UNIT OPERATIONS-1

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	15BT32	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students

- To the fundamental concepts of fluid statics and fluid dynamics.
- To train them to solve engineering problems related to fluid transportation and metering.
- To understand design concepts of fluid flow and particulate technology.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE -1 **FLUID MECHANICS CONCEPTS** Fluid statics and its applications-Hydrostatic equilibrium, Barometric equation, manometers, continuous gravity and centrifugal decanter. Fluid flow Phenomena-Rheological behavior of fluids, viscosity and momentum flux, turbulence, deviating velocities in turbulent flow, Reynolds stress and eddy viscosity, boundary layers. Basic equations of fluid flow-Continuity and Bernoulli equations, corrections for Bernoulli equation, pump work in Bernoulli equations.	**10 Hours**	**L1, L2,L3**
MODULE -2		
FLOW IN PIPES AND CHANNELS Incompressible flow in pipes and channels-shear stress and skin friction in pipes, laminar flow in pipes and channels, Hagen-Poiseuille equation, laminar flow of non-Newtonian liquids, laminar flow in annulus, turbulent flow in pipes and channels, friction factor chart, friction from changes in velocity or direction. Flow of compressible fluids-Basic equations, isentropic flow through nozzles, adiabatic frictional flow, isothermal frictional flow.	**10 Hours**	**L1, L2,L3,L4**
MODULE -3		
TRANSPORTATION AND AGITATION Flow past immersed objects: drag and drag coefficients, flow through beds of solids, Kozeny-Carman and Burke-Plummer equations. Motion of particles through fluids-terminal velocity, criteria for settling regime, fluidization. Transportation and metering of fluids-pipes, fittings and valves, positive-displacement and centrifugal pumps, fans, blowers and compressors, venturi and orifice meters, Rotameter, pitot tube, notches. Agitation and mixing of liquids-agitated vessels, standard turbine design, flow number, power correlations, blending and mixing, dispersion operations, agitator selection and scale-up.	**10 Hours**	**L1,L2,L3,L4**
MODULE -4		
PARTICULATE SIZE REDUCTION AND SEPARATION Properties and handling of particulate solids-characterization of solid particles, average particle size, screen analysis. Mixing of solids-mixers for non-cohesive and cohesive solids. Size reduction- characteristics of comminuted products, crushing laws and work index. Equipment for size reduction-crushers, grinders, hammer mills and impactors, roller mills,	**10 Hours**	**L1, L2, L3, L4**

attrition mills, tumbling mills, ultrafine grinders. Mechanical separations-screening, screening equipment.		
MODULE -5		
FILTRATION EQUIPMENT Filtration-cake filters, filter press, shell-and-leaf filters, rotary drum filters, centrifugal filters, filter media and filter aids. Principles of cake filtration, pressure drop through filter cake, constant pressure filtration, continuous filtration, constant rate filtration, clarifying filters, cross flow filters-membrane filters. Gravity sedimentation process-differential settling methods, clarifiers and thickeners, flocculation, batch sedimentation, equipment for sedimentation-thickeners, clarifier and thickener design, centrifugal sedimentation process- cyclones, tubular centrifuge, disc centrifuge, principles of centrifugal sedimentation.	**10 Hours**	**L2, L3**
Course outcomes: After studying this course, students will be able to: • State and describe the nature and properties of the fluids. • Study and design different flow measuring instruments. • Study and understand the principles of various size reduction and conveying Equipment. • Evaluate the energy requirements for various mechanical operations. • Design settling & sedimentation tanks, agitating vessels & mixing tanks.		
Graduate Attributes (as per NBA): • Engineering Knowledge. • Problem Analysis. • Design / development of solutions.		
Question paper pattern: • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. • The students will have to answer 5 full questions, selecting one full question from each module.		
Text Books: 1. Unit Operations of Chemical Engineering by Warren L. McCabe, Julian C. Smith and Peter Harriott, McGraw Hill Education (India) Edition 2014. 2. Transport Process Principles and Unit Operations by Christie Geankoplis, Prentice Hall of India. 3. Fluid Mechanics by K L Kumar, S Chand & Company Ltd.		
Reference Books: 1. Engineering Fluid Mechanics by Kumar K.L., Eurasia Publishing House (P) Ltd., New Delhi, 1984. 2. Chemical Engineering by Coulson and Richadrson, J.F., Vol-I, 5^{th} ed., Asian Books (P) Ltd., New Delhi, 1998. 3. Introduction to Chemical Engineering by Badger W. I. and Banchero J. T., Tata McGraw Hill, New York, 1997		

BIOCHEMISTRY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	15BT33	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students

- To learn basic principles of biochemistry occurring at cellular and molecular level in living organisms.
- To understand cross-functional nature of biochemistry in life sciences, food, agriculture, pharma, medicine.
- To apply the concepts at lab level.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE -1 **BASIC CONCEPTS & BIOMOLECULES** Types of chemical reactions, pH, buffers and their properties, concentration of solutions. Stereo chemistry of carbon compounds. Carbohydrates, fats and lipids, structure and properties of phospholipids, glycolipids, steroids, amino acids and proteins. Classes of Enzymes with examples. Biologically important peptides, purines, pyrimidines, nucleic Acids- DNA and RNA.	**10 Hours**	**L1, L2**
MODULE -2		
BIOENERGETICS Energy, energy flow cycle, energy conversion. Structure and properties of ATP. High energy compounds, Thermodynamic considerations, coupling reactions of ATP and NDP (Nucleotide di phosphate); photosynthesis, light reaction, dark reaction, ancillary Pigments, Photosystems PS I & II.	**10 Hours**	**L1, L2,L4**
MODULE -3		
TRANSPORT MECHANISM Biological membranes: structure, permeability, properties, passive transport and active transport, facilitated transport, energy requirement, mechanism of Na^+ / K^+, glucose and amino acid transport. Organization of transport activity in cell. Action Potentials. Role of transport in signal transduction processes.	**10 Hours**	**L1, L2, L3**
MODULE -4		
METABOLISM OF CARBOHYDRATES AND LIPIDS Glycolysis –metabolism. Aerobic and anaerobic pathway and regulation, TCA cycle, NADPH Cycle, Glyoxylate cycle, Pentose Phosphate Pathway. Electron transport chain and oxidative phosphorylation, energetics, energy balance sheet, oxidative stress. Gluconeogenesis – regulation of gluconeogenesis. Biosynthesis of polysaccharides. Disorders of carbohydrate metabolism. Biosynthesis of fatty acids, cholesterol, phospholipids, glycolipids. Biodegradation of triglycerides and fatty acids. Disorders of Lipid metabolism.	**10 Hours**	**L1, L2, L3, L4**
MODULE -5		

METABOLISM OF AMINO ACIDS & NUCLEIC ACIDS Biosynthesis and catabolism of essential amino acids: Lysine, Phenylalanine and Glutamine. Deamination, transamination and urea cycle. Disorders of amino acid metabolism. Metabolism and regulation of Purines, pyrimidine and precursors of nucleic acids (nucleosides & nucleotides).Disorders of nucleic acid metabolism.	**10 Hours**	**L1,L2, L3**

Course outcomes:

After studying this course, students will be able to:

- Know about bio molecules
- Understanding basic metabolic pathways
- Understand metabolic disorders

Graduate Attributes (as per NBA):

- Lifelong learning.
- Problem Analysis
- Societal concern.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Principles of Biochemistry by Albert Lehninger, CBS publishers
2. Biochemistry by Nelson and Cox, Palgrave Macmilan, Freeman Edn.
3. Principles of Biochemistry by Lubert Stryer, Freeman Int. Edition
4. Biochemistry by Mathews, Vanholde & Arhen, Pearson Education.
5. Biochemistry by Garett & Grisham Thompson Learning.
6. Bioenergetics by L Eruster, Greena Publishing Associates.
7. Fundamentals of Biochemistry by Dr.J.L.Jain, Sunjay Jain and Nitin Jain, S.Chand Publishers.

Reference Books:

1. Biochemistry by Voet &Voet, Wiley New York.
2. Biochemistry by Trehan. K, New Age International.
3. Biochemistry & Molecular Biology by Elliot, William H., Oxford University Press.
4. Biochemistry of cell signaling by Helmreich, Oxford University Press.
5. Bioorganic Chemistry by Hermann Dugas, Spinger.
6. Biochemistry by U Sathyanarayana, Books & Allied Publishers.
7. Biochemistry & Molecular Biology y Elliott & Elliott, Oxford Press Publishers, 4th Edition.
8. A textbook of Biochemistry for medical students by Rafi.M.D, 2nd edition, University Press.

MICROBIOLOGY

Foundation course

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	15BT34	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students

- To learn the details of classification, structural features and functional aspects of prokaryotic and eukaryotic microorganisms.
- To gain insights into microbial metabolism and metabolic pathways.
- To understand the details of microbial techniques for growth, cultivation and characterization of microorganisms.
- To appreciate the recent developments in the area of medical microbiology, environmental microbiology, industrial microbiology, etc.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE -1 **INTRODUCTION TO MICROBIOLOGY AND STUDY OF MICROORGANISMS** Scope of microbiology, History of microbiology, Origin of life, Prokaryotes and Eukaryotes. Microbial Diversity and Taxonomy. Structure, Classification and Reproduction of bacteria, Fungi, Viruses, Protozoa and Algae. General features of Prions, Spirochetes, Actinomycetes and Rickettsiae.	**10 Hours**	**L1, L2**
MODULE -2		
METHODS AND TECHNIQUES IN MICROBIOLOGY Microscopy: Concepts, Light, Electron, Phase Contrast, Acoustic Microscopy, camera Lucida and Micrometry. Media preparation, types of media, Culture methods, pure culture techniques, Staining Techniques. Sterilization & disinfection.	**10 Hours**	**L1, L2,L3**
MODULE -3		
MICROBIAL GROWTH AND METABOLISM Growth curve patterns, Physical conditions required for growth. Metabolism; Primary and Secondary metabolites with examples, metabolic pathways important in Microorganisms-Respiration and Fermentation.	**10 Hours**	**L1, L2, L3**
MODULE -4		
MEDICAL MICROBIOLOGY Introduction to Medical Microbiology, Common diseases caused by microbes: Bacterial diseases: Typhoid, Diphtheria, Cholera, Tuberculosis, Leprosy, Plague, Syphilis, Gonorrhea; Viral diseases: Herpes, Polio, Hepatitis, AIDS, Rabies, SARS and H1N1; Protozoan diseases: Malaria: common types of fungal infections.	**10 Hours**	**L1, L2, L3, L4**
MODULE -5		
SOIL, ENVIRONMENTAL & INDUSTRIAL MICROBIOLOGY Soil Microbiology: Soil micro flora and biogeochemical cycles. Bio fertilizers: VAM and Rhizobium. Atmospheric Microbiology: Aerobiology and allergy. Air sampling	**10 Hours**	**L2, L3,L5**

principles and types of samplers, Selective media for air sampling, significance of aerobiological studies. Aquatic Microbiology: Marine micro flora, fresh water microflora, Microbiology of potable water, Purification, Sewage disposal, Microbes in Bioremediation. Industrial Microbiology: Production of antibiotics (penicillin), Organic acids (citric acid), Enzymes from Microbes (proteases). Production of Vitamin B_{12}.		

