Marks: 50	**SEE Marks:100**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 3 hrs**	

UNIT-I

1: **Introduction**

Introduction to homogeneous and heterogeneous reaction in ideal reactors. Elementary and Non-elementary reactions kinetics of homogeneous and heterogeneous reactionsystem.

06 hours

2: **Interpretation of Batch Reactor data**

Introduction to analysis of experimental reactor data, evaluation of rate equation, integral and differential analysis of kinetic data's, constant volume system and variable volume System. Total pressure technique of analyzing the kinetic data of gaseous reaction system.

08 hours

3. **Introduction to Bioreactor Design.**

General discussion on basics bioreactor design. General material balance equation for various conditions. Ideal reactors for a single reaction. Design equations for homogeneous system: batch, stirred tank and tubular flow reactor, size comparison of reactor systems. **08 hours**

UNIT-II

4: Design for Multiple Reactions

Introduction, general design approach to multiple reactions. Quantitative and qualitative analysis of product distribution. Effect of temperature and pressure on single reaction. General graphical procedure, optimum temperature progression. Factors affecting choice of reactors: optimum yield, conversion, selectivity and reactivity.

08 hours

5: Non-Ideal Reactors

Non-ideal reactors, residence time distribution studies, Stimulus Response Technique, pulse and step input response of reactors, RTD's for CSTR and PFR, Relationship between C, E and F-curve. Kinetic models for non Ideal reaction system, Axial Dispersion Model **04 hours**

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6: Microbial kinetics:

Introduction to microbial kinetics, Yield coefficients. Simple kinetic models for microbial growth, transient growth kinetics Factors affecting the kinetics of Monod model; Growth of Filamentous Organisms. kinetic Models for product formation and substrate degradation **08 Hours**

UNIT-III

7: Heterogeneous Reactor System:

Heterogeneous reactions in Bioprocessing. The rate equation for surface for kinetics, Pore diffusion kinetics with combined with surface kinetics. Porous catalyst particle Performance equation for reactor containing Porous catalyst particles. External and internal mass transfer effects.

04 Hours

8: Reactor Engineering

Bioreactor configurations: Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed,

04 Hours

Text Books

1) Chemical Reaction Engineering by Octave and Levenspiel., John Wiley, 3rd Edition, 2006.
2) Elements of Chemical Reaction Engineering by Fogler, H.S., Prentice Hall, 1986.

Reference Books

1) Bioprocess Engineering Principles by Pouline M Doran Academic Press , 2003
2) Biochemical Engineering Fundamentals By Bailey and Ollies McGraw Hill 2nd Edition
3) Chemical Reactor Analysis and Design by Forment G F and Bischoff K B. John wiley,1976

4) Chemical engineering By J.F Richardson and J.M Coulson Volume 6

Program: Biotechnology		
Course Title: Biological Thermodynamics		**Course Code:15EBTC304**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours:40**
CIE Marks:50	**SEE Marks:50**	**Total Marks:100**
Teaching Hours:40	**Examination Duration:3 hours**	

Unit I

1. Basic concepts

System, Surrounding, State and Properties, Intensive and extensive properties, State and path functions, Heat reservoir, Hess Law, energy and biological world, energy flow transformation, energy conversions, energy, nutritional requirements of living systems, Flow of electrons in organism, energy flow in metabolic process, division of labor in cells, Numerical problems

06 hours

2. Basic laws of thermodynamics

Zeroth law, First law of Thermodynamics, cyclic process, non-flow process, flow Process, internal energy, Heat capacity, second law of thermodynamics, Concept of entropy, Calculation of entropy changes, Third law of thermodynamics. Numerical problems.

09 hours

Unit II

3. PVT behavior

P-V-T Behavior of pure fluid, Processes involving ideal gases, Equation of state for real gases: Vander Waals equation, Redlich-Kwong equation, Peng-Robinson equation, Virial equation. Compressibility charts: Principle of corresponding states, Numerical problems.

07 hours

4. Thermodynamic properties of Biological fluids

Classification of thermodynamic properties, Work function, Gibbs free energy, Gibbs-Helmholtz equation, ATP Synthesis in cell and Protein Folding, Metabolic reactions in cells. Entropy - heat capacity relationships, Relationships between C_p and C_v,, Activity of molecule, Chemical potential, Oxidation-Reduction reaction, Cell Membrane Transportation & Protein Extraction, Osmosis, Nernst equation in membrane transportation, Numerical problems.

08 hours

Unit III

5. Statistical Thermodynamics

Boltzmann distribution & partition function, Protein folding and helix-coil transition, Binding equilibria, Oxygen biding to myoglobin & Hemoglobin.

04 hours

6. Reaction Equilibria

Reaction Stoichiometry, Effect of temperature on standard heat of reaction. energy coupling reactions, activation energy, Criteria of chemical reaction equilibrium, Relationship between Equilibrium constant and standard free energy change, Effect of temperature, pH and pressure on equilibrium constants and other factors affecting equilibrium conversion, Numerical problems**.**

06 hours

Text Books

1. Biological Thermodynamics by Donald T. Haynie, 2nd edition, Cambridge University Press,2008
2. Introduction to chemical engineering thermodynamics by J.M.Smith, H. C. VanNess, M.M. Abbott, 7th edition, Tata McGraw-Hill, NewDelhi, 2005.

Reference Books

1. Thermodynamics. An engineering approach, by Yunus A. Cengel, Michael A. Boles, 8th edition, McGraw- Hill, 2014.
2. Chemical Engineering Thermodynamics by Y.V.C. Rao. 2nd edition, Universities Press, 1997.
3. Chemical and Process Thermodynamics by B.G.Kyle. 3rd edition, Prentice Hall of India Private limited,2015.

Program: Biotechnology		
Course Title: Research Methodology		**Course Code:15EBTC305**
L-T-P: 3-0-0	**Credits: 03**	**Contact Hours: 40**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 hours**	

Unit I

1. Introduction to Research and Research Methodology

Introduction, Objectives and scope of research, Research methods and Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical Concept of Translatory research.

04 hours

2. Research Philosophy and Formulation of Research Problem

Concept of Research Philosophy- (Ontology, Logic, Method and Epistemeology) Formulation of Research Problem- Necessity of defining the research problem and framing the problem statement.

03 hours

3. Sources and Review of Literature

Introduction and need for Literature Review., Search Procedures and Gap analysis.

Sources of Literature - Research articles, review articles, Research communications, Book chapters. Bibliometrics- Citation index, Impact factor, H- Factor

08 hours

Unit II

4. Sampling & Data Collection

Explain sampling and its significance. Describe different methods of sampling. **03 hours**

5. Statistical Analysis of Data

Measures of Central Tendency, Measures of Dispersion and variance, Correlation and Regression Development of hypothesis and testing : Chi- square test, Student's t-test, ANOVA

07 hours

6. Design of Experiments

Introduction and significance of DOE, Types - Factorial Design, Plackett Burman Design, Central Composite Design, Introduction to Response Surface Methodology.

