Department of Bio- Engineering

B.I.T., Mesra, Ranchi

B.E. Course Structure w.e.f. 2011 Batch

Course No	Course Title	L	T	P	CREDIT
1st Semester					
HU-1101	Technical English	3	0	0	3
PH1201	Physics	3	1	0	4
MA1201	Engg. Mathematics	3	1	0	4
EE2201	Principles of Electrical Engg	3	1	0	4
CH1401	Engg. Chemistry	3	0	0	3
ME1202	Engg. Graphics	1	0	3	3
CS1302	Fundamental of Unix & C Programming	1	0	3	3
PE1202	Workshop Practice	0	0	3	2
PH1202	Physics lab	0	0	3	2
GA1002/ GA1004 GA1006/GA1008	NCC / NSS / PT & Games / C. Arts	0	0	2	1
				Total	**29**

2nd Semester					
EC2001	Principle of Electronics Engg	3	0	0	3
MA2201	Advance Engg Mathematics	3	1	0	4
CH2203	Environmental Science	3	0	0	3
CS2301	Fundamentals of Data Structure	3	1	0	4
ME2001	Principles of Mechanical Engg	3	0	0	3
AM1201	Engineering Mechanics	3	1	0	4
CH1402	Chemistry Lab	0	0	3	2
EE3202//AM2202	Basic Electrical Engg Lab/ Engineering Mechanics Lab	0	0	3	2
EC2002	Basic Electronics Engg Lab	0	0	3	2
CS2302	Data Structure Lab	0	0	3	2
GA2/ 4/6/8	NCC / NSS / PT & Games / C. Arts	0	0	2	1
				Total	**30**

3rd Semester					
BT3023	Cell & Molecular Biology	3	0	0	3
BT3025	Bio-analytical techniques	3	0	0	3
BT3027	Biomolecules& Bioenergetics	3	0	0	3
BT3029	Chemical Engineering I	3	0	0	3
BT3021/HU4001	Biological Science/ Foreign Language	3	0	0	3
AM2202/EE3202/	Engineering Mechanics Lab/Basic Electrical Engg Lab	0	0	3	2
BT3024	**Cell &Molecular Biology Lab.**	0	0	3	2
BT3026	**Bio-analytical techniques Lab.**	0	0	3	2
BT3028	**Biochemistry Lab.**	0	0	3	2
GA3002/4 /6/8	**NCC/NSS/PT & Games/ Creative Arts**	0	0	2	1
				Total	**24**
4th Semester					
BT4021	Chemical Engineering II	3	1	0	4
BT4023	Microbiology	3	0	0	3
BT4025	Immunology	3	0	0	3
BT4027	Thermodynamics of Chemical & Biological Systems	3	0	0	3
HU4001/ BT3021	Foreign Language/ Biological Science	3	0	0	3
BT4022	**Chemical Engineering I Lab.**	0	0	3	2
BT4024	**Microbiology Lab.**	0	0	3	2
BT4026	**Immunology Lab.**	0	0	3	2
GA4002/4 /6/8	**NCC/NSS/PT&Games/ Creative Arts**	0	0	2	1
				Total	**23**

Course No	Course Title	L	T	P	CREDIT
5th Semester					
BT5021	Bioprocess Engineering	3	0	0	3
BT5023	Chemical Engineering III	3	1	0	4
BT5025	Functional Genomics and rDNA Technology	3	0	0	3
BT5027	Reaction Engineering	3	0	0	3
	Breadth Subject-I	3	0	0	3
BT5022	**Bioprocess Engineering Lab.**	0	0	3	2
BT5024	**Chemical Engineering Lab. II**	0	0	3	2
BT5026	**rDNA Tech. Lab**	0	0	3	2
				Total	**22**
6th Semester					
BT6021	Bioseparation Engineering	3	0	0	3
BT6023	Plant & Agriculture Biotechnology	3	0	0	3
BT6025	Food &Enzyme Technology	3	0	0	3
BT6027	Process Measurement and Control	3	0	0	3
	Breadth Subject-II	3	0	0	3
BT6022	**Bioseparation Engineering Lab.**	0	0	3	2
BT6024	**Plant Cell Technology Lab.**	0	0	3	2
BT6026	**Enzyme Technology Lab.**	0	0	3	2
				Total	**21**
7th Semester					
BT7021	Biological Waste Management	3	0	0	3
BT7023	Bioreactor and Bioprocess Design	3	0	0	3
	Breadth Subject-III	3	0	0	3
ELECTIVE- I	[**DEPT.]** (Any one from following)	3	0	0	3
BT7025	Bioenergy				
BT7027	Bioremediation				
BT7029	Pharmaceutical Biotechnology				
BT7031	Mineral Biotechnology				
BT7033	Animal & Stem Cell Technology				
BT7035	IPR, Biosafety & Bioethics				
ELECTIVE- II	[**OPEN]**(Any one from following)	3	0	0	3
BT7022	**Environmental Biotechnology Lab.**	0	0	2	2
BT7024	**Bioinformatics Lab I**	0	0	3	2
BT7050	**Dept. Project I**	0	0	6	4
				Total	**23**
8th Semester					
BT8021	Biotechnology Management	3	0	0	3
BT8040	**Industrial Training (To be evaluated with Dept. Project II)**				
BT8050	**Dept. Project II**	0	0	6	4
				Total	**7**

Total Credits : 29+30+24+23+22+21+23+07=179

3rd Semester

BT3021Biological Sciences

Module-I

Nature of living things: Definition of life, Miller's experiment, theories and evidences about origin of life, levels of biological organization, classification of living world.

Module-II

Biomolecules: composition of living matter, water, carbohydrates, lipids, proteins, nucleic acids, vitamins and minerals.

Module-III

Biochemistry: Bioenergetics and thermodynamics, biological oxidation-reduction reactions, glycolysis, citric acid cycle, fatty acid metabolism, electron transport chain, aerobic and anaerobic respiration

Module-IV

Molecular organization of cell: Viruses, cellular structure of microorganism, animal and plant, salient features of intracellular organelles, cell division and cell cycle, structure of chromosomes, difference between prokaryotes and eukaryotes.

Module-V

Molecular biology: Structure of DNA and RNA, DNA as genetic material, central dogma of molecular biology, DNA replication, transcription and translation, Introduction to bioinformatics and drug designing.