Course outcomes:

After studying this course, students will be able to:

- Describe the structure and function of typical prokaryotic and eukaryotic cell structure like bacteria, algae, yeast & molds, protozoa, viruses, etc.
- Understand the techniques used for the isolation, growth, identification, disinfection and sterilization of microorganisms.
- Define the role of microorganisms towards environmental protection, industrial applications and infectious diseases.
- Out-line industrial fermentation processes leading to the production of antibiotics, organic acids, enzymes, vitamins and therapeutic products.

Graduate Attributes (as per NBA):

- Problem Analysis.
- Societal and environmental concern.
- Innovation and entrepreneurship

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. General Microbiology by Roger Y Stanier, John L Ingraham, and Mark L Wheels, Macmillan Press Ltd.
2. Microbiology by Michael J Pelczar Jr Chan ECS, Noel R Krieg, Tata McGraw Hill Publishing co ltd.
3. Microbiology by Prescott, Harley, Klein, McGraw Hill.
4. Industrial Microbiology by Samuel C Prescott, Cecil G Dunn, Agro bios (India)
5. Palynology and its applications By Shripad N.Agashe, Oxfor and IBH publishing Pvt. ltd
6. Biotechnological Applications of Microbes by Edite-Ajit Verma, IK Intl. Pub House.
7. Alcamos Fundamentals of Microbiology by Jeffery C Pommerville, Jones and Bartlett Publishers.
8. Microbiology, an Introduction, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, 2012. Pearson
9. Principles of Microbiology: Ronald M Atlas, 1995.McGraw-Hill Inc., US (addition)
10. Microbiology: Principles and Explorations, Jacquelyn G. Black, 8thEdition, John Wiley & Sons,2012
11. Roger Y Stanier, John L Ingraham, and Mark L Wheelis- General Microbiology, 5th Edition- Macmillan Press Ltd.
12. Jacquelyn G. Black - Microbiology: Principles and Explorations, 8th Edition, John Wiley & Sons.

Samuel C Prescott, Cecil G Dunn- Industrial Microbiology, 1st Edition- Agro bios (India

Reference Books:

1. THE AIR SPORA: A manual for catching and identifying airborne biological particles. Maureen E. Lacey and Jonathan S. West. Springer
2. Soil Microbiology by NS Subba Rao, Oxford and IBH.
3. Palynology and its applications By Shripad N.Agashe, Oxfor and IBH publishing Pvt. ltd
4. Text Book of Microbiology by Anantahnarayan and Jayaram Panicker, Universities Press.

5. Gerard J. Tortora, Berdell R. Funke, Christine L. Case- Microbiology: An Introduction, 11th Edition- Pearson publications.
6. Michael J Pelczar Jr Chan ECS, Noel R Krieg- Microbiology: Concepts and Applications, 5Th edition- Tata McGraw Hill Publishing Co ltd.
7. Jeffery C Pommerville- Alcamos Fundamentals of Microbiology, 9th Edition- Jones and Bartlett Publishers.
8. A Textbook of Microbiology by Dr.R.C.Dubey and Dr.D.K.Maheshwari, S.Chand Publishers.

CELL BIOLOGY AND GENETICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	15BT35	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students

- To gain basic concepts of cell biology and genetics.
- To understand cellular processes, pathways occurring at cellular level in living organisms.
- To learn and apply the Fundamental aspects of genetics in biotechnology.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE -1 **CYTOSKELETON** Eukaryotic and prokaryotic cells, Plant and animal cells, brief mention of membrane organization. Cytosketal elements, Microtubules: structure & functions, shaping of the cells and mechanical support. Microfilaments: structure & functions. Structure of intermediate filaments. Cytoplasmic micro trabecular system (lattice). Covalent modifications of cytosketal proteins. Cytoskeletal architecture.	**10 Hours**	**L1, L2**
MODULE -2		
CELL STRUCTURE AND FUNCTION Mitosis and Meiosis. Structure of cytoplasm, Nucleus, Mitochondria, Ribosome, Golgi bodies, Lysosomes. Endoplasmic Reticulum, Peroxisomes, Chloroplast and Vacuoles. Cell to cell integration, Cell locomotion (Amoeboid, Flagella, Cillar).Types of cell functions, cell division. Apoptosis and Ageing.	**10 Hours**	**L1, L2**
MODULE -3		
GENETICS Nature of genetic material, Mendelian Laws of inheritance, monohybrid and dihybrid inheritance, law of segregation & independent assortment, Gene interactions, supplementary genes - Comb patterns in fowls, Complementary genes - Flower color in sweet peas, Epistasis- Inhibitory and colored genes in fowls, simple problems. Identification of genetic material, classical experiments- Hershey & Chase, Avery, McLeod etc., Multiple alleles and groups antigens. Numericals based on concepts.	**10 Hours**	**L1, L2, L3,L4**
MODULE -4		
CHROMOSOMES STRUCTURE AND ORGANIZATION & POPULATION GENETICS Chromosome, Centrosome, telomere, Chemical composition of chromatin, structural organization of nucleosomes, heterochromatin. Polytene and lamp-brush chromosomes, human chromosomes. Introduction, Gene frequency, and equilibrium estimation, changes in gene frequency, inbreeding and heterosis, genetic structure of population, speciation and evolution, prospects for the control of human evolution. Spontaneous and induced mutations, Eugenics. Pedigree analysis.	**10 Hours**	**L1, L2, L3, L4**

MODULE -5		
SEX CHROMOSOMES AND INHERITED DISEASES The organ of heredity, chromosomes, morphology, classification. Sex determination in plants, animals XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types in animals. Chromosomal disorders. Sex linked inheritance molecular diseases, hemoglobinpathies. Disorders of coagulation, Color blindness, hemophilia, Non-disjunction as a proof of chromosomal theory of inheritance, Linkage maps, crossing over. Chromosomal maps, interference coincidence.	**10 Hours**	**L2, L3L5**

Course outcomes:

After studying this course, students will be able to:

- To gather contemporary knowledge of cell biology & genetics
- To be able to understand the basis of inherited disorders.

Graduate Attributes (as per NBA):

- Problem Analysis.
- Societal and environmental concern.
- Life-long learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Cell Biology by Kimbal, Willey Pub.
2. Cell Biology by S C Rastogi, New Age International Pub.
3. Genetics by Monroe W Strickberger, Macmillan Pub. Newyork.
4. Principles of Genetics by Gardener, Simmons and Slustad. Wiley Pub.
5. Principles of Gene manipulation and Genomics by Primrose, Oxford University Press.
6. Genetics W Strick by Monroe, Macmillan Publication
7. Cell Biology by T.Devasana, Oxford Press publishers.

Reference Books:

1. Molecular Cell Biology by Darnell, and Baltimore, Freeman Pub.
2. Molecular Aspects of Cell Biology by Garret and Grisham. Cengage Learning.
3. Cellular & Biochemical Science by G. Tripathi, I K Intl.
4. Genes and Genomes by M Singer, and P Berg, Blackwell Scientific Pub.
5. Developmental Genetics by Gurbachan s & Miglani, I K Intl. Pub.
6. Problems on Genetics, Molecular Genetics and Evolutionary Genetics by Pranab Kr. Banerjee, New Central Book Agency.

HUMAN PHYSIOLOGY
(Elective Subject)
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject Code	15BT361	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students

- To gain insight into human physiology with respect to its structure and function.
- To understand the disorders associated with various physiological systems.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE -1 **SKELETAL & MUSCULAR SYSTEM** Cartilage and bone; Comparison between cartilage and bone; Functions of skeletal system; Joints; Muscles of limb movement. Principal types of muscles; General properties of muscles; Mechanism of muscle contraction and relaxation, Red and white muscle fibers; related disorders.	**08 Hours**	**L1, L2,L3**
MODULE -2		
CIRCULATORY SYSTEM Structure, Composition and functions of blood. Blood Groups and Rh factor**.** Hematopoiesis. Immunity and antibody formation. Heart and Blood vessels, Arterial and Venous system. Properties of Heart Muscle. Action of Heart and Heart Beat. Blood Pressure. Lymph and Lymphatic system; related disorders.	**08 Hours**	**L1, L2,L3**
MODULE -3		
DIGESTIVE SYSTEM & RESPIRATORY SYSTEM Overview of digestive system, functional anatomy of digestive system: mouth, pharynx, esophagus, the stomach the small and large intestine. Digestive glands, Enzymes; Physiology of Digestion and Absorption. Energy requirements of the body; related disorders. . Introduction to respiratory system; structure of respiratory organs; Mechanism of breathing; Pulmonary air volumes, Gas exchange in the lungs; respiratory adjustments in exercise, Artificial respiration; Kinds of respiration; Transport of respiratory gases in the blood; Cellular respiration; Respiratory quotient; Some respiratory disorders; Control of respiration.	**08 Hours**	**L1, L2, L3**
MODULE -4		
EXCRETORY SYSTEM & REPRODUCTIVE SYSTEM Methods of excretion; Physiological processes involved in excretion; Kidneys; Anatomy and physiology, Nephron and its structure. Functions of nephron; Nephron physiology and mechanism of urine formation; Regulation of urine formation; Osmoregulation by kidney. related disorders. Physiology of male and female reproduction systems, invitro fertilization, fertility in males and females, factors influencing fertility, test tube baby,	**08 Hours**	**L1, L2, L3**

sperm count preservation of sperms.		
MODULE-5		
NERVOUS SYSTEM & ENDOCRINE SYSTEM Introduction; Role of nervous system; Generalized neuron; Morphological types of neurons; Physiological or functional types of neurons; Main properties of nervous tissue; Stimulus; Mode of action of nerves; Conduction of nerve impulses; Reflex action; Central nervous system; The brain; The spinal cord; Peripheral nervous system and reflux activity; related disorders. Introduction to Endocrine system; Endocrine systems of vertebrates; Pituitary gland; Thyroid gland; Parathyroid gland; Pancreas; Adrenal or suprarenal glands; Sex glands; Gastrointestinal mucosa; Thymus gland; Pineal gland; Summary of different endocrine glands; their hormones and influence; Summary of the effect of hyper secretion and hyposecretion of some important endocrine glands; related disorders.	**08 Hours**	**L1,L2, L3**

Course outcomes:

After studying this course, students will be able to:

- To understand the physiological processes of the human body and to gather new information on different organ systems.