05 hours

Unit III

7. Research Communication

Written Communication- Introduction, Structure and components of scientific reports – Bibliography, referencing and footnotes . Oral Presentation – Developing and delivering presentation **05 hours**

8. Environment, Ethics and IPR in Research

Impacts of Research on Environment, - Ethical issues, ethical committees, Research Generated Intellectual Property Rights- Copy-right & royalty, Patent law, Trade mark, Trade secret, Geographical Indicator,

Industrial Design. Concept of Plagiarism **05 hours**

Text Books

1.C.R. Kothari and Guarav Garg, Research Methodology, III Edition, New Age International Publisher, New Delhi, 2014

2. N. Gurumani, Research Methodology for Biological Sciences, I Edition, MJP Publishers, Chennai, 2007

Reference Books

1. Design and Analysis of Experiments by Montgomery D. C. John Wiley Publishers

2. An Introduction to Research Methodology by Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K. RBSA Publishers

Program: Biotechnology		
Course Title: Genetic Engineering & Immunotechnology Lab		**Course Code: 15EBTP301**
L-T-P: 0-0-1	**Credits:1.0**	**Contact Hours: 2Hrs/week**
CIE Marks: 80	**SEE Marks: 20**	**Total Marks: 100**
Teaching Hours: 24	**Examination Duration: 03 Hours**	

List of Experiments:

1. Preparation of Competent *E coli* cells (Exercise)
2. Ligation of DNA fragment with vector and Transformation (Demonstration)
3. Restriction digestion analysis of plasmid DNA (Structured Inquiry)
4. Introduction to PCR –Programming, and amplification of DNA (Exercise)
5. Screening of Transformants by Colony PCR (Demonstration)
6. TA Cloning method for cloning of PCR product. (Demonstration)
7. Demonstration of Southern blotting (Demonstration)
8. Agglutination techniques – Heam agglutination techniques and Bacterial agglutination techniques (Exercise)
9. Radial diffusion and Rocket Immunoelectrophoresis (Exercise)

   Dot-ELISA(Enzyme Linked Immuno Sorbent Assay) (Exercise)

Text Books/Reference Books

1.Principles of Gene Manipulations- Introduction to Genetic Engineering, by R.W. Old and S.D. Primrose(2007), Blackwell Scientific Publications.

2. Molecular Cloning- By T.Maniatis, E.F. Fritsch and J. Sambrook, Cold spring Harbour (2009)

Program: Biotechnology		
Course Title: Bioinformatics Lab		**Course Code: 15EBTP302**
L-T-P: 0-0-1	**Credits:1.0**	**Contact Hours: 2Hrs/week**
CIE Marks: 80	**SEE Marks: 20**	**Total Marks: 100**
Teaching Hours: 24	**Examination Duration: 03 Hours**	

List of Experiments:

1. Searching bibliographic database for relevant information
2. Searching sequence and retrieve from nucleic acid and Protein sequence database

3. PDB: Protein Data Bank and structure visualization
4. Pair wise alignment of the sequences
5. Searching sequence database using BLAST and FASTA algorithm
6. Multiple Sequence Alignment: CLUSTALW.
7. Evolutionary Relationship/ Phylogenetic Analysis.
8. Gene structure Prediction
9. Protein Secondary Structure Prediction
10. Pattern searching in proteins.
11. Define gene structure and design primers specific to the identified gene of microorganisms and draw restriction digestion map for sequence identified

Text Books/Reference Books

1. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd, Wiley-Inte, 2005
2. David Mount, Bioinformatics: Sequence and Genome Analysis , 2nd, Cold Sprin, 2004

Laboratory Title: Mini Project	**Lab. Code: 15EBTW301**
Total Hours: 90	**Duration of SEE Hours: 3**
SEE Marks: 50	**CIE Marks: 50**

Guidelines:

- Mini project to be carried out in a group of maximum 4 students.
- Every student needs to maintain laboratory work book which should contain the details of all the work carried out in the laboratory.
- Entries to be done in log books for instrument usage.
- Timely report submission to the coordinator.
- Requisitions for chemicals and glassware's to be provided in advance for the project work

Review committee:

Review committee is formed by the project coordinator taking into consideration that review committee consists of faculty experts from all domains. Review committee consists of the guide of the respective project group also.

Reviews:

- Continuous internal evaluation will be done by the respective guides/review committee as per the rubrics.
- Total of 3 **reviews** per semester will be carried out to evaluate the progress of the project.
- At each review students have to submit a report duly signed by guide.
- Final evaluation will be done by examiners during semester end examination as per the SEE evaluation scheme.

Phases of Minor Project:

Sl. No	Phases	Reviewed	Activities
1	Review-1	By Review committee	Need analysis, Detail Review of literature, Objectives, Overall plan of work.
2	Review-2	By Project Guide	Development of protocols, Standardization and screening. Design of experiments, Conduct of experiments, Initial experimental data.
3	Review-3	By Review committee	Final experimentation, Data interpretation and analysis, Conclusion.

Year of offering: 2017-18
Batch- 2015-19 (6th semester)

Program: Biotechnology		
Course Title: Bioprocess Engineering		**Course Code:15EBTC306**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 hours/week**
CIE Marks:50	**SEE Marks:50**	**Total Marks:100**
Teaching Hours:50	**Examination Duration:3 hrs**	

Unit - 1

1.Media and Inoculum development for industrial fermentations

Bioprocess development: An interdisciplinary challenge, Biotechnology & Bioprocess Engineering, steps in bioprocess development, Media ingredients, medium formulation, oxygen requirements, antifoams, medium optimization, Ingredients for mammalian cell culture and plant cell culture.

Introduction, Criteria for transfer of inoculum, development of inocula for bacterial processes, yeast processes and mycelial processes. Inoculum development for plant Fermenter.

8 Hours

2.Sterilization

Media sterilization, Design of sterilization process: Batch Process (Dell factor, holding time, and thermal death kinetics), continuous sterilization process; sterilization of fermenter and other ancillaries. Scale up of sterilization, filter sterilization of air and media.

5 Hours

3.Design of bioreactors

Basic objective of fermenter design, aseptic operation & containment regulation, achievement and maintenance of aseptic conditions, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Animal cell bioreactors.

7 Hours

Unit - II

4.Scale Up of Bioreactor

Scale up of bioreactors: Introduction, Scale-Up methods: Geometric and Dynamic Similarity, Criteria for scale-up: Constant power consumption/volume, constant KLa, constant mixing time, constant tip speed, Regime analysis: Time constant for transport phenomena, time constant for conversion. Scale down approach.

5 Hours

5.Heat Transfer

Heat transfer in Bioprocess: Design equation for heat transfer process, Energy balance, Logarithmic and arithmetic mean temperature difference, Calculation for heat transfer coefficient, applications of design equations, Relationship in between heat transfer, cell concentrations and stirring conditions, Numerical based examples on above.