Module-VI

Enzymology:, Mechanism of enzyme action, Lock and key model and induced fit model, active site, MichaelisMenten equation, reversible and irreversible inhibitors, competitive, non-competitive and uncompetitive inhibition.

Module-VII

Techniques in biological sciences: Centrifugation, chromatography, gel electrophoresis, spectroscopy, thermal analysis,.

Books Recommended

1. Purves et al, Life: The Science of Biology

2. R. Dulbecco, The Design of Life.

3. Lehninger A, Principals of Biochemistry

4. Stryer L, Biochemistry

5. K. Wilson & K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry.

BT3023 Cell & Molecular Biology

Module-I

Introduction To The Cell: Evolution of cell, prokaryotic and eukaryotic cell, unicellular and multicellular organisms.Cell Organells:Cell wall, cell membranes, cytosol, mitochondria, chloroplast, nucleus, ribosome, lipososmes, golgibody, endoplasmic reticulum, motility organelles, flagella, pilli**,** cilia, Cell division

Module-II

Cell Signaling: General principles of cell signaling, Signaling via G-Protein linked cell-surface Receptors, Signaling via Enzyme- linked cell-surface Receptors, target cell adaptation

Module-III

DNA structure & Chromosomes::DNA as genetic material, structure of DNA, DNA replication, repetitive DNA, Chromosomal DNA and its packaging,

Module-IV

Genetic organization:Discovery and salient features of genetic code, overlapping genes, organellar genetic code, colinearity of genes and protein, organelle and extranuclear inheritance.

Module-V

Regulation of gene activity: Central dogma, difference in genetic organization of prokaryote and eukaryote, *lac* operon, regulation of bacteriophage λ life cycle, nucleic acid binding motifs in regulatory proteins.

Module-VI

Mutation:General properties and types of mutation**,** DNA damage and repair, reverse and suppressor mutations, duplications, deletions, inversions and translocations, polyploidy, transposable elements, inborn errors of metabolism.

Module-VII

RNA & Protein:RNA synthesis & RNA processing,Protein synthesis, Posttranslational modifications.

Books Recommended

1. Alberts et al, Molecular Biology of the Cell
2. Lodish et al, Molecular Cell Biology
3. DeRobertis, Cell Biology
4. Harper, The Cell

BT3025 BIOANALYTICAL TECHNIQUES

Module-I

Centrifugation Techniques: Introduction, basic principle of sedimentation, basic idea of types of centrifuges, density gradient centrifugation, preparative centrifugation, analysis of subcellular fractions, & applications of analytical centrifugation.

Module-II

Chromatographic Techniques – I: (a) Introduction to chromatography; General principles, column chromatography – columns, stationary phases. Partition and adsorption chromatography. (b) Affinity Chromatography; Principle, materials – matrix, selection of attachment of ligands, practical procedures, specific and non-specific elution, applications. (c) Ion Exchange Chromatography: Principle, types of exchangers, materials, choice of exchangers and buffers and applications.

Module-III

Chromatographic Techniques – II: (a) Gas Chromatography: Principle of GC system, solid support, capillary column, stationary phase, preparation and application of sample, separation conditions, detection systems and applications. (b) HPLC: Principle, components of HPLC system, pumping systems, detectors systems, and its applications; UPLC.

Module-IV

Electrophoresis: (a) General principle, factors affecting electrophoresis – voltage, current, resistance, buffer – composition, concentration, pH. (b) Gel electrophoresis;Types of gels (starch, agarose, polyacrylamide), Idea of electrophoresis unit, preparation of gel, sample application, running the samples, SDS-PAGE - Principle, apparatus and methods, gradient gels, Two dimensional gels, isoelectric focusing.

Module-V

Spectroscopy – I: (a) Spectroscopic Techniques; Introduction, Energy levels and transition of electrons, Types of spectra, Beers Lamberts law, molar and extinction coefficient. (b)Visible and UV Spectrophotometry; Principles,Instrumentation and applications. (c) Spectroflourimetry; Principle, stoke's shift, quantum efficiency, instrumentation, & applications

Module-VI

Spectroscopy – II: (a) Atomic & Flame spectrophotometry ; Principles, Instrumentation & applications for flame emission / atomic absorption spectrophotometry and their comparative study; ICP (b) Mass spectrometry; Principles, Instrumentation and applications

Module-VII

Thermal Analysis: Differential scanning calorimetry and differential analysis - Instrumentation, Thermogravimetry, Methodology of Thermogravimetry, differential scanning calorimetry and differential thermal analysis.

Books Recommended:

K. Wilson & K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry.

Willard and Merrit, Instrumental Methods and Analysis

Ewing GW, Instrumental Methods of Chemical analysis.

BT3027 Biomolecules & Bioenergetics

Module-I

Nucleic Acids: Generalised structural plan of nucleic acids(DNA, RNA), Nucleotides, Nucleosides, features of DNA double helix, phosphodiester bonds, hypochromic effect, different types of DNA

Module-II

Proteins: Structure and properties of 20 amino acids, Zwitterion nature of amino acids in aqueous solution, Abbreviation and classification of 20 amino acids, definition of N-terminal and C-terminal amino acids, basic understanding of primary, secondary, tertiary, quaternary structure of proteins, elementary idea of protein denaturation and loss of biological activity

Module-III

Carbohydrates: Definition, empirical formula, classification into mono, oligo, & polysaccharides, structure of biologically important carbohydrates (D-glucose, D-galactose, D-mannose,), formation of D-maltose, D-sucrose, D-lactose, Polysaccharides such as starch, glycogen, cellulose

Module-IV

Carbohydrate Metabolism: Individual reactions of glycolysis, alcoholic fermentation, gluconeogenesis, Oxidation of Pyruvate to Acetyl CoA, individual reactions of TCA cycle,regulation of TCA cycle

Module-V

Lipids: Definition, general formula of fatty acids, properties of fatty acids, general structure and function of major lipid sub-classes: triacylglycerol, phosphoglycerides, waxes, sterols, beta oxidation pathway, omega oxidation, oxidation of unsaturated fatty acids, biosynthesis of fatty acids