Graduate Attributes (as per NBA):

- Problem Analysis.
- Professional Ethics
- Societal concern.
- Lifelong learning

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Textbook of medical physiology by Arthur C Guyton, Saunders College Publishing.
2. Ross & Wilson's Anatomy and Physiology in Health and Illness – by Anne Waugh and Allison Grant, Churchill Livingstone Publications.
3. Essentials of Medical Physiology - by K. Sembulingam and Prema Sembulingam, Jaypee Publications.
4. Text book of Human Physiology by Chakraborthy & Ghosh, Paramount Pub.
5. Seeley-s Fundamental of Human Anatomy and Physiology by Cinnamon Vanputte and Jennifer Regan. McGraw Hill Education publisher

Reference Books:

1. Human Anatomy & Physiology by Marieb, Pearson Education.
2. Concise Medical Physiology- by Sujit K. Chaudhuri, New Central Book Agency Pvt. Ltd.
3. Mader's Understanding Human Anatomy and Physiology by Susannah N Longenbaker McGraw Hill Education publisher
4. A Handbook of Basic Human physiology by Dr.H.D.Singh, S.Chand Publishers, 1st Edition.

BASICS OF COMPUTER APPLICATIONS

(Elective Subject)

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	15BT362	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students

- To gain knowledge about the different languages
- To gain the functioning and understanding the usage of internet, use of HTML in web-based designing
- To learn and implement different languages in biological applications
- To use of ontology for effective representation of data

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE -1 **LINUX & XML** Introduction to Linux, basic commands, working with files, file attributes, installing programs using rpm, working with basic editors sed, awk and vi, using the shell, pipes, wildcards, checking processes, killing processes, basic decision making statements: if...then.... else...if - test - while...do...done - until...do...done - for...in..Do...done - case...in...esac - select...in...do., basic regular expressions, using grep command, string search applications using regular expressions. Structured and unstructured data, XML fundamentals, XML documents and XML files, elements and character tags, attributes, XML names, CDATA sections, XML declarations, DTD, element declarations, attribute declarations, namespaces, programming applications of XML; General features of NCBI's Molecular biology data model, BioXML, NeuroML, Chemical Markup Languages (CML), Microarray ML(MAML), RiboML and SBML.	**08 Hours**	**L1, L2**
MODULE -2		
INTERNET and DATABASE MANAGEMENT Internet Addresses, Internet Protocol, Transport layer, Upper layer protocols, Internet access and applications. Overview of HTML and HTTP; Web servers, Web access, Security, WWW (World Wide Web) proxies, HTML applications related to biotechnology. Novell's WWW service, Web based applications, Biology search engines, legal and ethical issues. Introduction to flat files, DBMS and RDBMS, E-R relationship, Introduction to SQL, basic commands, using SQL in MS Access, creating and modifying tables, joining tables, simple queries using SQL, inner join, outer joins.	**08 Hours**	**L1, L2,L3**
MODULE -3		
ONTOLOGIES and MATLAB Overview of ontologies, gene ontologies, Open biological ontologies (OBO) and its applications, TAMBIS ontology, cell cycle ontology,	**08 Hours**	**L1, L2, L3**

GeneX ontology. Building ontology, ontology development tools (protégé 2000, GKB editor, OilEd), Ontology integration of bio-ontologies. Different types of data formats (CSV and tabbed formats for general file representation, data cleaning, flat file) Introduction to MATLAB, features of MATLAB toolbox, Usage of MATLAB towards bio statistical and biochemical applications. Modeling of biochemical and biotechnological systems using MATLAB scientific computing environment.		
MODULE -4		
C++ CONCEPTS AND BIOPERL Overview of C programming concepts, Variables, Operators, Statements, Functions and Pointers. Introduction to Classes, Objects, C++ string classes, Introduction to OOPs concepts with respect to C++ (Encapsulation, polymorphism, Inheritance, Abstraction, Dynamic binding), data types, Arrays. Introduction to basic concepts of Bioperl**.**	**08 Hours**	**L1, L2, L3, L4**
MODULE -5		
APPLICATIONS OF C AND C++ IN BIOTECHNOLOGY Writing a C program using numerical analysis technique towards solving the differential equations to biotechnology (such as finding the thermal death kinetics of microorganisms, holding time for sterilization, estimating the length of the lag phase, calculation of specific growth rate, doubling time, and substrate-to-cell yield coefficient, etc.). Write a C++ Program to find the optimum pH and temperature for maximum enzyme activity, to derive the column height needed to achieve the specified degree of conversion in a fluidized-bed biofilm reactor, to find the optimal dilution rate for maximum cell productivity, etc. Usage of NCBI's C++ tool kit to demonstrate certain features of sequence analysis.	**08 Hours**	**L1-L6**
Course outcomes: After studying this course, students will be able to: • Understand C- language with updated tool usage. • Apply the basic concepts of MATLAB, Internet. • Use the software with special reference to biotechnological applications.		
Graduate Attributes (as per NBA): • Computational Knowledge. • Problem Analysis. • Conduct investigations of complex computing problems • Design / development of solutions.		
• **Question paper pattern:** • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. • The students will have to answer 5 full questions, selecting one full question from each module.		
Text Books: 1. Linux: the complete reference by Richard Peterson, McGraw Hill. 2. Internet: The complete reference by Margaret Levine Young, Tata McGraw Hill. 3. C Programming by E Balaguruswamy, Tata McGraw Hill. 4. HTML and XML for beginners by Michael Morrison, Microsoft Press. 5. A study in Ontology by Peter Simons, Oxford Press**.** 6. Essential MATLAB for Scientists and Engineers by Arnold, Wiley, NY. 7. Beginning Perl for Bioinformatics by James Tisdall"O'Reilly Media, Inc".		
Reference Books:		

1. SAMS teach SQL in 10mins by Ben Forta, Williams Publishing.
2. Beginning XML by David Hunter, Wrox Press.
3. Introducing UNIX and LINUX by Mike Joy, Palgrave Macmillan.
4. SQL Simplified: Learn to read and write SQL by Cecelia. L. Allison, Jones and Bartlett.
5. SQL queries for mere mortals: A hands-on guide to data manipulation in SQL by Michael J. Hernandez and John. L. Viescas, Addison Wesley.

CLINICAL BIOCHEMISTRY
(Elective Subject)
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject Code	15BT363	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students

- To Learn the structure and function of metabolic pathways for carbohydrates, amino acids and lipids; their alterations in disorders.
- To Gain insight into the clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE -1 Disorders of carbohydrate metabolism: Diabetes mellitus, glycohemoglobins, hypo-glycemias, galactosemia and ketone bodies. Various types of glucose tolerance tests. Glycogen storage diseases. Physiology of lipids/lipoproteins. Lipidosis. Clinical inter-relationships of lipids (sphingolipidosis and multiple sclerosis), lipoproteins and apolipoproteins. Diagnostic tests for HDL-cholesterol, LDL-cholesterol and triglyceride disorders.	**08 Hours**	**L1, L2**
MODULE -2		
Inborn errors of metabolism: a) Disorders of amino acid metabolism - Phenylalanemia, homocystinuria, tyrosinemia, MSUD, phenylketonuria, alkaptonuria, albinism and animoacidurias. b) Disorders of nucleic acid metabolism- Disorders in purine/ pyrimidine metabolism.	**08 Hours**	**L1, L2**
MODULE -3		
Disorders of acid-base balance and their respiratory and renal mechanisms. Evaluation of organ function tests: Assessment and clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions. Clinical importance of bilirubin. Diagnostic enzymes: Principles of diagnostic enzymology. Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase and lactate dehydrogenase. Enzyme tests in determination of myocardial infarction. Enzymes of pancreatic origin and biliary tract.	**08 Hours**	**L1, L2, L3**
MODULE -4		
Hormonal disturbances: Protein hormones (anterior pituitary hormones, posterior pituitary hormones), steroid hormones, adrenocorticosteroids, and reproductive endocrinology. Disturbances in thyroid function. Disorders of mineral metabolism: Hypocalcaemia, hypocalcaemia, normocalcaemia, hypophosphatemia and hypophosphatemia.	**08 Hours**	**L1, L2, L3, L4**
MODULE -5		
Biochemical aspects of hematology: Disorders of erythrocyte	**08 Hours**	**L2, L3**

metabolism, hemoglobinopathies, thalessemias thrombosis and anemias. Laboratory tests to measure coagulation and thrombolysis. Detoxification in the body: enzymes of detoxification, polymorphism in drug metabolizing enzymes. Mechanism of drug action and channels of its excretion, Disorders of vitamins and trace elements.		

Course outcomes:

After studying this course, students will be able to:

- Discuss the biochemistry and pathophysiology associated with various disorders of metabolism and inborn errors of metabolism
- Describe the structure and function of metabolic pathways for carbohydrates, amino acids and lipids,
- Explain the medical problems associated with abnormal lipoprotein levels and therapeutic agents used to treat lipid disorders.
- Assess the clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions.