4 Hours

6.Mass Transfer

Mass transfer in Bioprocess: Role of diffusion in bioprocessing, Different equations in mass transfer (liquid-solid, liquid-liquid and gas-liquid) , Oxygen uptake in cell culture: Factors affecting cellular oxygen demand, Oxygen transfer from gas bubble to cells, Oxygen transfer in fermenter, measuring dissolved oxygen concentrations, Measurement of KLa: Oxygen balance method, Gassing out techniques (static method of Gassing out and dynamic method of Gassing out) Sulphite oxidation, Factors affecting KLa, Oxygen transfer in large vessels, Numerical based examples on above.

5 Hours

7.Fermenter fluid rheology

Fermentation broth: Viscosity, Viscosity measurement, Rheological properties of fermentation broths, Factors affecting broth viscosity , Mixing in Fermenters: Mechanism of mixing, Assessing mixing effectiveness, estimation of mixing time, Power requirement for mixing: Ungassed Newtonian fluids,ungassed non-Newtonian fluids, Gassed fluids, Calculation of power requirements,Scaleupof mixing systems, Improving mixing in Fermenters, Effect of rheological properties on mixing, Role of shear in stirred fementers: Interaction between cells and turbulent eddies,Bubble shear, operating conditions for shear damage. Numericals

6 Hours

Unit - III

8.Bioreactor kinetics

Batch reactor kinetics, CSTR kinetics, Fedbatch kinetics and plug flow kinetics, Numericals

5 Hours

9.Solid State fermentation:

Introduction, SSF v/s SMF, Types of SSF reactors, Microbial growth kinetics in SSF, Heat & Mass Transfer in SSF

5 Hours

Text Books

1. Pauline M. Doran, Bioprocess Engineering Principles, 2, Academic Press, 2003
2. Stanbury & Whittaker, Principles of Fermentation Technology, 2, Pergamum Press, 2000

Reference Books

1. Michael L. Shuler & Fikret Kargi, Bioprocess Engineering, 2, Prentice Hall, 2001
2.Bailey, James E.; Ollis, David F., Biochemical Engineering Fundamentals, McGraw-Hill Education, 1986

Program: Biotechnology		
Course Title: Bioprocess Control and Automation		**Course Code:15EBTC307**
L-T-P: 3-0.5-0	**Credits: 3.5**	**Contact Hours: 3 hours/week**
CIE Marks:50	**SEE Marks:50**	**Total Marks:100**
Teaching Hours:40	**Examination Duration:3 hrs**	

Unit I

1: Instrumentation & Process Dynamics: Introduction to Measurement of important physicochemical and biochemical parameters in bioprocess. Methods of on line and off line estimation of biomass, substrates and products. Brief introduction to typical automatic control system and its components. Open loop and closed loop control systems.

05 hours

2: First & Second Order Systems: Mathematical representation of physical systems. Transfer function representation of linear first order systems, Examples: mercury in glass thermometer & Liquid level system. Mathematical forms of standard Input function/Forcing Functions such as Step input, Impulse Input, Linearly increasing Input and Sinusoidal Input. Response of first order system for step input, Features of step response, Response of linearly increasing input. Conceptual numerical. First Order Systems in Series: Interacting and Non-Interacting systems & their Transfer function representation. Second Order Systems: Transfer function representation of Second order systems, Example: Pneumatic Control Valve.

10 hours

Unit II

3: Controller and Final Control Elements: Different types of controllers-P (Special case of P-controller i.e ON-OFF controller), PI, PD, PID controllers. Derivation of Transfer Functions of different types of controllers.Final control element: The role of Final control Element in control system. Example: Pneumatic Control Valve: Working of Pneumatic control valve, Types of Pneumatic Control Valves i.e. Air to close & air to open.

08 hours

4: Block Diagram Reduction: Block diagram representation of control systems, Block diagram reduction in case of Servo and Regulatory control systems. Reduction of block diagrams for single input & Single output systems (SISO) & Multiple Input & Multiple Output Systems (MIMO), Problems on block diagram reduction.

07 hours

Unit III

5: Transient response of different controllers for Servo & Regulatory control Problems: Transient response of P, PI, PD & PID controllers for servo and regulatory problems. The determination of offset in all cases.

05 hours

6: Analysis of Stability: Concept of stability, stability criterion. Routh test for stability. Theorems of Routh Array test, Conceptual numerical on Routh test for stability. **05 hours**

Text Books

1. Process System analysis and control by Donald R Coughnowr, 2nd Edn.Mc Graw Hill,1991
2. Chemical Process Control by George Stephanopoulos, Prentice Hall of India, 1999

Reference Books

1. Process Control-Peter Harriott, Tata McGraw-Hill Publishing Company Limited, 2004.

Program: Biotechnology		
Course Title: Bio Analytical Techniques		**Course Code: 15EBTC308**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1. Introduction to Bio-analysis

Introduction to instrumentation, Functional elements of an instrumentation system, static and dynamic characteristics, calibration of instrumental methods, Types of errors, Methods of expressing precision and accuracy, Confidence limits, Uncertainties in Instrumental measurements – Sensitivity and detection, preparation & storage of solutions, usage of laboratory glasswares, statistical analysis of experimental data, Electrodes and Biochemical preparation.

05 Hours

2: Spectroscopy

General principles–Radiation, energy and atomic structure- types of spectra and their biochemical usefulness basic laws of light absorption. Electromagnetic radiation & Spectrum, Beer – Lambert's Law and apparent deviations; UV – VIS Spectrophotometer

05 Hours

3: Advanced Spectroscopy

Spectroflourimetry, Atomic absorption spectroscopy, IR spectroscopy, FTIR, Nuclear Magnetic Resonance, Mass spectroscopy, ORD, CD, X-ray diffraction.

05 Hours

Unit II

4: Chromatographic techniques

Analytical techniques for biomolecules purification, Paper chromatography, thin layer chromatography, Column chromatography, Gas chromatography, Ion-exchange chromatography, molecular exclusion chromatography, affinity chromatography, High performance liquid chromatography & UPLC- Principles, Methods, Instrumentation, Detectors, Analysis of data.