Module-VI

Enzymes: IUB enzyme classification (overview), Lock and key model and induced fit model apoenzyme, holoenzyme, Mechanism of enzyme action by lowering activation energy, concept of active site, MichaelisMenten equation, Effect of temperature, pH and substrate concentration on enzyme action, enzyme turnover number Specific activity

Module-VII

Enzymes Immobolization: Definition, methods of immobilisation -covalent coupling to supports (brief), physical adsorption, entrapment, chemical aggregation, microencapsulation, immobilisation through carbohydrate chains. Effect of pH, temperature, chemical denaturants on immobilised enzymes. Applications of immobilised enzymes (brief)-in medicine, industry

Books Recommended:

Albert Lehninger, Principles of Biochemistry
Lehninger, Nelson, Cox, Principles of Biochemistry
Cohn and Stumpf, Outlines of Biochemistry
LubertStryer, Jeremy M. Berg, John L. Tymoczko, Biochemistry
R.K. Murray, D.K. Granner et al., Harper's Biochemistry
Voet&Voet, Biochemistry

BT3029 CHEMICAL ENGINEERING I

Module-I

Introduction to chemical engineering calculations- Units and dimensions, mole units, basis of calculations, the chemical equation and stoichiometry, dimensional analysis.

Module-II

Material balance fundamentals, conversion and yield, material balance problems that do not involve chemical reactions.

Module-III

Material balance problems that involve chemical reactions, recycle, bypass and purge calculations.

Module-IV

Ideal Gas Law, real gas relationship, vapor pressure, saturation and equilibria.

Module-V

Vapor-liquid equilibria, partial saturation and humidity, condensation and vaporization.

Module-VI

Energy balance concepts and units, enthalpy changes, general energy balance that do not involve reactions.

Module-VII

Energy balance that involves chemical reactions, Heat of solution and mixing, Humidity charts and their use.

Books Recommended:

Himmelblau, Basic Principles and Calculations in Chemical Engineering.

Hougen, O.A. and Watson, K.M. Chemical Process Principles (Part I)

BT3024 Cell and Molecular Biology Lab.

1. Microscopy
2. Cell motility and flagellar staining, Photography and videotaping (motility, morphometry)
3. Micrometry: Calibration of stage and ocular micrometer and measurement of the given biological sample.
4. Haemocytometer: calibration and measurement of biological samples.
5. Gram staining, Giemsa, Trypan blue staining.
6. Isolation and purification of genomic DNA from bacteria/plant.
7. Isolation and purification of plasmid DNA.
8. Analysis of DNA by agarose and polyacrylamide gel electrophoresis.
9. Recovery of DNA from gels.
10. Restriction analysis of DNA.

BT3026 Bioanalytical Techniques Lab

1. Gas Chromatography
2. Liquid Chromatography
3. Mass Spectrometry
4. FTIR
5. DSC
6. SEM
7. ICP-OES
8. TGA

BT3028 BIOCHEMISTRY LAB.

1. Introduction to measurements: balances and pipetting Preparation of solutions of given normality and its standardization
2. pH meter: preparation of buffers of different capacity
3. Colorimetry: To determine the dissociation constant of a given indicator colorimetricallyand to prepare the buffer solutions in the pH range of 2.2 to 8.0
4. Chemical analysis of water
5. Thin layer chromatography: lipids, mixture of dyes
6. Spectrophotometry: Analysis of glucose, sucrose and ethanol
7. ELISA Reader and spectrophotometer: Estimation of protein by Lowry, Biuret and Bradford methods
8. Enzyme assays
9. Protein estimation.

4th Semester

HU4001 Language

BT4021 Chemical Engineering II

Module-I

Basic Equations of Fluid Flow: Fluid-Flow Phenomena, Newtonian and non-Newtonian fluids, Turbulence and its nature, Reynolds number and transition from laminar to turbulent flow, flow in boundary layers, boundary layer formation in straight tubes, continuity equation, Bernoulli equation with and without fluid friction, pump work in Bernoulli equation, angular momentum equation.

Module-II

Flow of Incompressible Fluids: Fluid flow in pipes, friction factor, laminar flow in pipes, Hagen-Poiseuille equation, turbulent flow in pipes and closed channels, effect of roughness, friction factor charts, Reynolds numbers and friction factor relationship, friction losses from sudden expansion and contraction of cross section, flow of liquids in thin layers.

Module-III

Flow of Compressible Fluids: Processes of compressible flow, Flow through variable-area conduits, adiabatic frictional flow, isothermal frictional flow, flow past immersed bodies, drag coefficients, stagnation point and stagnation pressure, motion of particles through fluids, hindered settling, fluidization, minimum fluidization velocity, types of fluidization.

Module-IV

Transportation and Metering of Fluids: pipe fittings and valves, positive displacement pumps, centrifugal pumps, head losses in centrifugal pump, blower and compressor, flow measuring devices such as venturimeter, orifice meter, pitot tube and rotameter.

Module-V

Heat transfer by conduction in solids: Fourier's Law, thermal conductivity, Steady state conduction, compound resistance in series, heat flow through a cylinder, one dimensional unsteady state heat conduction.

Module-VI

Heat transfer by convection: Thermal boundary layer, Heat transfer by forced convection in laminar and in turbulent flows, heat transfer by natural convection in laminar flow, heat transfer from condensing vapors, filmwise and dropwise condensation.

Module-VII

Radiation heat transfer: Fundamental facts concerning radiation, emission of radiation, black body radiation, absorption of radiation by opaque solids, Kirchhoff's Law, radiation between surfaces, view factors, combined heat transfer by conduction-convection and radiation.

Books Recommended:

1. McCabe, Smith and Harriot, Unit Operation of Chemical Engineering
2. Fox and McDonald, Introduction to fluid mechanics
3. Hollman, Heat transfer, 8^{th} Ed.
4. Foust, Wenzel, Clump, Maus and Andersen, Principles of Unit Operations.
5. Geankoplis, Transport processes and unit operations

BT4023 Microbiology

Module-I

Introduction: History of Microbiology, Methods in Microbiology-Microscopy, Methods of sterilization; culture media, Pure culture methods, Staining of Bacteria, Micrometry, culturing cells and spores, Classification of microorganisms into different groups: Bacteria, Viruses, Fungi, Actinomycetes, Outline of classification of bacteria and fungi

Module-II

Structure of Microorganisms and Microbial Metabolism: Fine structure of bacteria, Archaebacteria, Mycoplasmas, Mycobacteria, Myxobacteria, Rickettisae and chlamydiae, structure and classification of Viruses (Bacteriophage, Oncogenic viruses), Growth of Microorganisms, Cell cycles, Population growth, Batch culture, Continuous culture, Synchronous growth, Fed-batch culture.