Graduate Attributes (as per NBA):

- Problem Analysis.
- Design / development of solutions (pharmacological).
- Professional Ethics
- Life-long learning

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Textbook of Medical Biochemistry by MN Chatterjea and Rana Shinde, Jaypee Brothers.
2. Lehninger- Principles of Biochemistry by David L. Nelson and Michael M. Cox, 5th Edition,WH Freeman and Company.
3. Medical Biochemistry (Paperback) By John W. Baynes and Marek Dominiczak. Publisher: Mosby.
4. Clinical Biochemistry: 3rd Ed By Allan Gaw, Michael Murphy, Robert Cowan, Denis O'Reilly, Michael Stewart and James Shepherd. Publisher: Churchill Livingstone.

Reference Books:

1. Review of Medical Physiology (Lange Basic Science) (Paperback) By William F. Ganong. Publisher: McGraw-Hilll Medical
2. Harper's Biochemistry (Lange Medical Books) (Paperback) By Robert K. Murray, Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell. Publisher: Appelton and Lange. 8. Clinical Biochemistry by Richard Luxton. Scion Publishing Ltd.
3. Clinical Biochemistry Paperbackby Nanda Maheshwari , 2008.
4. Appreciate the biochemical aspects of hematology.

Fundamentals of OS and DBMS
(Elective Subject)
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject Code	15BT364	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students to

- To Gain comprehensive understanding of the underlying principles, techniques and approaches of operating systems.
- To understand database storage structures and access techniques.
- To learn applications of DBMS techniques such as database integrity, database transaction management and database recovery.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **INTRODUCTION TO OS AND PROCESS MANAGEMENT** What is O.S? Von-Neumann architecture, Supercomputers, Mainframe systems, Desktop system, Multiprocessor systems, Distributor systems, Clustered systems, Real time systems, Hand held systems, Future migration, Computing environment, System components, OS services, System calls, System programs, system structure, OS design and implementation, micro kernels, virtual machines. Process concept, process state, process control block, process scheduling, snail diagrams, schedulers, creation and removal of a process, inter process communication, models for IPC, independent and cooperating processes, threads, overview, multithreading, applications, critical selection problem, Semaphores, deadlocks and starvation.	**08 Hours**	**L1, L2**
Module -2		
STORAGE MANAGEMENTAND LINUX AND WIN NT Memory management, dynamic loading and linking, overlays, logical vs physical address space, memory management unit, swapping, contiguous allocation, fragmentation, paging, page table, segmentation, virtual memory, demand paging, thrashing file system, interface-file concept, directory implementation. Linux: Design principles, Kernel modules, process management, scheduling, memory management systems, input and output, inter-process communication. WinNT: Design principles, system components, environmental subsystems, file system, networking and programming interface.	**08 Hours**	**L1, L2**
Module -3		
DBMS Introduction to DBMS, terminology, Systems Development Life Cycle, terms of reference, feasibility report, data flow diagrams, addition of data sources, identification of individual processes, inputs and outputs, system boundaries, Entity-Relationship modeling, examples, database creation	**08 Hours**	**L1, L2, L3**

using MS Access, designing tables using Access, Data Integrity, Normalization, relationships between tables, comparing E-R design with Normalization design, Inclusion of new requirements from feasibility report, documentation, amending primary keys and database tables, Practical examples.		
Module -4		
DATA DICTIONARY, QUERY DESIGN, REPORTING, TESTING AND DOCUMENTATION Data dictionary, criteria, compiling a list of field names, entry sequence for the table data, entering, sorting and filtering of data in a table, introduction to queries, identifying field names, selection criteria and sort order in a query, calculations in queries, modifying a query, creating a query using design view and wizard in MS Access. Introduction to reporting, dataflow diagram based reporting and table based reporting, form creation using wizard, entering and searching records in a form, modifying forms and reports, Introduction to testing, types (unit testing, system testing, integration testing, interface testing, performance testing and user testing), test data, executing and error reporting, introduction to documentation, areas of documentation.	**08 Hours**	**L1, L2, L3, L4**
Module -5		
APPLICATIONS : SETTING UP THE DATA AND HOUSEKEEPING Approaches to set up data (parallel, big bang, phased and pilot implementation), working data, and data entry methods to the database (systems screen, external source), introduction to housekeeping, regular backups, archiving old data, maintaining security in a database.	**08 Hours**	**L2, L3**

Course outcomes:

After studying this course, students will be able to:

- Apply various types of operating systems including Linux in practical situations.
- Apply various process management concepts including scheduling and synchronization.
- Transform traditional file system based on DBMS concepts.

Graduate Attributes (as per NBA):

- Computational Knowledge.
- Problem Analysis.
- Design / development of solutions.
- Modern Tool Usage.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Mastering Database Design by Helen Holding, Macmillan publications.
2. Operating system concept by Silberschatz, Peterhalvin and Greg Gague, John Wiley.
3. Database Management Systems by PS GILL, IK Publishers.
4. Linux: the complete reference by Richard Peterson, McGraw Hill.
5. Database System by Elmasri and Navathe.

Reference Books:

1. Operating System – A concept based approach by D Dhamdene, Tata McGraw Hill.
2. A Beginners guide by Abbey and Corney.
3. The complete reference by Coach and loney.

BIOCHEMISTRY LABORATORY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Laboratory Code	15BTL37	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Marks	80
		Exam Hours	03

CREDITS – 02

Course objectives: This laboratory course enables students to get practical experience in

- Qualitative and quantitative analyses of cellular components and processes.
- To design lab experiments, to make understand as to how problems are scientifically solved with supporting data.
- Acquire means to manage experiments independently.

Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
1. pH measurements, volume / weight measurements, concentration units, sensitivity.	**L1, L2, L3, L5**
2. Specificity, precision, accuracy, preparation of buffers of constant strength.	**L2, L3, L4**
3. Titration of amino acids with acids & bases.	**L2, L3, L4**
4. Qualitative tests for carbohydrate and lipids.	**L5, L6**
5. Qualitative tests for amino acids and proteins.	**L5, L6**
6. Estimation of blood sugar by Folin method and by O-toluene method.	**L2, L3, L4**
7. Estimation of inorganic phosphate by Fiske-Subbarao method.	**L5, L4**
8. Estimation of amino acid by ninhydrin method.	**L2, L3, L4**
9. Estimation of total cholesterol from Serum.	**L2, L3, L4**
10. Determination of Saponification value and iodine value of lipids with error analysis.	**L5, L6**
11. Determination of acetyl value of a lipid with error analysis.	**L5, L6**
12. Estimation of urea by diacetyl monooxime method with error analysis.	**L5, L6**
13. Estimation of iron from hemoglobin with error analysis.	**L2, L3, L4**

Course outcomes: On the completion of this laboratory course, the students will be able to:

- Know about biomolecules with special reference to physiological samples.
- Determine the levels of metallic ions, fats and oils and other biomolecules.

Graduate Attributes (as per NBA).

- Problem Analysis.
- Design/Development of solutions.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Book:

1. Modern Experimental Biochemistry by Rodney Boyer, Pearson Education.
2. Practical Biochemistry by Cole, Cambridge University Press.
3. Practical Biochemistry by Keith Wilson, Cambridge University Press.
4. An introduction to practical biochemistry by Plummer, Tata McGraw Hill.
5. Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande, I.K.Intl.
6. Lab Math by Dany Spencer Adams, IK Intl. Pub. House.
7. Lab Ref by Jaine Roskams & Linda Rodgers, IK Intl. Pub. House.
8. Manual of Practical Biochemistry for medical students, 2nd edition, University Press.
9. Practical Manual Of Biochemistry by Sharma S. Medtech ,2016

MICROBIOLOGY LAB

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Laboratory Code	15BTL38	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Marks	80
		Exam Hours	03

CREDITS – 02

Course objectives: This laboratory course enables students to get practical experience in

- Working principle and use of Microbiological Lab equipment's like autoclave, incubators, LAF, microscope, etc.
- The basic laboratory techniques for isolation, characterization, enumeration and control of microorganisms.

Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
1. Study of Laboratory Instruments	L5, L4
2. Media preparation, Preparation of plates and tubes.	L2, L3, L4
3. Pure culture techniques (Streak, pour and spread - plates)	L1, L2, L3, L4, L5
4. Enumeration of microbes by Plate count and haemo-cytometer.	L2, L4, L5, L6
5. Determination of size of cell or fungal spores by Micrometry.	L2, L3, L5
6. Gram staining, Capsule staining, and endospore and flagella staining.	L2, L3, L4
7. Staining of fungi.	L2, L3, L4

8.	Characterization of bacteria by Biochemical Tests: IMViC, Starch hydrolysis, carbohydrate fermentation, Catalase, Urease, hydrogen sulphide, Nitrate reduction.	L1, L2, L3, L4, L5, L6
9.	Isolation of actinomycetes and rhizobium and their identification.	L1, L2, L3, L4, L5
10.	Determination of bacterial motility by hanging drop technique.	L1, L2, L3, L4
11.	Growth curve studies.	L1, L2, L3, L4, L5
12.	Antibiotic sensitivity tests.	L1, L2, L3, L4, L5

Course outcomes: On the completion of this laboratory course, the students will be able to:

- Use different laboratory equipment and instruments such as Microscope, Laminar Air Flow Station, Autoclave, oven, incubators.
- Prepare the media and use for the cultivation of the microorganisms.
- Perform laboratory experiments for the isolation, identification and characterization of microorganisms.
- Carry-out experiments for the enumeration, staining and control

Graduate Attributes (as per NBA)

- Problem Analysis.
- Design/Development of solutions.
- Professional ethics
- Societal and environmental concern.
- Modern tool usage.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Book:

1. Microbiology: A Lab Manual by Cappuccino Pearson education, 2007
2. Lab Math by Dany Spencer Adams, IK Intl. Pub house.
3. Lab Ref by JaineRoskams& Linda Rodgers IK Intl.Pub house.
4. Case-Microbiology: An Introduction by Gerard J. Tortora, Berdell R. Funke, Christine L. 11thEdition- Pearson publications.
5. Laboratory Manual Of Microbiology And Biotechnology by Aneja K.R. Medtec, 2014