09 Hours

5: Electrophoretic techniques

Theory & application of polyacrylamide & Agarose gel electrophoresis for protein & nucleic acids, capillary electrophoresis, pulsed field gel electrophoresis, Iso-electric focusing, 2D-gel electrophoresis and Immunoelectrophoresis

06 Hours

Unit III

6: Centrifugation techniques

Basic principles of sedimentation, centrifuges and their uses, preparative ultracentrifuges, density gradient ,analytical ultra centrifuges, applications

06 Hours

7. Advanced Instrumental methods

LC-MS, GC-MS, HPTLC, SEM, Atomic Force Microscopy, transmission electron microscopy (TEM)

04 Hours

Text Books

1. Wilson K & Walker J., Principles and Techniques of Practical Biochemistry, 5th edition, Cambridge Univ. Press., 2000.
2. Rodney Boyer, Modern Experimental Biochemistry, 3rd edition, Pearson Education, 2002
3. Chatwal and Anand, Spectroscopy, Himalaya Publishing house-New Delhi, 2016

Reference Books

1. Willard H. W. & Meritt L. L, Instrumental methods for chemical analysis, 7th edition. CBS Publishers & Distributors, 2004
2. Chatwal and Anand, Instrumental methods for chemical analysis, Himalaya Publishing house, 2012

Program: Biotechnology		
Course Title: Bioprocess Engineering Lab		**Course Code: 15EBTP303**
L-T-P: 0-0-1.5	**Credits:1.5**	**Contact Hours: 3Hrs/week**
CIE Marks: 80	**SEE Marks: 20**	**Total Marks: 100**
Teaching Hours: 36	**Examination Duration: 03 Hours**	

List of Experiments:

1. Study of Lab fermenter
2. Determination of thermal death kinetics of microorganism.
3. Batch growth kinetics
4. Fed Batch kinetics
5. Determination of kinetic parameters of microorganism using batch mode.
6. Kinetics of product formation
7. Kinetics of substrate degradation
8. Design an experiment to determine mixing time and power requirement of fermenter
9. Determination of K_{La}
10. Solid state fermentation
11. Design an experiment to study the effect of mass transfer on microbial growth.

Text Books/Reference Books

1. Pauline M. Doran, Bioprocess Engineering Principles, 2, Academic Press, 2003
2. Stanbury & Whittaker, Principles of Fermentation Technology, 2, Pergamum Press, 2000

Laboratory Title: Minor Project	Lab. Code: 15EBTW302
Total Hours: 12	Duration of SEE Hours: 3
SEE Marks: 50	CIE Marks: 50

Experiment wise Plan

List of experiments/jobs planned to meet the requirements of the course.

Category: Open Ended		Total Weightage: 50.00		No. of lab sessions: 40.00
Expt./ Job No.	**Experiment / Job Details**	**No. of Lab Session(s) per batch (estimate)**	**Marks / Experiment**	**Correlation of Experiment with the theory**
1	Production of Protease/Amylase and study of effect of physico-chemical parameters	40.00	50.00	
	Learning Outcomes: The students should be able to: 1. Prepare the media and inoculum for enzyme production 2. Operate different instruments by using SOP 3. Analyze the effect of parameters on enzyme production 4. Conduct the statistical analysis of the results and correlate to the theortical concepts and principles 5. Work effectively in a group to fulfill the defined objectives 6. Write the technical report and present the results orally by using the media effectively			Minor project is related to the courses studied in 3rd, 4th and 5th semester

Year of offering: 2018-19
Batch- 2015-19 (7th semester)

Program: Biotechnology		
Course Title: Downstream Processing and Technology		**Course Code: 15EBTC401**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1.Introduction

Role and importance of downstream processing in biotechnological processes. Characteristics of biological mixtures, Process design criteria for various classes of byproducts (high volume, low value products and low volume, high value products), Steps involved, case studies

05 Hours

2. Primary separation techniques

Cell disruption methods for intracellular products, Removal of insoluble, Biomass (and particulate debris) separation techniques; Flocculation and Sedimentation, Centrifugation filtration methods.

09 Hours

Unit II

3. Membrane separation processes

Membrane – based separations theory; Design and configuration of membrane separation equipment; Concentration polarization and fouling – causes, consequences and control techniques; Applications: Reverse osmosis, Dialysis, Ultra filtration, Micro filtration **09 Hours**

4. Enrichment operations

Precipitation methods with salts, organic solvents, and polymers, Extraction methods for separations. Aqueous two-phase extraction, Supercritical extraction; In situ product removal / integrated bio-processing. **07 Hours**

Unit III

5. Product recovery I

Introduction to chromatography, Van Deemter equation**,** Reversed Phase Chromatography, Hydrophobic Interaction Chromatography, Ion Exchange Chromatography.

05 Hours

6. Product recovery II

Gel Filtration Chromatography, Affinity Chromatography, Polishing Operations: Crystallization, Drying **05 Hours**

Text Books:

1. Product Recovery in Bioprocess Technology - BIOTOL Series,VCH,1990
2. Bioseparations: Principles and Techniques by B. Sivasankar, 2005

Reference Books:

1. Separation Process Principles by J D Seader and Ernest J Henley, 1998.
2. Bioprocess Engineering by Shuler and Kargi Prentice Hall, 1992.
3. Separation Processes in Biotechnology by Asenjo J. and Dekker M, 1993.
4. Bioseparations by Belter P.A. and Cussier E., Wiley, 1985

Program: Biotechnology		
Course Title: Bioprocess Equipment Design		**Course Code: 15EBTC402**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit – I

1. Notation and terminologies

Pipe Joints: Flanged pipe joint, Hydraulic pipe joint, Gland & stuffing box expansion joint, Union joint, Socket & spigot Joint. Welded joints: Butt, Fillet, lap welded joint. Vessel openings: Manholes, nozzles, drains, sight Glasses. Pipe design: Basic notation and terminologies, Schedule 10 and 40. Introduction to design.

04 Hours

2. Materials of Construction

Material properties: Mechanical & types of Corrosion; Materials used: Stainless steel and their alloys, properties of different metals used in stainless steel, Selection criteria, Different Standards (Indian steel codes, American Society for Mechanical Engineers-Bioprocess Engineer (ASME BPE) standard, AISI (American Iron & Steel Institute) standard), different Stainless steel grade: 304, 316.

08 Hours

Unit – II

3. Design of Bioreactor

Fermenter: Steps involved in the design: Volume of Reactor, H/D ratio, impeller design, baffle design, shaft design, Thickness of the shell, thickness of the top & bottom Cover, thickness of jacket, heat transfer area of jacket, Power number**,** Power required to drive the Impeller.

09 Hours

4. Design of shell and tube Heat exchanger

Heat exchangers: Steps involved in the design, Energy balance, LMTD, Tubing characteristics, Tube side heat transfer coefficient, baffle spacing, shell side heat transfer coefficient, Fouling, Overall heat transfer coefficient, Tube side & shell side Pressure drop calculations.

09 Hours

Unit – III

5. Equipment qualification & Validation

Design qualification, FAT (factory acceptance test), Site acceptance test, Commissioning, Installation Qualification, Operational qualification, Performance qualification, Equipment validation.

05 Hours

6.Bioreactor Accessories

Sterilization by filters, Design criteria for filters, filter housing, Filter Integrity test: Diffusive air flow test, Bubble point test, Pressure drop test, Water intrusion test; Valves: Diaphragm valve, Pneumatic valve, pinch valve, Non-return safety Valve; Aseptic seals in fermenter (Gasket, Lip seal, O rings).

05 Hours

Text Books:

1. Chemical Engineering Design by R K Sinnott, vol-6, 4th edition, Butterworth-Heinemann, 2005.
2. Process Equipment Design by M. V. Joshi & V. V. Mahajani, 3rd edition, Macmillan India Ltd, 1996.