Module-III

Environmental Microbiology: Distribution of Microbes in Air and water, Allergic disorders by air microflora, air sampling, Microbial components of water, Water treatment, Bacteriological analysis of water. Microbiology of Extreme environments (Methanogens, Halobacteria, Thermoacidophiles), Microbiology of sewage.

Module-IV

Agricultural Microbiology: Parasitism, Commensalism, Symbiosis and related microbial interactions, Rhizosphere and Rhizoplane, Bioinoculants. Beneficial plant-microbial interactions.Microbial Biodeterioration of agricultural products, Mycotoxins, control of microbes and safe storage of agricultural products, RH value, Aw values.

Module-V

Aquatic microbiology: microbiology of sewage, aquatic microorganisms & their interactions, Role of relative humidity (RH) & water availability (Aw) in Microbial interactions

Module-VI

Microbial Biotechnology: Microbes in metal recovery, microbes in paper industries, Microbes as a source in vitamin production. Industrially important micro-organisms, secondary metabolites from micro-organisms.

Module-VII

Medical Microbiology: Diseases caused bacteria, virus, fungi, and protozoans; Fungal diseases (Mycoses), Microbial flora of healthy human host, host – microbe interactions, natural resistance and nonspecific defense mechanisms. Microbial agents of disease

Books Recommended:

Pelczar, Chan and Krieg, Microbiology

Stanier et al, General Microbiology

Rangaswamyet. al. Agriculture Microbiology

Gary Stacey,& Noel T. Keen Plant-Microbe interactions

Effect of Mineral-Organic-Microorganism Interactions on Soil by J. Berthelin, P. M.

Huang, J. M. Bollag, F. Andreux (Plenum Publishing Corporation)

BT4025 Immunology

Module-I

Introduction and history.The immune system, innate and acquired immune system, components of immune system, role of humoral and cell-mediated immunity.

Module-II

Antibodies, the genetic basis of antibody diversity, structure-function, immunoglobulin classes.Polyclonal and Monoclonal antibodies, Catalytic antibodies.

Module-III

Structure and properties of antigens, biological aspects of antibody-antigen interaction.

Module-IV

Identification and measurement of antibodies and antigens, Radial Immuno diffusion, Ouchterlony Double diffusion, Immuno electrophoresis, Radio Immunoassay, ELISA, Western blot, Immunofluorescence. Agglutination and complement

Module-V

Hypersensitivity, Type I, Type II, Type III, Type IV

Module-VI

Major histocompatibility complex, Development of DNA vaccine

Module-VII

Immunological disorders

Books recommended

Essential ImmunologyRoitt,

Immunology, the immune system in health and diseaseJareway et al,

BT4027 Thermodynamics of Chemical & Biological Systems

Module-I

Introduction: Concept of Continuum. Macrose approach, Thermodynamics system control volume intensive and extensive properties, Thermodynamic equilibrium, State of system, state diagram, path and process, Zeroth law Thermodynamics, concept of temperature, Heat and work.

Module-II

Thermodynamic properties of pure substances in solid, Liquid and vapour phases, Equations of state, Thermodynamic property table and charts. First law of Thermodynamics: Energy and its forms, Enthalpy, specific heats, Compressibilities and expansion coefficient, First law applied to control volumes (Open System) – Steady & Unsteady flow analysis. Typical applications.

Module-III

Second Law Of Thermodynamics: Second Law, Kelvin-Plank and Clausius statement. Corollaries of Second Law – Reversible and irreversible processes, Thermodynamic (absolute) temperature scale.

Module-IV

Entropy: Inequality of Clausius and concept of Entropy. Entropy change of a system and Control Volume.Principle of increase of Entropy, available and Unavailable Energy.

Module-V

Ideal Gases: Definition, Specific Heats, Entropy change for Flow and Non-Flow processes. Cycles: Simple Vapour power cycles – Carnot, Rankine. Air-Stand Cycles – Joule, Otto, Diesel Cycles. Vapour compression refrigeration cycle.

Module-VI

Gibbs – Duhem equation, phase rule, single component phase equilibria. Thermodynamics of solutions.Ideal and non-ideal solutions. Estimation and determination of activity coefficients

Module-VII

Regular solution theory.Fugacity and properties of mixture.Chemical reaction equilibria.Homogenous and heterogeneous reaction systems.Thermodynamic analysis of biochemical reactions.Classical and non-equilibrium thermodynamics of biochemical reactions.

Books Recommended:

P.K. Nag, Thermodynamics

Wylen, Fundamentals of classical thermodynamics.

Denbigh, Principles of chemical equilibria

Dodge, Chemical engineering thermodynamics

Stephanoponlos et al, Metabolic engineering, Principles and Methodologies.

BT4022 Chemical Engineering I Lab.

1. Introduction to Good Laboratory Practice (GLP).
2. Material balance in a chemical reaction by gas flow meter.
3. To calibrate a rotameter and plot correction curves at various pressure heads.
4. To draw the distribution curve for methanol water system using vapor-liquid equillibria set up.
5. To determine the heat of solution by mixing using a calorimeter.
6. To determine the mass flow rate and pressure drop across the venturimeter.
7. To draw the characteristic curve for the flow through venturimeter.
8. To study the flow behavior across the orifice meter and draw the characteristic curves for various inlet pressures.
9. To test the significance of Bernaulli's equation for the energy balance by orifice meter.
10. To study the flow across the various notches.
11. Calculate the velocity of the flow and pressure drop across the pitot tube.
12. To study the fluidization effect and pressure drop in a fluidized bed column.
13. To calculate the pressure drop and superficial velocity of flow in packed bed column.
14. To calculate the pressure drops in various pipes and fitted valves in pipefittings.
15. To study the pattern of flow in free and forced vertex.
16. To calculate the loss of heads in centrifugal pump.