BIOSTATISTICS AND BIOMODELING

(Core Subject)

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	15BT41	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Appreciate the wide range of utilities of statistics and probability to Biological data
- Apply the concepts related to curve fitting, correlation coefficient, regression analysis etc., to specific cases.
- Learn the concepts of basic probability and random variables, while deciphering the applications of distributions and stochastic process for defined cases.
- Study the importance of modeling and simulations for biological problems.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE -1 **BASIC STATISTICS** Histogram, Ogive curve, Pie Diagram. Measure of dispersion (range, quartile deviation, mean deviation and standard deviation, coefficient of variation), Skewness& kurtosis**.**	**10 Hours**	**L1, L2**
MODULE -2		
BI-VARIATE DISTRIBUTION Correlation, rank correlation and regression analysis (simple and linear) curve fitting (linear, non-linear and exponential).	**06 Hours**	**L1, L2**
MODULE -3		
PROBABILITY Axioms, conditional probability, Bayes rule, Genetic Applications of Probability, Hardy - Weinberg law, Wahlund's Principle, Forensic probability determination, Likelihood of paternity, Estimation of probabilities for multi-locus/ allele finger print systems. Random variables-Discrete and Continuous Probability distribution, Mathematical expectations	**10 Hours**	**L1, L2, L3**
MODULE -4		
PROBABILITY DISTRIBUTIONS Discrete probability distributions- Binomial, Poisson, normal, exponential derivations. Central limit theorem. T distributions.	**08 Hours**	**L1, L2, L3, L4**
MODULE -5		
STATISTICAL INFERENCE Estimation theory and testing of hypothesis, point estimation, interval estimation, sample size determination, parametric and	**16 Hours**	**L2, L3**

non-parametric distributions -F-test, Chi Squared distribution, and goodness of fit test analysis of variance (one-way classifications). Randomization, random assignments, single and double blind experiments. Case studies of statistical designs of biological experiments. Microbial Growth in a Chemostat, Growth Equations of Microbial populations, Models of Commensalisms, Mutualism, Predation and Mutation. Volterra's Model for n Interacting Species. Cigarette smoking, Lung cancer, epidemics.		

Course outcomes: After studying this course, students will be able to:

- Fit a suitable curve for the tabulated data by the method of least squares, find correlation coefficients and analyze
- Apply different types of tests to test the hypothesis relating to small samples
- Appreciate the concepts of probability, distributions and various stochastic process
- Perform modeling and simulations experiments for select biological processes using appropriate data.

Graduate Attributes (as per NBA):

- Computational Knowledge.
- Problem Analysis.
- Design / development of solutions.
- Modern tool usage.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Principles of Biostatistics by Marcello Pagano & Kimberlee G, Thompson Learning.
2. Introduction to Biostatistics by Ronadd N Forthofer and EunSul Lee, Academic Press.
3. Mathematical Models in Biology and Medicine by J.N.Kapur New Age International.
4. Introduction to Biostatistics by Ipsen, Feigl & Bancroft, Harper & Row, Publishers,NY.
5. Basic Biostatistics & its Applications by Animesh K Datta , New Central Book Agency.
6. Fundamentals of Biostatistics by P Hanumanth Rao and K Janardhan, IK Intl. Publishers.
7. Biostatistics by Rastogi V.B. Medtec 3rded , 2015

Reference Books:

1. Statistical methods in Bioinformatics by Warren J. Ewens, Gregory R. Grant, Springer publications, 2nd edition, 2006.
2. An Introduction to Biostatistics by P. S. S. Sundar Rao and J. Richard, Prentice Hall of India, 4th edition, 2006.
3. Biostatistics: A foundation for Analysis in the Health sciences by Wayne W. Daneil, John Wiley & Sons, 7th edition, 2000.
4. Fundamentals of Biostatistics by Veer BalaRastogi, Ane Books India.

UNIT OPERATIONS-2
(Core Subject)
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	15BT42	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Be exposed to the fundamental concepts ofHeat and Mass Transfer.
- Solve engineering problems related to heat flow so that they will be able to design and operate heat exchange equipment successfully.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE -1 **HEAT TRANSFER CONCEPTS** Heat transfer by conduction-steady state conduction, heat flow through a cylinder, unsteady state conduction, heat flow through variable surface temperature. Principles of heat flow in fluids-typical heat exchange equipment, heat flux and heat transfer coefficients, LMTD, individual heat transfer coefficients, calculation of overall heat transfer coefficients, resistance from overall coefficient, fouling factors. Heat transfer by forced convection in laminar and turbulent flow, the Reynolds analogy, natural convection. Heat transfer to fluids with phase change-heat transfer from condensing vapors, drop-wise and film-type condensation, heat transfer to boiling liquids.	**10 Hours**	**L1, L2,L3**
MODULE -2		
RADIATION AND HEAT EXCHANGE EQUIPMENT Radiation heat transfer-emission of radiation, emissivity, black body radiation, absorption of radiation by opaque solids, Kirchhoff's law. Radiation between surfaces, radiation to semitransparent materials, combined heat transfer by conduction-convection-and radiation. Heat-Exchange equipment-Shell-and-tube heat exchangers, single pass 1-1 exchangers, multi-pass exchangers, correction of LMTD, heat transfer coefficients in Shell-and-tube heat exchangers, cross flow exchangers, heat transfer units, double pipe heat exchangers, plate type heat exchangers, extended surface equipment, air-cooled exchangers, heat pipes, scrapped surface exchangers, condensers and vaporizers, heat transfer in	**10 Hours**	**L1, L2**

agitated vessels, heat transfer in packed beds.		
MODULE -3		
MASS TRANSFER CONCEPTS: Molecular Diffusion in fluids-Steady state molecular diffusion in fluids at rest and laminar flow, Momentum and heat transfer in Laminar flow, Mass Transfer coefficients-Mass transfer coefficients in Laminar and turbulent flow, Mass, heat and Momentum transfer analogies, Simultaneous Mass and heat transfer.	**10 Hours**	**L1, L2, L3**
MODULE -4		
DIFFUSION IN SOLIDS & INTERPHASE MASS TRANSFER: Diffusion in solids-Fick's law of diffusion, types of solid diffusion, Interphase mass transfer-Equilibrium, diffusion between phases, Material balances, Stages	**10 Hours**	**L1, L2, L3, L4**
MODULE -5		
Distillation-Vapour-liquid equilibrium, single stage operation, differential of simple distillation, continuous rectification-binary systems, multistage stage tray towers-method of McCabe and Thiele method. Liquid-liquid extraction-Liquid equilibrium, stage type extractors, Drying-drying operations, batch and continuous drying.	**10 Hours**	**L2, L3,L5**

Course outcomes:

After studying this course, students will be able to:

- Apply principles of Thermodynamics to solve engineering problems related heat & mass transfer operations.
- Develop correlations using elementary dimensional analysis and comprehend the laws governing heat & mass transfer operations.
- Design heat transfer equipment suitable for specific requirement.

Graduate Attributes (as per NBA):

- Problem Analysis.
- Design / development of solutions.
- Computational Knowledge.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. A Text Book of Chemical Engineering Thermodynamics by K V Narayanan, Prentice-Hall of India Private Limited, Tenth print (October 2007)-For units I, II & III
2. Unit Operations of Chemical Engineering by Warren L. McCabe, Julian C. Smith and Peter Harriott, McGraw Hill Education (India) Edition 2014.(For units IV & V)

3. Mass-transfer operationsBook by Robert Ewald Treybal.

Reference Books:

1. Introduction to Chemical Engineering Thermodynamics by Smith J M., Vanness H C. and Abbott, M. M., 5th edition, McGraw Hill, New York, 1996.
2. Process Heat Transfer by Kern D Q., McGraw Hill, New York.
3. Unit Operations of Chemical Engineering by Chattopadhyaya, Vol I & II, Khanna Publishers, Delhi-6, 1996.
4. Chemical Engineering Thermodynamics by YVC Rao, University Press, 2013.

MOLECULAR BIOLOGY
(Core Subject)
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	15BT43	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- The underlying concepts of Central Dogma and learn the mechanism of replication of DNA, Transcription of a gene and Translation of mRNA.
- Gene expression in a prokaryotic and eukaryotic cell.
- The importance of genetic recombination, damage and repair.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE -1 **INTRODUCTION & REPLICATION OF DNA** Chromosomal theory of heredity, genes and their location. Genetic code, Information flow in biological systems: central dogma, updated central dogma. Structures and forms of nucleic acids – DNA and RNA. Replication of DNA, structure and function of DNA polymerases, models of replications in prokaryotes, mechanism of DNA replication and enzymes involved.	**10 Hours**	**L1, L2,L3**
MODULE -2		
TRANSCRIPTION Structure and function of RNA polymerases (prokaryotes & eukaryotes), mechanism of transcription in prokaryotes and eukaryotes, transcription factors, post-transcriptional processing (RNA editing, siRNA, splicing, poly A tail and 5' capping), transcription inhibitors.	**10 Hours**	**L1, L2,L4**

MODULE -3		
TRANSLATION Mechanism of translation, activation of amino acid initiation, elongation and termination of protein synthesis. Post translational modification and protein targeting, protein splicing. Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of translation.	**10 Hours**	**L1, L2, L3**
MODULE -4		
GENE EXPRESSION IN PROKARYOTES & EUKARYOTES Regulation of gene expression in prokaryotes: Operon model, gal, lac, trp Operons; positive versus negative regulation. Regulation of eukaryotic gene expression, transcriptional control, homeobox in the control of developments in insects and vertebrates.	**10 Hours**	**L1, L2, L3, L4**
MODULE -5		
GENETIC RECOMBINATION, MUTATION & GENE MAPPING Genetic recombination in bacteria and viruses, site specific recombination, transposons and insertion sequences; Retroviruses. DNA damage & Repair, Mutation, Role of recombination and transposition in evolution; gene mapping techniques.	**10 Hours**	**L2, L3**

Course outcomes:

After studying this course, students will be able to:

- Explain replication, transcription and translation processes with underlying differences in prokaryotic and eukaryotic systems.
- Elaborate importance of genetic recombination with special reference to bacterial system.
- Outline DNA damage and repair mechanisms

Graduate Attributes (as per NBA):

- Modern tool usage.
- Lifelong learning.
- Problem analysis

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Essentials of Molecular Biology by David Freifelder, Narosa Pub. House.
2. Molecular Biology of the Cell by Alberts et al., Garland Publishing.
3. Principles of Gene manipulation and Genomics by Primrose, Oxford University Press.
4. Molecular Biology of the Gene by James D Watson et al., Pearson Education.