Reference Books:

1. Fermentation & Biochemical engineering handbook by H. C. Vogel & C. L. Todaro, 2nd edition, Standard publishers distributors.
2. Introduction to chemical equipment design by B. C. Bhattacharyya, 1st edition, CBS Publishers & distributors, 1985

Program: Biotechnology		
Course Title: Industrial Biotechnology		**Course Code: 15EBTE401**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1. Beverage products

Fermentative production Alcoholic beverages: Beer, Wine, Whisky.

05 Hours

2. Fermentation of food products

Cheese and types of cheese, biomass production (single cell protein, baker.s yeast), L-Glutamic Acid

05 Hours

3. Industrial Chemicals

Citric Acid, Ethanol, Lactic Acid, Acetone & Butonol

05 Hours

Unit II

4. Biomolecules

Microbial Flavors & fragrance, Amino acid production: Phenylanine, L-Lysine, Aspartic Acid

05 Hours

5. Enzymes

Amylases, Proteolytic enzymes, Pectinases, Lipases, Glucose Isomerase

05 hours

6. Biopharmaceuticals

Production of penicillin, Streptomycin, Cephalosporins

05 Hours

Unit III

7.a. Health Care Products:

Interferon's, Anticancer agents, Steroid fermentation

05 Hours

7.b. Health Care Products:

Insulin, Vaccines, Monoclonal Antibodies

05 Hours

Text Books:

1. L.E.Casida,JR ,Industrial Microbiology, New Age International (P) Ltd Publication.
2. Prescot and Dun, Industrial Microbiology, McGraw-Hill Book Company, Inc. New York

Reference Books:

1. D.Lanch,Drew,Wang, Comprehensive Biotechnology-Volume 3,Elsevier Publication.
2. George T. Austin, Nicholas Basta; Shreves Chemical Process Industries Handbook; McGraw Hill Professional, 1998

Program: Biotechnology		
Course Title: Food Processing Technology		**Course Code: 15EBTE402**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1. Fundamentals of Food Processing Technology

Basic concepts about properties of foods: liquid, solid and gases; Introduction to food processing: scope and significance; Principles of food processing and preservation

04 Hours

2. Microbial Food Spoilage

Food as substrate for microorganisms, Primary sources of micro organisms in foods, Microbes induced biochemical changes in foods, Microbiological Examination of foods , Food poisoning, and types. , A brief account of various organisms related with food poisoning- *E. coli, Clostridium, Bacillus, Staphylococcus and Vibrio*

.

07 Hours

3. Food biotechnology and Applications

Enzymes, organic acids, antibiotics, baker's yeast, single cell protein and Mushrooms. Biocolours, Concept of fermented foods and beverages, Probiotics, Prebiotics & Symbiotics, Genetically Modified Foods

04 Hours

Unit II

4. Unit Operations in Food Processing

Introduction, Food Engineering operations- raw material preparation, cleaning, sorting, grading and peeling. Food conversion operations- size reduction, emulsification, filtration, membrane separation, centrifugation and extraction. Pulsed Electric Field processing, High-Pressure Processing,

04 Hours

5. Thermal Processing of Foods

Heat processing using steam or water, Blanching, Pasteurization, Heat Sterilization, Evaporation, Distillation, Extrusion and Canning. dielectric heating, ohmic and infrared heating. Dehydration, Intermediate Moisture Foods, Baking and Roasting, Heat processing using hot oils- Frying.

06 Hours

6. Non-Thermal Processing of Foods

Chilling, Freezing, Freeze-drying, Vacuum Concentration, Processing by chemical methods- sugar, salt, curing, smoking, acid and chemicals. Irradiation of foods. Controlled and Modified–Atmosphere Packaging. Concept of hurdle technology. **05 Hours**

Unit III

7. Food Product Development

Concept and need of new product development, testing and sensory evaluation,Development of product formulation and development,, Role of food ingredients in human health Packaging and shelf life of food products. Concept of Functional Foods and Nutraceuticals.

05 Hours

8. Food laws, Labeling and Regulatory Bodies

Food Laws- General Standards and Regulations as per FSSAI, . Regulatory bodies governing food laws. Certification and labeling of foods. Concept of HACCP and AGMARK

05 Hours

Text Books:

1. P.J.Fellows, Food Processing Technology. Principles and Practices, Second Edition, Woodland Publishing Ltd,Cambridge,England,2002
2. Avantina Sharma, Text Book of Food Science and Technology, International Book Distributing Co, Lucknow, UP, 2006

Reference Books:

1. Ramaswamy H & Marcotte M. Food Processing: Principles and Applications. Taylor & Francis. 2006

Program: Biotechnology		
Course Title: Bioprocess Modeling and Simulation		**Course Code: 18EBTE401**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1.Introduction to modeling:

Introduction, Mathematical Modeling of Bioprocess Engineering System, General Aspects of the Modeling Approach, General Modeling Procedure: Fundamentals uses of mathematical model, scope of coverage, principles of formulation; Fundamental Laws of Modeling: continuity equation, energy equation with examples 05 Hours

2.Fundamental Laws of Modeling:

Equation of motion, transport equation, equation of state, phase and chemical equilibrium, chemical kinetics; Lumped and distributor parameters with examples 05 Hours

3. Mathematical models of Biochemical Engineering Systems:

Modeling of Batch reactors, modeling of CSTR, Numericals. Plug flow reactor, Fluidized bed

reactor, Reactors used in effluent treatments, packed bed reactor. 05 Hours

Unit II

4. Use of MATLAB in Process Simulation:

Basics-Data analysis-curve fittings, Numerical integration, Euler and fourth order RungeKutta method, Input and Output in MATLAB. Solving problems using MATLAB by numerical integration, Euler and fourth order Runge Kutta methods. Simulation of CSTR and Batch Reactor, Simulation of Plug flow reactor. 10 Hours

4.Introduction to Process Design:

Steps involved in process design, Process flow diagram structure and hierarchical approach, importance of Material and Energy balance, selection of unit operations,

05 Hours

Unit III

5.Introduction to process simulation software

Bioprocess design with example: Process Description, Specifying Process Sections, Specifying Equipment Sharing, Initialization of Reaction Operations, Process Analysis, Cost Analysis and Economic Evaluation, Environmental Impact.

05 Hours

6. Use of Super Pro in Process Simulation:

Components and mixtures, Physical and Chemical properties of components, material and energy balance simulation, adding unit operation, scheduling the unit process, process cost estimation, sizing of the unit operation.Case study: Monoclonal antibody production, Enzyme production

05 Hours

Text Books:

1.Luyben W.L., Process Modeling Simulation and Control for Chemical Engineers., McGraw Hill, 1988.

2. Pauline M. Doran, “Bioprocess Engineering Calculation”, Blackwell Scientific Publications.

Reference Books:

1. Kenneth J. Beers. “Numerical Methods for Chemical Engineering Applications in MATLAB®”, Massachusetts Institute of Technology, Cambridge University press 2007 edition.