BT4024 Microbiology Lab.

1. Cleanliness, media preparation, sterilization, culturing methods, dilution techniques, and isolation of pure cultures – techniques.
2. Staining techniques in microbiology i) simple staining ii) negative staining iii) positive staining iv) spore staining v) capsule staining and identification.
3. Culture characteristics of microbes, identification of unknown bacteria by biochemical tests.
4. Bacterial growth curve – serial dilution plating and turbidity measurement.
5. Competent cell preparation, replica plating.
6. Extracellular enzymatic activities of microbes, immobilization of *Sacchromycescerevisiae* and alcohol.
7. Standard qualitative analysis of water.
8. Antibiotic sensitivity test, LD50, Potency of drugs/antibiotics and biotransformations.

BT4026 Immunology Lab

1. Immunodiffusion
2. Immunoelectrophoresis
3. Western blotting
4. Production of monoclonal antibodies and testing,
5. Antigen – Antibody reactions (Widal test, Blood grouping, Rh factor)
6. RBC & WBC count by haemocytometer
7. ELISA

5th Semester

BT5021 Bioprocess Engineering

Module-I

Cell growth and bio-product formation kinetics: Quantification of cell growth, growthpatterns and kinetics in batch culture, environmental factors affecting growth kinetics, heat generation by microbial growth, unstructured non segregated model, models for transient behavior, kinetics of product formation.

Module-II

Mass balance and yield concepts: Yield and maintenance coefficients, calculation basedon elemental balances, degree of reduction, theoretical predictions of yield coefficients.

Module-III

Enzyme kinetics: Introduction to enzymes, mechanistic models for simple enzymekinetics, rate parameters, models for more complex enzyme kinetics, effect of pH and temperature, methods of immobilization, diffusional limitations in immobilized enzyme systems, brief introduction to large scale enzyme production.

Module-IV

Media and air sterilization: introduction and the kinetics of death, batch and continuoussterilization of media, air sterilization, various type of sterilization equipments, sterilization of media by membrane filters.

Module-V

Agitation and aeration: types of impellors and sparger, oxygen transfer rate, oxygenuptake rate, volumetric oxygen transfer rate (k_La), measurement of k_La, power requirement for agitation in gaseous and non gaseous systems.

Module-VI

Operating considerations for bioreactors: Choosing the cultivation methods, Batch,fed-batch and continuous bioreactors:

Module-VII

Analysis of ideal bioreactors: Fed-batch reactors, Enzyme catalysed reactions in CSTRs, CSTR reactors with recycle and wall growth, ideal Plug-flow tubular reactor.

Books Recommended:

Lee, Biochemical Engineering

Shuler and Kargi, Bioprocess Engineering – Basic Concepts. Prentice Hall PTR

Aiba and Humphary. Biochemical Engineering

Doran, Bioprocess Engineering Principles

Bailey and Ollis, Biochemical Engineering Fundamentals

BT5023 Chemical Engineering III

Module-I

Phase diagram, temperature concentration diagram, enthalpy concentration diagram, Ideal solution, Roult's Law, relative volatility, azeotropes. Differential distillation, flash vaporization, vacuum and steam distillation

Module-II

Multistage contact operations, characteristics of multistage towers, McCabe Theile Method, reflex, maximum, minimum and optimum reflex, tray efficiency, determination of height and column diameter.

Module-III

Ternary liquid equilibria, triangular graphical representation, concept of theoretical or ideal stages and multistage continuous operation.

Module-IV

Leaching, solid-liquid equilibrium, equipments used in solid-liquid extraction. Single and multiple contact. Overall stage efficiency, graphical determination of number of stages.

Module-V

Description of adsorption and absorption processes and their applications, types of adsorption, nature of adsorbents adsorption equillibria.

Module-VI

Properties and handling of particulate solids, size reduction, screening and particle size distribution.

Module-VII

Drag force and terminal settling velocity, principles of filtration, centrifuges.

Books Recommended:

McCabe, Smith and Harriot, Unit Operations of Chemical Engineering

Foust et al, Principles of Unit Operations

Treybal, R.E. Mass Transfer Operations

Badger and Banchero.Introduction to Chemical Engineering.

BT5025 Functional Genomics and rDNA Technology

Module-I

Creation Of Recombinant Molecules: Characteristics of plasmid and other cloning vectors, artificial chromosomes, prokaryotic and eukaryotic expression vectors, Recombinant Protein purification by IMAC method.

Module-II

Genomic evolution: The world of RNA, ribozyme, Genetics to genomics to functional genomics. Forward and Reverse genetics

Module-III

Methods In Genetic Engineering: Restriction and modifying enzymes, Restriction mapping, Southern blot, Northern blot, Western blot, Polymerase Chain Reaction: Thermostable DNA

Polymerases, PCR technique, Inverse PCR, Nested PCR, RACE PCR, RealTime PCR, Site directed mutagenesis,

Module-IV

DNA sequencing: Sanger, Pyrosequencing and other NGS Whole Genome Sequencing: Strategies used,

Module-V

Post-Transcriptional Gene silencing: RNA interference, antisense RNA, siRNA, MiRNA,

Module-VI

Libraries: Genomic, cDNA, EST, Cot-based, Screening of libraries with DNA probes and with antisera. Large insert genomic libraries and physical mapping Strategies and approaches to genome sequencing

Module-VII

Applications Of Recombinant DNA Technology: Transgenic plants and animals, DNA vaccine, Gene therapy, PCR based diagnosis.

Books Recommended

Old and Primorose- Gene Manupulation

Alberts et al, Molecular Biology of the Cell

Watson, Recombinant DNA.

BT5027 REACTION ENGINEERING

Module-I

Kinetics of homogeneous reactions: classification of reactions, reaction rate, speed of reaction, rate equation, concentration-dependent term of rate equation, rate constant, order and molecularity, representation of elementary and nonelementary reactions, kinetic models for nonelementary reactions, temperature-dependent term of a rate equation, activation energy and temperature dependency.

Module-II

Kinetic analysis of batch reactor data: Integral and differential methods for analyzing kinetic data, interpretation of constant volume batch reactor, data for zero, first, second and third order reactions, half life period, irreversible reaction in parallel and series, auto catalytic reaction.