5. Genes IX, by Benjamin Lewin, Jones & Bartlett Publishers.
6. Molecular Biotechnology – Principles & Practices by Channarayappa, University Press, 2006.
7. Principles of Molecular Biology 2nd edition 2016, by Veer BalaRastogi , MEDTECH.

Reference Books:

1. Molecular Cell Biology by Darnell J Lodish& H Baltimore, Freeman Pub.
2. Biochemistry & Molecular Biology by William H Elliot and Daphane C Elliot, Oxford University Press.
3. Current protocols in molecular biology edited by Frederick M. Ausubel et al., John Wiley & Sons.
4. Methods in enzymology by Berger S.L. & Kimmel A.R., Academic Press
5. Cell & Molecular Biology by Pragya Khanna, I K Intl.
6. Molecular Biology by N.Arumugam, Saras Publications.

BIOPROCESS PRINCIPLES & CALCULATIONS
(Foundation Course)
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	15BT44	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Learn fundamentals of chemical calculations and material and energy balance.
- Discuss the material balance aspects involving chemical reactions and without chemical reactions.
- Highlight the energy balance and material balance for the development of bioprocess technology.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE -1 **BASIC CHEMICAL CALCULATIONSAND MATERIAL BALANCE** Concept of atom and mole, expressing composition of mixtures in Solids, liquids and gases. Expressing composition of mixtures and solutions - Percentage by weight percentage, mole percentage and Volume percentage; Normality, Morality, Molality. Generalized material balance equations for distillation, absorption, extraction, crystallization, mixing,	**10 Hours**	**L1, L2,L3**

drying and evaporation		
MODULE -2		
MATERIAL BALANCE WITHOUT CHEMICAL REACTIONSAND FUELS Material balances calculation in Distillation, Absorption, Extraction, Crystallization, Drying, Mixing and Evaporation Operations, Fuels – types of fuels, (solid, liquid and gaseous fuel), relevance to biofuels, characteristics of fuels, Ultimate and proximate analyses of fuels.	**10 Hours**	**L1, L2,L3**
MODULE -3		
MATERIAL BALANCE INVOLVING CHEMICAL REACTIONS Material balances calculation involving bypass, recycle and operations. Generalized material balance equations, Principles of stoichiometry, Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, Selectivity, unit process – neutralization, oxidation, nitration, hydrolysis, and problems relating to these unit processes.	**10 Hours**	**L1, L2, L3,L4**
MODULE -4		
ENERGY BALANCE General energy balance equation for steady state. Heat capacity, estimation of heat capacity for solids, liquids, gases and their mixtures. Enthalpy, Standard Heat of formation, standard heat of reaction, Standard heat of combustion and calorific value, Calculation of heat of reaction at elevated temperature.	**10 Hours**	**L1, L2, L3, L4**
MODULE -5		
BIOPROCESS PRINCIPLES and STOICHIOMETRY OF BIOPROCES Historical development of bioprocess technology; Bioprocess principles and operations, generalized process flow sheets. General material balance equation for steady state (for manufacture of penicillin and ethanol) - outline of a bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses. Stoichiometry ofmicrobial growth and product formation.	**10 Hours**	**L2, L3,L5**
Course outcomes: After studying this course, students will be able to: • Discuss the significance of material and energy balance for bioprocess technology. • Solve problems related to material and energy balance to give solutions for bioprocess development. • Develop the flow-sheet for general processes operating in bioprocess industry. • Appreciate the stoichiometry of microbial growth and product formation involved in		

bioprocess technology

Graduate Attributes (as per NBA):

- Problem Analysis.
- Design / development of solutions.
- Computational knowledge.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Principles of Biochemistry by David L. Nelson (Editors), W.H. freeman and company.
2. Bioprocess Engineering Principles by Pauline Doran, Academic Press.
3. Biochemical Engg. Fundamentals by J E Bailey & D. F. Ollis, McGraw Hill.
4. Biochemical Calculations by I.H.Segel, John Wiley & Sons.

Reference Books:

1. Basic Principles and Calculations in Chemical Engineering by David Himmelblau, PHI
2. Bioprocess Engineering by Shule and Kargi, Prentice Hall.
3. Chemical Process Calculations by R.Asokan, University Press, 2011.

STRUCTURAL BIOLOGY

(Foundation Course)

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	15BT45	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Appreciate the importance of structure, scope and function of macromolecules
- Understand the structure organization, work and function of macromolecules at molecular level
- Know the various qualitative and quantitative physical methods available for structure elucidation
- Learn the various interactions involved in macromolecular structure and their roles towards stability and function

Modules	**Teaching**	**Revised Bloom's**

	Hours	Taxonomy (RBT) Level
MODULE -1 **INTRODUCTION & PROTEIN STRUCTURE** Levels of molecular organization, Brief discussions on: Amino acids, Nucleic acids, Adenylates, Carbohydrates, Lipids, Cofactors, Vitamins, and Hormones. Composition and primary structures of proteins, Conformational analysis and forces that determine protein structures, geometries, phi, psi, omega angles, Ramachandran or steric contour diagram, allowed chi angles of side chains in proteins, hydrogen bonding, disulphide bonds, hydrophobic interactions, vanderwaals forces, potential energy calculations, alpha helices, beta sheets, helix to coil transition, general features and thermodynamic aspects of protein folding, folding kinetics, protein-ligand interactions, Scatchard plot, co-operative interactions, allosteric effects, Hill constant; Relationship between the primary, secondary, and tertiary structure of proteins. Structure of IgG, fibrous proteins (structure of collagen, keratin). Quaternary structures - dimers, homo & hetero dimers, trimers, tetramers; Protein folds, structural families and classes, multifunctional domains (qualitative examples)	**10 Hours**	**L1, L2**
MODULE -2		
STRUCTURE OF NUCLEIC ACIDS AND BIOMEMBRANES General characteristics of nucleic acid structures (A, T, G, C, U), forces and stabilizing geometries, glycosidic bond, rotational isomers. Stabilizing ordered forms of DNA (A, B and Z), base pairing types, base stacking, tertiary structure of DNA (Supercoiled DNA), Melting of the DNA double helix (Hyperchromicity), Interaction with small ions and small molecules. Ribose puckering and Tertiary structure of tRNA. Structure and conformational properties of cell membranes, Singer and Nicholson model, integral proteins in membranes, conformational variations during ion transport, Signal transduction and molecular reception (qualitative).	**10 Hours**	**L1, L2**
MODULE -3		
BIOPHYSICAL TECHNIQUES Rayleigh scattering, ultra-centrifugation, viscometry. Electron microscopy (SEM-TEM, AFM), luminescence (fluorescence & phosphorescence), Calorimetry, DSC, Mass spectrometry, LC-MS, MALDI-TOF, Voltage Clamp and Patch Clamp (measurements of membrane potentials).	**10 Hours**	**L1, L2, L3,L4**
MODULE -4		
SPECTROSCOPIC TECHNIQUES	**10 Hours**	**L1, L2, L3,**

X-ray diffraction : structure determination via single crystal diffraction, fibre diffraction; Neutron diffraction. XAFS. NMR spectroscopy (structure determination). ORD/CD, UV, IR, Laser Raman, ESR/EPR.		**L4**
MODULE -5		
BIOMOLECULAR INTERACTIONS & MOLECULAR DYNAMICS Association of macromolecules, molecular conjugates, supramolecular interactions, protein-protein interactions, protein-nucleic acid interactions, lipid/membrane-protein interactions. Molecular mechanics and dynamics (Newtonian and Monte Carlo simulations), theoretical principles and its importance towards insilico simulations, results of molecular dynamics calculations and their implications to biological function.	**10 Hours**	**L2, L3,L4,L5**
Course outcomes: After studying this course, students will be able to: • Present the foundational principles of macromolecular structure and function • Apply diverse techniques that enable the elucidation of molecular structure, their organization, stability, associations and functionalities		
Graduate Attributes (as per NBA): • Problem Analysis. • Design / development of solutions. • Lifelong learning.		
Question paper pattern: • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. • The students will have to answer 5 full questions, selecting one full question from each module.		
Text Books: 1. Biophysical Chemistry by Cantor R. and Schimmel P.R, W. H. Freeman. 2. Physical Biochemistry by David Freifelder, W H Freeman and Company. 3. Biophysical Principles of Structure & Function by Fred M. Snell & Sidney Shulman 4. Introduction to Protein Structure by Carl Branden and John Tooze, Garland Publishing. 5. Proteins Structure – A Practical Approach by Creighton, Oxford University Press. 6. Physical Chemistry: Principles and Applications in Biological Sciences by Tinoco and others, Prentice Hall.		
Reference Books: 1. Biophysics – An Introduction by Cotterill, Wiley Student Edition. 2. Foundations of Biophysics by A.L. Stanford, Academic Press. 3. Principles of protein structure by G Schulz and R H Schrimer, Springer Verlag. 4. Principles of nucleic acid structure by Sanger, Springer Verlag. 5. Introduction to Protein Science by Arthur M Lesk, Oxford University Press. 6. Biological Spectroscopy by J. D. Campbell and R. A.Dwek, Plenum Press.		