2. Bailey and Ollis, “Biochemical Engineering Fundamentals”, 2 nd ed.,McGraw Hill, 1986.

Program: Biotechnology		
Course Title: Plant and Animal Biotechnology		**Course Code: 15EBTE403**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1. Introduction to plant tissue culture

Introduction and scope of plant tissue culture. Historical events in the development of plant tissue culture method. Practical applications and recent advances. Laboratory organization, Cell culture media and its components. Aseptic manipulation in plant tissue culture laboratory.

05 Hours

2. Methods and Techniques in Plant tissue Culture.

Callus and suspension culture, Micropropagation, Protoplast culture & Somatic Hybridization, Anther & Ovary Culture, Somatic Embryogenesis, Embryo & Endosperm culture, Somaclonal variation Germplasm storage by cryopreservation – pretreatment for cryopreservation, freezing, thawing, plant growth and regeneration and applications. **04 Hours**

3. Introduction to animal cell and tissue culture

History and Scope of Animal cell and Tissue culture, Advantages and Disadvantages of Cell culture, laboratory facilities for tissue culture. Culture media for cells and tissues. Laboratory layout, Essential equipments and Consumable items, Aseptic Techniques- elements of aseptic environment and culturing vessels Types of tissue culture – Primary cultures and Cell lines maintenance of cell line cultures **06Hours**

Unit II

4.Culture characterization and culture maintenance

Need for characterization, Parameters of Characterization, Cell Morphology, Confocal microscopy, DNA content analysis, Enzyme activity and Antigenic markers. Contamination in cell culture – sources, monitoring and eradication of contamination Cryopreservation and transportation. **04 Hours**

5. Animal Cell culture Scale up and Automation

Introduction to scale up and automation. Scale up in suspension culture: Continuous culture, Scale & complexities, Mixing & Aeration. Scale up in Monolayer culture: Multi surface propagators, Roller culture, Microcarriers, and Perfused Monolayer culture. Process control and Automation: Robotic cell culture and High throughput screening. **05 Hours**

6. Animal cell culture and Biopharmaceuticals production

Mammalian cells as desired expression systems for protein biopharmaceuticals, Construction and selection of high-producing cell lines, Medium development for mammalian cell culture, and Process development for mammalian cell culture. Single use disposable animal cell culture technologies for biopharmaceutical manufacturing. **06 Hours**

Unit III

7. Plant Cell culture and Secondary Metabolite production

Introduction, Selection of high yield cells and Mass cultivation of plant cells: Free cell suspension culture, Immobilized plant cell culture, and Two phase system culture. Elicitor induced accumulation of products. Biotransformation using plant cell cultures, Genetic modification and factors limiting large scale production of useful compounds. **05 Hours**

8. Animal cell culture applications and Tissue engineering

Hybridoma Technology and Animal cell culture applications in Monoclonal antibodies production. Products of Animal tissue culture – Erythropoietin, Tissue Plasminogen Activator & Factor VIII etc. Tissue Engineering – Introduction, Cell types, Extracellular matrix and Tissue engineering concepts. Artificial skin development by tissue engineering and its applications.

05 Hours

Text Books:

1. Introduction to Plant tissue culture Second edition. M K Razdan Oxford & IBH Publishing Co Pvt Ltd, New Delhi. 2003
2. Animal Cell Culture – Concept and Application by Sheelendra M Bhatt, Narosa Publishing House, New Delhi ISBN: 978-81-7319-926-4

Reference Books:

1. Introduction to Plant Cell, Tissue and Organ culture Sunil D Purohit PHI Learning Private Ltd, New Delhi 2013. ISBN – 978-81-203-4677-2
2. Culture of Animal Cells - A Manual of Basic Technique by R. Ian Freshney A John Wiley & Sons, Inc., Publication New York (2000)

Program: Biotechnology		
Course Title: Biopharmaceuticals		**Course Code: 15EBTE404**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1. Introduction:

Introduction to pharmaceutical industry, API and pharmaceutical products, Formulation Industry, Introduction to dosage forms, Biopharmaceuticals & Biotechnology, Biopharmaceuticals: Current status & future prospects. Drug discovery & development process, Sources of Biopharmaceuticals, Dosage forms and routes of drug administration.

06 Hours

2. Pharmacokinetic and Pharmacodynamics of Peptide & Protein Drugs:

Introduction to pharmacokinetics and pharmacodynamics, drug as agonist & antagonist, Pharmacokinetics of protein therapeutics, ADME study for small molecules & protein therapeutics, optimization of pharmacokinetic profile, Pharmacodynamics of protein therapeutics, PK/PD

Models.

10 Hours

Unit II

3. The Drug Manufacturing Process:

Pharmacopeias, good manufacturing practices (GMP), good laboratory practices (GLP), manufacturing facilities, clean rooms, water plant & grades of water, production of final product & formulation, analysis of final product (Qualitative & Quantitative), documentation: SOP, specifications & records, batch manufacturing records (BMR), batch packaging records (BPR).

08 Hours

4. Therapeutic Agents:

The cytokines (Interleukins & Interferons), haemopoetic growth factors (erythropoietin), hormones of therapeutic interest (insulin & glucagon), preservation and clinical use of blood products, therapeutic enzymes, monoclonal & polyclonal antibodies, vaccines and vaccine technology (with appropriate case studies).

08 Hours

Unit III

5. Quality in Pharmaceutical Industry:

Quality Assurance & Quality Control, validation & qualification studies, aseptic fill-process validation, cleaning validation, Validation Master Plan, Qualification: IQ, OQ and PQ. Calibration of analytical instruments.

04 Hours

6. Regulatory issues and Drug product approval

Drug approval process (NDA & ANDA), Regulatory framework: Quality, Safety & Efficacy, Biosimilars and follow-on biologics, FDA & its Organizational structure, European regulations, Drug Registration in Japan, World harmonization of drug approvals (The ICH).

04 Hours

Text Books:

1. Biopharmaceuticals: Biochemistry & Biotechnology. Author: Gary Walsh. Second Edition, 2011. Pub: John Wiley & Sons.
2. Pharmaceutical Biotechnology: Fundamentals and Applications. Ed: Daan J.A. Crommelin et al. Third Edition. Publisher: Informa Healthcare.

Reference Books:

1. Molecular Biotechnology: Principles & Applications of r-DNA. Author: Bernard Glick & Jack Pasternak. 2002. Pub: Panima Books.
2. Manual of Industrial Microbiology & Biotechnology by Arnold L. Demain. 1999 Pub: ASM Press.
3. Biopharmaceuticals: An Industrial perspective. Authors: Gary Walsh & Brendan Murphy. 2009. Pub: Spring Books.