Module-III

Kinetic interpretation of batch reactor data for single reactions: interpretation of variable volume batch reaction data for zero, first and second order reactions, Ideal batch reactor, steady state CSTR and plug flow reactors and their use for kinetic interpretation.

Module-IV

Design for single reaction: size comparison of single reactors, plug flow reaction in series and/or parallel, equal and different size of mixed reactor in series, finding the best system for given conversion, recycle reactor, Design of multiple reactions in batch, CSTR and PFR,

Module-V

Energy balance equations: equations for batch, CSTR and PFR and their application to the design of reactors, concepts of non-ideality, residence time distribution of fluids in vessels, models for non-ideal flow.

Module-VI

Reaction catalyzed by solids: introduction to heterogeneous reactions, rate equation for surface kinetics, pore diffusion resistance combined with surface kinetics, porous catalyst particles, performance equations for reactors containing porous catalyst particles, experimental methods for finding rates, advantages and disadvantages of packed bed and fluidized bed catalytic reactors.

Module-VII

Biochemical reaction systems: enzyme fermentation, Michaelis-Menten kinetics, inhibition by foreign substances, kinetics of competitive and noncompetitive inhibitions, microbial fermentation, batch fermentor and mixed flow fermentor, kinetic expressions of fermentation.

Books Recommended

Levenspiel, O. Chemical Reaction Engineering Ed.3, John Wiley & Sons (Asia)

Smith, Chemical Engineering Kinetics

Foggler, Elements of Chemical Reaction Engineering

BT5022 Bioprocess Engineering Lab.

1. Sterilization of inlet and outlet air filters by steam.
2. *In situ* Sterilization of empty bioreactor.
3. Medium preparation and in situ sterilization of medium in the bioreactor.
4. Study of induction effect of galactosidase enzyme in *E. coli.*
5. Fermentation of ethyl alcohol using *Candida albicans.*
6. Fermentation of citric acid using *Aspergillusniger*
7. Creation of auxotrophic mutants for lysine, valine and other essential amino acids.
8. Designing of fermentation processes for penicillin and 6- APA.
9. Designing of fermentation process for lysine
10. Yeast fermentation to produce ethanol.
11. Fermentation of *Penecilliumcrysogenum* to produce penecillin
12. Determination of volumetric oxygen transfer coefficient (k_La) by sulphite oxidation method.
13. Determination of volumetric oxygen transfer coefficient (k_La) by dynamic method.

BT5024 Chemical Engineering Lab. II

1. To determine thermal conductivity of metal rod by Searl's apparatus.
2. To determine the thermal conductivity of composite wall of insulating materials.
3. To determine convective heat transfer coefficient by electrically heated vertical pipe by free and forced convection.
4. To determine the emissive power of a gray body kept near a black body.
5. To determine the overall heat transfer coefficient of shell and tube heat exchanger.
6. To determine the overall heat transfer coefficient of double pipe heat exchanger.
7. To calculate the heat loss in a lagged pipe made of various insulating materials.
8. To study the performance and determine the equilibrium relationship in bubble cap distillation column.
9. To separate the solute from one phase to another (aqueous to solvent) phase by liquid-liquid extraction.
10. To study the performance of leaching process by solid-liquid extractor and determine the equilibrium relationship.
11. To determine the loss of weight of naphthalene balls in solid air diffusion apparatus.
12. To determine the coefficient of absorption in packed bed column.
13. To study the performance of membrane separation unit.
14. To study crystal size distribution in a crystallizer.
15. To study the rate of drying in forced draft tray drier coupled with IR balance.
16. To study the performance of an ion exchange unit.

BT5026rDNA Tech. Lab

1. Isolation of RNA
2. Electrophoresis of RNA on denaturing gels.
3 cDNA synthesis
4. PCR technique
5. Cloning & 6. Sequencing

6th Semester

BT6021 Bioseparation Engineering

Module-I

Separation of insoluble products: sedimentation, filtration, centrifugation, coagulation and flocculation.

Module-II

Cell Disruption: Mechanical methods, Non-mechanical methods.

Module-III

Separation of soluble products: Liquid-liquid extraction, aqueous two-phase extraction, precipitation, adsorption.

Module-IV

Dialysis, electro-dialysis, ultra-filtration and micro-filtration, cross-flow ultra-filtration and micro-filtration.

Module-V

Chromatography: Adsorption chromatography, Ion- exchange chromatography, gel-filtration chromatography, affinity chromatography, high pressure liquid chromatography, hydrophobic chromatography.

Module-VI

Chromatography scale-up.

Module-VII

Crystallization and drying.

Books Recommended:

M.R. Ladisch, Bioseparations Engineering, Wiley Interscience 2001

Kennedy and Cabral, Recovery processes for biological materials.

Heinemann, Product Recovery in Bioprocess Technology, Butterworth Publication.

BT6023 Plant & Agriculture Biotechnology

Module-I

In Vitro culture: benefits and limitations, Culture media components, role of plant growth regulators, sterilization techniques, aseptic manipulation techniques.

Module-II

Callus Culture: Organogenesis and Embryogenesis, Clonal/Micro Propagation, Somaclonal Variation, Artificial Seeds, Production and Use of Haploids.

Module-III

Suspension Cell Cultures: Cell Cycle Synchronization, Production of Secondary Metabolites and other Plant-Derived Chemicals, Bioreactors, Bio-transformation, Long-term storage of cultures.

Module-IV

Protoplast Culture: Isolation, Purification and Plating; Regeneration, Protoplast Fusion, Somatic Hybrids and Cytoplasmic Hybrids.

Module-V

Genetic Improvement of Plants using different In vitro culture Techniques**.**Development of crops adaptable to environmental stresses, diseases and pests. Agrobacterium mediated plant transformation and hairy root cultures

Module-VI

Transgenic plants:Molecular Farming: Plants As factories for biopharmaceuticals, Transgenic value added speciality crops, Use of antisense RNA and other technologies.

Module-VII

Indian Agriculture scenario and policy; Use of nanotechnology in Agricultural sciences; Use of remote sensing in Ag sc; Molecular Breeding and Molecular Assisted Selection; Value addition and sustainable agriculture, terminator technology, golden rice.