STATISTICAL TOOLS AND TECHNIQUES

(Elective Subject)

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	15BT461	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students to

- Explain the merits and limitations of various statistical techniques.
- Performance statistical analysis on paper as well as using Excel.
- Interpret examples of methods for summarizing data sets
- apply quantitative techniques to solve a variety of business problems

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
MODULE -1 Introduction to Statistics Scope of Statistics: In the field of Industry, Biological Sciences, Medical Sciences, and Agriculture Descriptive Statistics: Graphical displays, Central tendency and its numerical measures. Attributes: Nominal scale, ordinal scale, Variables: Interval scale, ratio scale, discrete and continuous variables, difference between linear scale and circular scale. Types of data: Primary data, Secondary data. Cross-sectional data, time series data, failure data, industrial data, directional data. Notion of a statistical population: Finite population, infinite population, homogeneous population and heterogeneous population. Notion of sample, random sample and non-random	**08 Hours**	**L1, L2**

sample.		
MODULE -2		
Probability Randomness, Uncertainty and probability, Probability distributions: Descrete and Normal, Sampling; Methods of sampling: Simple random sampling with and without replacement, stratified random sampling, systematic sampling, and cluster sampling. Classification: Raw data and its classification, discrete frequency distribution, Sturge's rule, continuous frequency distribution, inclusive and exclusive methods of classification, Open end classes, cumulative frequency distribution and relative frequency distribution.	**08 Hours**	**L1, L2**
MODULE -3		
Statistical Inference Confidence intervals; large populations; differences between two population proportions; and differences between two population means; Hypotheses testing on large samples. Confidence intervals and hypothesis tests on small samples; differences between two population proportions; and differences between two population means. Chi-square procedures; Tests for goodness-of-fit and test for independence; Benford's law. One-way analysis of variance; Hypothesis testing, test statstic and F distribution; Single factor Anova tests	**08 Hours**	**L1, L2, L3,L4**
MODULE -4		
Correlation Bivariate data, bivariate frequency distribution. Concept of correlation between two variables, positive correlation, negative correlation, zero correlation. Scatter diagram, conclusion about the type of correlation from scatter diagram. Covariance between two variables: Definition, computation, effect of change of origin and scale. Karl Pearson's coefficient of correlation (r) Definition, computation for grouped and ungrouped data and interpretation. Properties: (i) $-1 \leq r \leq 1$ (with proof), (ii) Effect of change of origin and scale (with proof). Spearman's rank correlation coefficient: Definition, computation and interpretation (without ties), Spearman's rank correlation coefficient (derivation of formula in case of without ties). In case of ties, compute Karl Pearson's correlation coefficient between ranks. (Spearman's rank correlation coefficient formula with correction for ties not expected.) Examples and Problems. Attributes: classification, notion of manifold classification, dichotomy, class-frequency, order of class, positive class-	**08 Hours**	**L1, L2, L3,L4**

frequency, negative class frequency, quanta class fre-quencies, ultimate class frequency, relationship among different class frequencies (up to three attributes), dot operator to find the relation between frequencies, fundamental set of class frequencies. Theorems on expectations of sum and product of two jointly distributed random variables. Conditional expectation. Definitions of conditional mean and conditional variance. Definition of raw and central moments.		
MODULE -5		
Regression Concept of regression, lines of regression, fitting of lines of regression by the least squares method, interpretation of slope and intercept. Regression coefficient (byx, bxy): Definition, computation, properties (with proof). Angle between the two lines of regression. Mean residual sum of squares, Residual plot and its interpretation. Non-linear regression: (1) Second degree curve, (2) Exponential curves, fitting of such curves by the least square method after logarithmic trans-formation, (3) Logistic curve $y = k$, Interpretation of $b < 0$, $b > 0$. Illustrations of logistic curve. Criteria to decide the best fit of the curve. Examples and Problems. Critical Thinking in Statistics: Pitfalls of statistics, Examples.	**08 Hours**	**L1, L2**
Course outcomes: After studying this course, students will be able to: • Understand and apply the basic concepts of statistics • Understand the pitfalls and strengths of using statistical inference • Develop the necessary numerical skills to perform statistical work on biological data.		
Graduate Attributes (as per NBA): • Computational Knowledge. • Problem Analysis. • Design / development of solutions. • Modern tool usage.		
Question paper pattern: • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. • The students will have to answer 5 full questions, selecting one full question from each module.		
Text Books: 1. Principles of Statistics by M G Bulmer 2. Understanding Basic Statistics by Brase and Brase 3. Collaborative Statistics by Illoswsky and Dean 4. Statistics: The Conceptual Approach by Iverson and Gurgen.		

Reference Books:

1. Statistics by Freedman, Pisani and Purves
2. Fooled by Randomness by Taleb

CAD AND MATLAB

(Elective Subject)

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	15BT462	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students to

- Learn to sketch and take field dimensions.
- Learn to take data and transform it into graphic drawings.
- Learn basic Auto Cad skills.
- Learn basic engineering drawing formats
- Do simple calculations and print out graphs.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE -1 **FLUID FLOW SYSTEMS** CAD of fluid flow system: Flow of Newtonian fluids in pipes. Pressure drop in compressible flow. Flow of non-Newtonian fluids in pipes. Pipe network calculations. Two phase flow system.	**08 Hours**	**L1,L2**
MODULE -2		
HEAT TRANSFER & MASS TRANSFER SYSTEMS CAD of heat transfer equipment: Shell and tube exchangers without phase change. Condensers, Reboilers, Furnaces. CAD of mass transfer equipment: Distillation, gas absorption and liquid extraction	**08 Hours**	**L1,L2,L3**
MODULE -3		
REACTOR SYSTEMS CAD of chemical Reactors: Chemical reaction equilibrium analysis of rate data, ideal reactor models. Non-ideality in chemical reaction. Performance analysis using residence time distribution. Temperature effects in homogeneous reactors. Heterogeneous systems. Fluidized bed reactors.	**08 Hours**	**L1,L2**
MODULE -4		
MATLAB Introduction to Matlab Environment, basics, mat lab sessions, creating an array of numbers, printing simple plots, creating,	**08 Hours**	**L1,L2,L3&L4**

saving and executing a script file, function file, working with files and directories. Programming Script files, function files, executing a function, sub functions, compiled functions, profiler, global variables, loops, branches and control flow, interactive input, recursion, multidimensional matrices, structures, cells, publishing reports.		
MODULE -5		
APPLICATIONS Solving a linear system, Gaussian elimination, finding eigenvectors and eigenvalues, matrix factorizations, polynomial curve fitting, least squares curve fitting, nonlinear fits, interpolation, data analysis and statistics, numerical integration, a first order linear ODE, specifying tolerance, the ODE suite, roots of polynomials, 2D plotting, options, overlay plots, 3D plotting, rotate view, mesh and surface plots, vector field, subplots for multiple graphs, saving and printing graphs.	**08 Hours**	**L1,L2,L3 &L4**

Course outcomes:

After studying this course, students will be able to:

- Perform basic sketching techniques will improve.
- Draw orthographic projections and sections.
- Use architectural and engineering scales will increase.
- Convert sketches to engineered drawings will increase.
- Develop basic MATLAB programming skills in a level to write medium level programs.
- Draw two and three dimensional figures with MATLAB.
- Apply MATLAB to solve some prototype engineering problems.

Graduate Attributes (as per NBA):

- Computational Knowledge.
- Problem Analysis.
- Design / development of solutions.
- Modern tool usage.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Fundamentals and Modeling of Separation Process by C.D. Holland, Prentice Hall, Inc. New Jercey.
2. Catalytic Reactor Design by Orhan, Tarhan McGraw Hill.
3. CAD/CAM: Computer Aided design and Manufacturing, MikellGroover and Zimmer, Pearson Education.
4. Computer Graphics, Hearn & Baker, PHI.
5. Essential MATLAB for Scientists and Engineers, Arnold / Wiley, NY.

Reference Books:

1. Chemical Process Computation by Raghu Raman, Elsevier Scientific Publishers, London.
2. Chemical Engineering, Vol. 6 by Sinnot, Pergamon Press.
3. Optimization Methods, S.S. Rao, New Age International Publications.
4. Computer Aided Engineering & Design, Jim Browne, New Age International Publications. Getting started with MATLAB 7, Rudrapratap, Oxford University Press.
5. A handbook on technique lab MATLAB based experiments by Mishra K. K., IK publishers.

Biomaterials

(Elective Subject)

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	15BT463	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students

- To identify new challenges and emerging trends in design of Biomaterials
- To know about material scienceand its applications in biotechnology.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **INTRODUCTION, METALS & CERAMICS** Introduction, Historical developments, construction materials, impact of biomaterials, strength of biological tissues, performance of implants, tissue response to implants, interfacial phenomena, safety and efficacy testing. Structure and Properties of Materials: Atomic and molecular bonds, crystal structure of solids, phase changes, crystal imperfections, non-crystalline solids, surface properties, mechanical properties of materials, thermal treatments, surface improvements, sterilization. Introduction, Stainless steels, Cobalt-Chromium alloys, Titanium based alloys, Nitinol, other metals, metallic Corrosion, biological tolerance of implant metals, Carbons, Alumina, Yttria stabilized zirconia, surface reactive ceramics, resorbable ceramics, composites, analysis of ceramic surfaces	**08 Hours**	**L1, L2**
Module -2		
SYNTHETIC POLYMERS & BIOPOLYMERS Polymers in biomedical use, polyethylene and polypropylene, per fluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization. Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli, yield strength and	**08 Hours**	**L1, L2**

fracture strengths, sterilization and disinfections of polymeric materials. Biocompatibility of polymers, polymers as biomaterials, heparin and heparin-like polysaccharides, proteoglycans, structure and biological activities of native sulfated glycosaminoglycans, chemically modified glycosaminoglycans, heparin like substances from nonglycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins.		
Module -3		
BIOCOMPATIBILITY Definition, Wound healing process-bone healing, tendon healing. Material response: Function and Degradation of materials in vivo. Host response: Tissue response to biomaterials, Effects of wear particles. Testing of implants: Methods of test for biological performance- In vitro implant tests, In vivo implant test methods. Qualification of implant materials.	**08 Hours**	**L1, L2, L3**
Module -4		
REGULATORY ISSUES Review of Cell and Tissue Structure and their Functions. Functional Requirements of Biomaterials and Tissue Replacements. Synthetic Biomaterials: Metals, Polymers, Ceramics, Gels, Hybrids, Sterilization Technology. Foreign Body Response, Biocompatibility and Wound Healing.	**08 Hours**	**L1, L2, L3, L4**
Module -5		
MEDICAL DEVICES & CARDIOVASCULAR BIOMATERIALS Polyurethane elastomers, applications of polymers in medicine and surgery. Skin graft polymers, biodegradable polymers in drug delivery and drug carrier systems. Properties of implant materials, metals and alloys, polymers, ceramics and composites, qualification of implant materials, goal of clinical trials, design and conclusion of clinical trials. Tissue properties of blood vessels, Treatments of atherosclerosis; Biomechanical design issues pertaining to stents, balloon angioplasty, and pacemakers. Soft Tissue Reconstruction; Natural and Synthetic. Wound healing. Tissue ingrowths: Stability; Bio fixation, Foreign Body response, Soft implants. Case Studies.	**08 Hours**	**L2, L3**
Course outcomes: After studying this course, students will be able to: • Know about biomaterials and their medical applications. • Understand the design of biomaterials of different types.		
Graduate Attributes (as per NBA): • Problem Analysis. • Design / development of solutions. • Societal and Environmental Concern. • Modern tool usage.		