Program: Biotechnology

Course Title: Bioprocess Plant Design and Economics		Course Code: 15EBTE406
L-T-P: 3-0-0	Credits: 3.0	Contact Hours: 03 Hours/Week
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 03 Hours	

Unit I

1. Introduction to Process Design Development

Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design, and comparison of different processes, Equipment design and specialization, factors affecting the investment. **06Hours**

2. General Design Considerations

Marketability of the product, availability of technology, Health and safety hazards, raw materials, human resources, loss prevention Environmental protection and utilities, site characteristics, plant location, plant layout, plant operation and control, utilities, structural design, storage, materials handling, materials and fabrication Selection, optimum design and design strategy. Waste disposal, physical treatment, chemical treatment and biological treatment, govt. regulations and other legal restrictions, community factors. Safety and hazard control measures.

10 Hours

Unit II

3. Cost Analysis and Manufacturing Cost

Cost Analysis: Factors involved in project cost estimation. Cash flow diagrams for the industrial operation, Cumulative cash position, factors affecting the Investment and production cost, Different methods employed for the estimation of the capital investment. Estimation of equipment cost by sixth tenth rule, Cost index. Marshall and swift installed – equipment indexes, Engineers News-Record construction index, Nelson –Farrar refinery construction index. and Chemical Engineering plant cost index Manufacturing Costs: Direct Production costs, indirect cost and fixed charges (including depreciation, taxes, insurance, rental costs etc.)

10 Hours

4. Bioprocess Economics:

Economic analysis for the production of following Products.(Historical Perspective, Fermentation Technology, Recovery of product and process economics of following products)

- High volume, low value products. (Citric acid, Ethanol and Amino acids etc)
- Medium volume, medium value products.(Antibiotics, Crude Enzymes and Vitamins etc)
- Low volume, high value products. (MAb, purified Enzymes and Therapeutic proteins etc)

06 Hours

Unit III

5. Profitability Analysis and Optimization Technique

i) Importance of profitability analysis in investment decision making. Different Methods for calculating the profitability. Minimum Acceptable Rate of return. Methods that Do not consider Time value of money. **04 Hours**

ii) General procedure to find the optimum conditions, factors affecting the optimization, comparison of analytical and graphical methods. Linear programming, Simultaneous Equations and dynamic programming **04 Hours**

Text Books:

1. Peters and Timmerhaus, Plant Design and Economics for Chemical Engineers, McGraw Hill 5th edition, 2004.
2. Chemical Engineering plant design, Frank C Vilbrandt and Charles E Dryden , McGraw Hill 4th edition, 1959

Reference Books:

1. Rudd and Watson, Strategy of Process Engineering, Wiley, 1987.
2. Backhurst, J.R And Harker, J. H - Process Plant Design, Heieman Educational Books, (1973).
3. Biochemical Engineering Fundamentals, James E Baily David F Oillis. McGraw-Hill 2nd Internatio Edition

Program: Biotechnology		
Course Title: Quality Assurance & Regulations		**Course Code: 18EBTE403**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1. Introduction

Introduction to Quality and Quality Regulation, Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP).

06 Hours

2. Quality and Quality Management

Terms Relating to Quality Management System, Quality Policy, Quality Objectives, Quality Planning, Quality Control, Quality Assurance, Quality Improvement, Continual Improvement, Effectiveness, Efficiency; Relating to Process and Product, Quality Characteristics; Terms Relating to Conformity, Non-Conformity, Defect, Preventive Action, Corrective Action, Rework, Repair, Scrap, Concession, Deviation Permit, Release; Terms Relating to Documentation.

10 Hours

Unit II

3. Process Validation

Definition and concept of validation, An introduction to process validation, Validation and Qualification, IQ, OQ and PQ. A Review of Prospective, Concurrent, Retrospective Validation Calibration and performance evaluation. Validation of Water & Thermal Systems, including HVAC Facilities & Cleaning Validation. Validation septic Processes, Computer software validation in pharmaceuticals (CSV).

10 Hours

4. Analytical Method Validation

FDA and ICH guidelines. Analytical method validation, Specificity, Linearity, Accuracy, Precision, Limits of detection (LOD) and quantification (LOQ), Minimum detectable amount (MDA), Sample stability and method robustness, System suitability, Statistical process control for HPLC, Troubleshooting out-of-control systems, Case studies, Validation of Analytical Methods.

06 Hours

Unit III

5. Quality Standards

Introduction, ISO 9000 Series of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, Control of Quality Records, Internal Quality Audits, Training, Servicing, Environmental Management System.

04 Hours

6. Implementation and Regulation

Role of QC and QA in Bio/Pharmaceutical organization, Quality System, Contract Review, Design Control, Document and Data Control, Product Identification and Traceability, Process Control, Control of Quality Records, Internal Quality Audits, Training.

04 Hours

Text Books:

1. Pharmaceutical Process Validation by Robert Nash and Alfred Wachter, Marcel Dekker. Publisher: Marcel Dekker Inc. 2011.
2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From Manufacturer to Consumer, Sidney J. Willig, Publisher: Marcel Dekker Inc. 2005.

Reference Books:

1. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker, 2008.
2. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance in the Pharmaceutical, Medical Device, and Biotech Industries, Syed Imtiaz Haider, Saint Lucie Press, 2004.

Program: Biotechnology		
Course Title: Downstream Processing Technology Lab		**Course Code: 15EBTP401**
L-T-P: 0-0-1	**Credits: 1.0**	**Contact Hours: 02 Hours/Week**
CIE Marks: 80	**SEE Marks: 20**	**Total Marks: 100**
Teaching Hours: 24	**Examination Duration: 03 Hours**	

List of Experiments

1. Cell disruption technique: Sonication.
2. Solid-liquid separation method: Filtration.
3. Solid-liquid separation methods: Centrifugation.
4. Product enrichment operations: Two – phase aqueous extraction.
5. Isoelectric precipitation of proteins
6. Membrane Separation methods: Tangential Flow Filtration
7. Chromatography techniques: Gel exclusion chromatography
8. Chromatography techniques: Ion exchange chromatography
9. Determination of protein molecular weight: SDS-PAGE
10. Estimation of metabolite using high performance liquid chromatography

Text Books/ Reference Books:

1. Bioseparations: Principle & Technique; Shiv Shankar B.; PHI LEARNING PRIVATE LIMITED;2009
2. Bioseparations: Downstream Processing for Biotechnology; Paul A. Belter E. L. Cussler Wei-Shou Hu; WILEY INDIA PVT. LTD.-NEW DELHI; 2011
3. Separation Processes in Biotechnology; Juan A. Asenjo; CRC Press (28 June 1990).
4. Protein Purification : Principles and Practice; Robert K Scopes;Springer; 2010 December

Year of offering: 2018-19
Batch- 2015-19 (8th semester)

Program: Biotechnology		
Course Title: Biological Data Analysis		**Course Code: 18EBTE402**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1.Introduction to Basic statistics:

Strategy of Experimentation, History of the Design of Experiments, Basic Principles of DOE: Randomization, Replication, Blocking, Multi-factor Designs, Confounding; Steps for Planning, Conducting and Analyzing an Experiment, Typical applications of Experimental design, Basic Principles, Guidelines for Designing, Concepts of random variable, probability, density function,cumulative distribution function. Concept of confidence level. Statistical Distributions: Normal, Log Normal &Weibull distributions. Hypothesis testing, Probability plots.