Books Recommended:

Dixon and Gonzales, Plant cell culture – a practical approach.

Razdan, An introduction to plant tissue culture.

A. Mizrahi, Biotechnology in agriculture

S. Natesh, Biotechnology in agriculture

BT6025 Food & Enzyme Technology

Module-I

An introduction to the chemical, physical and biochemical properties of foods; proteins, lipids, carbohydrates, vitamins, minerals, pigments.Application of rheology in food system. Food texture studies

Module-II

Discovery, classifications and nomenclature of enzymes and enzyme kinetics, Enzyme isolation & Techniques used in the purification of the enzymes.Enzyme assay, Intracellular localization of enzymes.Isozymes, Multienzyme complex, and multifunctional enzymes, Food enzymes.

Module-III

Introduction to food preservation and food processing; heating, chilling, freezing, dehydration; use of salt, sugar, acid, chemical preservatives, modified atmospheres in food preservation; water relations and chemical and microbial stability of foods.

Module-IV

Fermentations: Beverages, Brewing of beer, wine and distilled liquors Fermented Vegetables, fermented diary products, oriental fermented foods.

Module-V

Enzyme immobilization, production and application of free and immobilized enzymes in food and feed, detergent, textiles, pulp and paper, pharmaceuticals, diagnostics.

Module-VI

Enzyme memory and pnemonical enzymes.Mechanism and action of chymotrypsin, glyceraldehyde, 3- phosphate dehydrogenase, lysozyme, carboxypeptidase, ribonuclease, aldolase and ribozyme.

Module-VII

Molecular structure and function of enzymes.Physico-chemical characterization of enzymes.Folding and active site formation in enzymes. Stability of enzymes: Enzyme stabilization by selection and genetic engineering, protein engineering, reaction environment rebuilding.

Books Recommended:

G.F. Stewart, Introduction to Food Science and Technology

R.P. Singh and D.R. Heldman, Introduction to Food Engineering, Academic Press.

Godfrey and West, Industrial enzymology

Bommarius, A.S. et al., Biocatalysis: Fundamentals and Application- Wiley Publication

Hans Bisswanger, Enzyme Kinetics- Wiley Publication

BT6027 Process Measurement and Control

Module-I

The general control system, transfer functions, process characteristics.

Module-II

Concept of feed back and feed forward control system, process measurements- temperature, pressure, flow, level, physical properties - density, viscosity, pH, power, rotational speed.

Module-III

Final control element, control valves and their characteristics, the controller, proportional integral, proportional integral derivatives controller, pneumatic and hydraulic controller.Servomotor technology in control.

Module-IV

Control system dynamics: transfer function of first order, second order systems. Response of control loop components to forcing functions. Transfer function of feedback control system. Tests for unstable system.

Module-V

Advanced control systems: multivariable control problem, ratio control, cascade control, computed variable control, feed forward control, override control, adaptive control.

Module-VI

Application of computer control, on line computer control, servomotor technology in control, brief idea about application of dynamic matrix control, predictive control, Fuzzy logic control.

Module-VII

Control of heat exchanger, distillation column, bioreactor control system analysis.

Books Recommended:

Coughanouer and Koppel, Process System analysis and Control

Perry's Chemical Engineers Handbook.

BT6022 Bioseparation Engineering Lab

1. Determination of filter efficiency
2. Harvesting of fermentation broth and its processing for product purification.
3. Solid-liquid separation
4. Liquid-liquid separation
5. Disruption of microbial cells
6. Separation by precipation through adding salts and solvents.
7. Dialysis
8. Ultrafilteration
9. Vaccum evaporation
10. Drying and crystallization.

BT6024 Plant Cell Technology Lab.

1. Preparation of Culture Media, Sterilization of Culture Media and Explant, Inoculation, Growth Analysis, Subculture.
2. Development and Propagation of Suspension Culture cells.
3. Isolation of protoplasts and plating.
4. Encapsulation of somatic embryos / Suspension Culture cells in Alginate Beads.
5. Agrobacterium mediated transformation.

BT6026 Enzyme Technology Lab

1. Isolation of enzymes from microbial sources.
2. Isolation of enzymes from plant sources.
3. Isolation of intracellular enzymes from microbial sources.
4. Enzyme assay techniques (β-galactosidase, time, temperature, protein concentration
5. Isozymes and activity staining
6. Determination of different kinetic parameters; Km, Vmax, optimum pH,
7. LDH : Km and Vmax, Various kinetic plots
8. Determination of activation energy.
9. Ammonium sulphate fractionation.
10. Purification of enzymes using Sephadex and gel filtration column.
11. Down stream processing of enzymes by Micro-filtration and Ultrafiltration
12. Immobilization of enzymes

7th Semester

BT7021 Biological Waste Management

Module-I

Physical, chemical and biological characteristics of waste water, BOD, COD

Module-II

Primary Treatment: Screening, Grit Chamber, removal of oil and grease.

Module-III

Aerobic processes of secondary treatment– activated sludge, lagoons, stabilization ponds, suspended growth, nitrification, trickling filters, rotating biological contactors, anoxic suspended growth and fixed film denitrification,

Module-IV

Anaerobic processes of treatment – biological concepts, suspended growth and fixed film processes and reactor configuration, Sequential batch reactor for combined processes (aerobic and anaerobic)

Module-V

Tertiary Treatment :Effluent disposal and reuse.

Module-VI

Solid waste management,

Module-VII

Designing aspects of Wastewater treatment plant

Books Recommended:

Metcalf and Eddy Inc., Waste water engineering

N.P. Cheremisinoft, Biotechnology of waste water treatment.

BT7023 Bioreactor and Bioprocess Design

Module-I

Design considerations for designing bioreactors: oxygen transfer, heat transfer,rheology, mixing.

Module-II

Study of anaerobic & aerobic processes: Ethanol production, Acetone-Butanol production, citric acid production and penicillin production

Module-III

Reactors with non-ideal mixing: Mixing time in agitated tanks, Residence timedistributions, Models for non-ideal reactors

Module-IV

Scale up and scale down concepts,

Module-V

Mechanical fittings in a bioreactor: vessel, agitation system materials, welds, finish,valves, piping and valves for biotechnology, special requirements of utilities and cleaning ofproduction plants.