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Biomaterials Science: An Introduction to materials in medicine by Buddy D Ratner. Academic Press.
2. Polymeric Biomaterials by SeverianDumitriu.
3. Material Science by Smith, McGraw Hill.
4. Material Science and Engineering by V Raghavan, Prentice Hall.
5. Biomaterials by Sujata V. Bhat, Narosa Publishing House.
6. Biomaterials, Medical Devices and Tissue Engineering: An Integrated Approach by Frederick H Silver, Chapman and Hall publications.

Reference Books:

1. Advanced Catalysts and Nanostructures Materials, William R Moser, Academic Press.
2. Biomaterials - Science and Engineering by J B Park, Plenum Press.
3. Biological Performance of materials by Jonathan Black, Marcel Decker.
4. Polymeric Biomaterials by Piskin and A S Hoffmann, MartinusNijhoff
5. Biomaterials by Lawrence Stark &GyanAgarwal.
6. Biomaterials - An Interfacial approach by L. Hench & E. C. Ethridge.

Facilitation, Validation & QC/QA
(Elective Subject)
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	15BT464	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students
Concepts underlying the various aspects related to quality control, monitoring, quality assurance matters related to final and finished products, product life cycles, and validation of the process , regulatory affairs, etc

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1Quality control and Assurance technique: Introduction, Basis concepts of Quality:- Developing quality	**08 Hours**	**L1, L2**

culture.Quality Assurance General Concepts:Definition of quality assurance concept and components of Q. A., Concept of Quality control, Quality control of Biological products:International Biological standards, safety testing of pharmaceutical Quality control of antibiotics. British and Indian pharmacopeias. Current GMP in manufacturing,		
Module -2		
Good Laboratory Practice: Current GLP in manufacturing, responsibilities. General provision, organization and personnel, building and facilities, equipment, control of components and drug product, laboratory and control of records and reports, Non-clinical testing.	**08 Hours**	**L1, L2**
Module -3		
Manufacturing operations and control: Revised schedule M, sanitation of manufacturing premises, Mix –ups and cross contamination, processing of intermediates and Bulk product, Packaging operations, I.P.Q.C., Release of finished products process deviations, Drug product inspection, expiration dating, Document and formats, Specification, Master production and control record, Batch production and control record Significance of SOPs and record, change control.	**08 Hours**	**L1, L2, L3**
Module -4		
Introduction to Pharmaceutical Validation: Definition, Manufacturing Process Model, Government regulation, scope of Validation, Advantage of Validation, Organizations for Validation, Validation Master plan, URS, D.Q., IQ, OQ & P.Q. of facilities. **,** General principles of analytical method validation, Validation of HPLC, Dissolution test apparatus Process Validation**:** Prospective, concurrent, retrospective & revalidation, Process validation of formulations. Validation of Pharmaceutical Water System & pure steam, Validation of Compressed air, Cleaning of Equipment, Cleaning of Facilities.	**08 Hours**	**L1, L2, L3, L4**
Module -5		
Drug Regulatory Affairs: Harmonization of regulatory requirements including ICH activity. Regulatory requirements of different regions applicable to pharmaceutical developments, manufacturing, quality control on finished products, extended release products, biopharmaceutical and bioequivalence assessment and good clinical practices and Comparison with regulation in India.	**08 Hours**	**L2, L3**
Course outcomes: After studying this course, students will be able to: • Demonstrate strong appreciation in applying the concepts and skills towards handling of finished products, • demonstrate the skills in quality assurance and validation of the finished products and their materials and work place		
Graduate Attributes (as per NBA):		

- Problem Analysis.
- Design / development of solutions.
- Societal and Environmental Concern.
- Modern tool usage.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Pharmaceutical Quality Assurance, MA Potdar, NiraliPrakashan, Pune
2. Validation of Pharmaceutical process, F. J. Carleton and J. Agalloco, Marcel Dekker Inc.
3. Pharmaceutical Process Validation, Second Ed., Ira R. Ferry & Robert Nash., Marcel Dekker Inc.
4. Quality Planning & Analysis by J. M. Juran and F. M. Gryna, Tata Mcgraw Hill, India.
5. Improving Quality through Planned experimentation by Moen, Tata Mcgraw Hill.

Reference Books:

1. Good Manufacturing Practices for Pharmaceutical; A Plan for total Quality Control, 4 th Ed, S willing.
2. Quality Assurance Guide by Organization of Pharmaceutical producers of India.
3. Pharmaceutical Process Validation; By F. R., Berory and Robert A. Nash
4. Impurities Evaluation of Pharmaceutical; Satinder Ahiya Marcel Decker.

CELL & MOLECULAR BIOLOGY LAB

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Laboratory Code	15BTL47	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Marks	80
		Exam Hours	03

CREDITS – 02

Course objectives: This laboratory course enables students to get practical experience in

- To understand the cell division: Mitosis and Meiosis.
- To study the somatic cell hybridization.
- To learn isolation of DNA from various sources
- To learn agarose gel electrophoresis for separation of nucleic acids

Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
1. Study of divisional stages in Mitosis	**L2, L4, L5**
2. Study of divisional stages in Meiosis.	**L2, L3, L4**
3. Study of Polytene and Lampbrush chromosomes using permanent slides.	**L2, L3, L4**
4. Isolation and fusion of plant protoplasts.	**L5, L6**
5. Isolation of plasmid DNA from bacteria.	**L5, L6**
6. Isolation of genomic DNA (plant / microbial sources)	**L2, L3, L4**
7. Agarose gel electrophoresis and quantification of nucleic acids (colorimetric, ethidium bromide dot blot and standard DNA marker)	**L5, L6**
8. Digestion and mapping of plasmid pUC18.	**L2, L3, L4**
9. Competent cell preparations.	**L2, L3, L4**
10. Transformation and selection of recombinants	**L5, L6**
11. Study of conjugation in E.coli.	**L5, L6**
12. Amplification of DNA by PCR.	**L5, L6**

Course outcomes: On the completion of this laboratory course, the students will be able to:

- To be able to understand the mitotic and meiotic cell divisions;
- Tobe able to carry out somatic cell fustion;
- Shouldbe able to separate DNA and run various fragments through electrophoresis.

Graduate Attributes (as per NBA)

- Engineering Knowledge.
- Problem Analysis.
- Design/Development of solutions.
- Modern tool usage.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. 4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Book:

1. Molecular Cell Biology by Darnell J Lodish& H Baltimore, Freeman Pub.
2. Biochemistry & Molecular Biology by William H Elliot and Daphane C Elliot, Oxford University Press.
3. Current protocols in molecular biology,edited by Frederick M. Ausubel et al., John Wiley & Sons.
4. Methods in enzymology by Berger S.L. & Kimmel A.R., Vol.152, Academic Press.
5. Cellular & Biochemical Science by G. Tripathi, IK Intl.

UNIT OPERATION LABORATORY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Laboratory Code	15BTL48	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Marks	80
		Exam Hours	03

CREDITS – 02

Course objectives: This laboratory course enables students to get practical experience in

1. Basic unit processes in industrial set up pertaining to fluid mechanics, mechanical operations.
2. Trouble shooting of problems related to fluid mechanics & Mechanical operations.

Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
A) Experiments based on principles of Fluid Mechanics & Mechanical Operations	
1. Friction losses in circular pipes	**L4, L5**
2. Flow measurements using Venturi /Orifice/ Rotameter.	**L2, L3, L4**
3. Centrifugal /Reciprocating pumps	**L2, L3, L4**

4. Packed bed flow	**L5, L6**
5. Batch sedimentation.	**L5, L6**
6. Ball Mill	**L2, L3, L4**
7. Cyclone separator	**L5, L6**
8. Leaf / Pressure filter	**L2, L3, L4**
9. Screen analysis/effectiveness.	**L2, L3, L4**
B) Experiments based on principles of Heat and Mass Transfer Operations.	
1. Natural convection in bare and finned tubes.	**L2, L3, L4**
2. Heat transfer in packed bed.	**L5, L6**
3. Emissivity determination	**L5, L6**
4. Critical thickness of insulation.	**L5, L6**
5. Diffusion of organic solvent in air.	**L2, L3, L4**
6. Simple Distillation.	**L2, L3, L4**
7. Steam Distillation.	**L2, L3, L4**
8. Liquid – liquid Extraction.	**L2, L3, L4**
9. Drying-Tray dryer	**L2, L3, L4**

Note: Minimum 12 experiments are to be conducted choosing at least 6 from sections A and B.

Course outcomes: On the completion of this laboratory course, the students will be able to:

1. Should be able to record observations systematically and arrive at required results based on experiments conducted
2. Study and design different flow measuring instruments.
3. Understand and Estimate the shape and size of irregular particles

Graduate Attributes (as per NBA)

- Engineering Knowledge.
- Problem Analysis.
- Design/Development of solutions.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Book:

1. Principles of Unit Operations by Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B.
2. Anderson, John Wiley & Sons.
3. Chemical Engineering by Coulson and Richardson. Vols I & II. Elsevier Science.
4. Chemical Engineers Hand Book by Perry, McGraw Hill Publications.
5. Process Heat Transfer by Kern, McGraw Hill.