04 Hours

2. Screening Design:

Introduction, Terminology: factors, levels, interactions, treatment combination, Orthogonal array, PB design, analysis of PD design, Numericals. **05 Hours**

3.Full Factorial Design:

Basic Definitions and Principles, The Advantage of Factorials, The Two-Factor Factorial Design, Statistical Analysis of the Fixed Effects Model, Model Adequacy Checking, Estimating the Model Parameters, Concept of the General Factorial Design, 2^k Factorial Design, The 2^2Design, The 2^3 Design, The General 2^k Design. **07 Hours**

Unit II

4. Response surface methods:

Introduction, Central composite design, Box Behnken design, importance of counter and surface plots. **05 Hours**

5. R Programming Basics:

Overview of R programming, Environment setup with R Studio, R Commands, Variables and Data Types, Control Structures, Vectors, Factors, Functions, Matrices, Arrays and Lists. **06 Hours**

6. Interfacing:

Interfacing R to other languages, Parallel R, Basic Statistics: Linear Model, Generalized Linear models, Non-linear models, Time Series, Autocorrelation and Clustering**.** **05 Hours**

Unit III

7. Introduction to Bioconductor for Sequence Data:

Sequencing Resources, Ranges Infrastructure, DNA /amino acid sequence from FASTA files, Reads from FASTQ files, Aligned Reads from BAM files, Called Variants from VCF files, Genome Annotations from BED, WIG, GTF files. **04 Hours**

8. Biological Data Analysis:

Preparing count matrices, The DESeq, DataSet, sample information, and formula design, exploratory analysis and visualization, Differential expression analysis, Plotting results, Annotating and exporting results **04 Hours**

Text Books:

1. R for Everyone: Advanced Analytics and Graphics: b y Jared P. Lander Addison Wesley Data & Analytics Series, 2013.

2. Design and analysis of experiments" by D.C. Montgomery, 7th edition John Wiley and sons, NewYork

Reference Books:

1. A Little Book of R for Bioinformatics: by Avril Coghlan, Release 0.1

2. Das. M.M. and Giri N.C. : - Design and Analysis of Experiments

Program: Biotechnology		
Course Title: Nano Biotechnology		**Course Code: 17EBTE401**
L-T-P: 3-0-0	**Credits: 3.0**	**Contact Hours: 03 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 03 Hours**	

Unit I

1. Introduction to Nanobiotechnology

Historical background, nature, scope and content of the subject, multidisciplinary aspects, industrial, economic and societal implications of Nanotechnology. Nanolithography, Nanofabrication, Bottom-Up versus Top-Down approaches. **08 Hours**

2. Nanomaterials and Nanostructures

Buckyballs, Nanotubes, Fullerenes, Magnetic systems, Carriers, Dendrimers, Nanoparticles, Membranes &Matrices, Nanoshells, Quantum Dot, Nanocrystals, hybrid biological: inorganic devices, Other Biological Nanostructures **06 Hours**

Unit II

3. Characterization of Nanoparticles and Nonmaterial - I

Optical methods, Electron microscope, Scanning tunneling microscopy, Transmission Electron Microscopy, Atomic force microscopy, XRD, etc. **07 Hours**

4. Characterization of Nanoparticles and Nonmaterial - II *In-vitro* laboratory tests on the interaction of nanoparticles with cells. Assessment of the toxic effects of nanoparticles based on *in-vitro* laboratory tests. Identification of pathogenic organisms by magnetic nanoparticle-based

techniques **07 Hours**

Unit III

5. Nanobiology

Biosynthesis of nanoparticles by microbes/plants, self assembly, interaction between biomolecules and nanoparticles, hybrid-nano bio assemblies, nano-probes and nano-devices, Analytical applications. **06 Hours**

6. Applications of Nanobiotechnology

Molecular Nano-machines, Nanobiotechnology and drug discovery and delivery, Nanodiagnotics, Nanorobots, Molecular Motors. Health risks and challenges **06 Hours**

Text Books

1. Biological molecules in Nanotechnology by Stephen Lee and Lynn M Savage
2. Nanobiotechnology Protocols, Rosenthal, Sandra J and Wright, David W., Humana Press, 2005

Reference Books

1. Nanotechnology in biology & medicine by tuan vo-dinh, Taylor Francis.
2. Nanotechnology By M. KARKARE (2008), IK Intl. Publishers

Program: Biotechnology		
Course Title: Project Work		**Course Code: 15EBTW402**
L-T-P: 0-0-14	**Credits: 14**	**Contact Hours: 42 Hours/Week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hours: NA	**Examination Duration: 03 Hours**	

Preamble:

The engineering graduate's capstone project is an essential part of the curriculum structure which integrates all the skills acquired during all the theory and laboratory courses addressing Bioprocess Engineering and Molecular Biotechnology verticals. The capstone project work requires exhaustive literature survey to define the problem statement and research objectives. Various optimization strategies help the student to select the best alternative and feasible solution. Capstone project emphasizes on solving real time problems depicting societal benefits and industrial applications. Students gain hands on experience during their capstone Project implementation. Projects also facilitate students to present their work on different platforms likes seminars, national and international conferences. Capstone project help students in their jobs opening and higher studies as well in higher research careers.

Guidelines:

1. Project has to be carried out in teams.
2. Every team needs to maintain laboratory work book which contains details of all the work carried out in the laboratory.
3. Make entries in log books for instrument usage.
4. Adhere on timely report submission to the coordinator.
5. Provide requisitions hand before for any project work

Review committee:

Review committee is formed by the project coordinator taking into consideration each review committee has faculty experts of all the domains. Review committee consists of the guide of the respective project group also.

Project evaluation:

Sl. No	Phase	Marks	Review
1	Definitive Phase	25	Guide/s
2	Final submission	25	Committee
3	SEE	50	External
	TOTAL	100	

Program: Biotechnology		
Course Title: Project Work		**Course Code: 20EBTW402**
L-T-P: 0-0-11	**Credits: 11**	**Contact Hours: 33 Hours/Week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: NA	**Examination Duration: 03 Hours**	

Preamble:

The engineering graduate's capstone project is an essential part of the curriculum structure which integrates all the skills acquired during all the theory and laboratory courses addressing Bioprocess Engineering and Molecular Biotechnology verticals. The capstone project work requires exhaustive literature survey to define the problem statement and research objectives. Various optimization strategies help the student to select the best alternative and feasible solution. Capstone project emphasizes on solving real time problems depicting societal benefits and industrial applications. Students gain hands on experience during their capstone Project implementation. Projects also facilitate students to present their work on different platforms likes seminars, national and international conferences. Capstone project help students in their jobs opening and higher studies as well in higher research careers.

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Project evaluation:

Sl. No	Phase	Marks	Review
1	Definitive Phase	25	Guide/s
2	Final submission	25	Committee
3	ESA	50	External
TOTAL		100	