Module-VI

Instrumentation and control of bioprocesses: Physical and chemical sensors for themedium and gases, online sensors for cell properties, off-line analytical methods;Biosensors.

Module-VII

Calculation for designing a bioreactor.

Books Recommended

Coulson, Richardson, Sinnott, An introduction to chemical engineering design,Pergamon Press.

Lydersen, D'Elia, Nelson, Bioprocess engineering: Systems and equipment.

Bailey and Ollis, Biochemical Engineering Fundamentals.

ELECTIVE- I [DEPT] (Any one from following)

BT7025Bioenergy

Module-I

Chemistry & Biochemistry of Biomass: Types of biomass (e.g. wood waste, forestry residues, agricultural residues, organic municipal solid waste); Composition of lignocellulose (lignin, hemicellulose, cellulose); energy crops; chemical pretreatment; enzymatic pretreatment.

Module-II

BioDiesel: Sources and processing of biodiesel (fatty acid methyl ester); Sources and characteristics of lipids for use as biodiesel. Economics and environmental issues of biodiesel; Components and operation of a bio-diesel processing system; Standards for biodiesel quality.

Module-III

BioEthanol& other Alcohols: Production of Bioethanol by yeast and bacteria; Substrate range and ethanol tolerance; Yield of ethanol production from sugars. Production of methanol and butanol; Technologies for hydrolysis and fermentation of lignocellulosic biomass for the production of alcohols.

Module-IV

BioMethane&BioHydrogen: Formation of biomethane or biogas from landfill and manure. anaerobic digestion; methanogenesis, rates of methane formation; and one and two stage fermentation. Biohydrogen synthesizing microorganisms and its production; Biohydrogen production rates; Production of hydrogen from waste water.

Module-V

Bio-Electricity: Current generation by microorganisms, microbial fuel cells (MFC) for current generation, choice of anode and cathode, Mediator and mediator less MFC, factors influencing the current intensity, simultaneous electricity generation and waste treatment (SEGAWT), aerobic, anaerobic and mixed processes for current generation, kinetics of substrate utilization and electricity generation microbial fuel cell battery.

Module-VI

Direct Biomass Combustion & Co-Firing Technologies: Aanalysis of biomass direct combustion, and co-firing in power plants with high biomass-to-fossil fuel ratios. Fixed-bed, fluidized bed, and dust combustion; Feedstock and plant design optimization, emissions, ash deposition and corrosion control, slagging and fouling problems.

Module-VII

Policies and Future R&D of Biofuels & Bioenergy: Evaluation of current and future R&D needs; legal framework to support sustainable development and increased use of biofuels; government policies and programs with regard to biofuels and investment opportunities worldwide.

Books Recommended:

Kennedy, et al 1985, Cellulose and its derivatives, chemistry, biochemistry and applications, Halsted Press, New York, 1985, 551 pp.
Bard, A. J., and L. R. Faulkner. 2001. Electrochemical methods fundamentals and applications, 2nd ed. John Wiley and Sons, New York, NY
Greg Pahl, 2005, Biodiesel, Chelsea Green Publishing Co
Richard L. Bechtold, 1997. Alternative Fuels Guidebook, SAE International

BT7027 Bioremediation

Module-I

Introduction,

Module-II

Environmental site assesments, microbial ecology of contaminated sites,

Module-III

Predictive models for efficacy of bioremediation, rates and dynamics of bioremediation,

Module-IV

Microorganisms involved in the biodegradation of organic compounds, heavy metals, bioconversion and removal of metals and radionuclides, adaptation:

Module-V

Dynamics of genes, enzyme activities and populations,

Module-VI

Phytoremediation processes, plants involved and their mechanisms in bioremediation,

Module-VII

Protein engineering for improved biodegradation of recalcitrant pollutants.

Books Recommended:

Wild, Varfolomeyev and Scozzafava. Perspective in Bioremediation: Technologies for Environmental Improvement

Singh and Ward Applied Bioremediation and phytoremediation Springer

BT7029 Pharmaceutical Biotechnology

Module-I

Genomics and its impact on medicine. Molecular medicine (Introduction only)

Module-II

Rational drug design,

Module-III

Gene testing, pharmacogenomics.

Module-IV

Principles of monoclonal antibodies, monoclonal antibodies in disease detection and treatment,

Module-V

Cancer oncogenes, tumor suppressor genes, growth factors.

Module-VI

Genetic diseases and DNA based diagnosis of genetic diseases. gene therapy,

Module-VII

Development of genetically engineered pharmaceuticals.

Books Recommended:

Maulik and Patel, Molecular Biotechnology – Therapeutic applications and strategies.

Zito, Pharmaceutical Biotechnology.

BT7031 Mineral Biotechnology

Module-I

Metal Microbe Ineraction: Extracellular complexation, extracellular precipitation of metal, Metal resistance in soil bacteria

Module-II

Metal extraction and recovery by microorganisms, Biosorption of metals, biossorption Kinetics, Metal recovery process

Module-III

Biogeotechnology; Bioleaching: low grade technology, high grade technology, bioleaching of gold, copper, uranium, Mechanism of bioleaching, Microbiology of leaching

Module-IV

Biomineralization: bacterial biomineralization, multicellular biomineralization, microbiologically induced corrosion

Module-V

Coal: Nature, structure and types, Bioprocessing of coal, clean coal technology, desulphurization of coal, biological conversion of coal to organic chemicals

Module-VI

Bioreactor design for mineral bioprocessing

Module-VII

Environmental control and mine site remediation, Acid mine drainage: chemistry and control

Books Recommended:

S.K. Kawatra, Mineral Biotechnology.

BT7033 Animal & Stem Cell Technology

Module-I

Basics of Cell and Tissue Culture: Laboratory requirements for tissue culture, substrates for cultures, culture media for animal cell cultures, culture procedures and principles, freeze storing of cells and transport of cultures.

Module-II

Characteristics of Cells in Culture: Contact inhibition, anchorage independence/dependence, cell-cell communication, cell senescence.

Module-III

Cell Culture Lines: Definition, development and maintenance, cloning of cell lines, cell synchronization viral sensitivity of cell lines, cell line preservation and characterization, stem cell lines.

Module-IV

General Tissue Culture Techniques: Types of tissue cultures, methods of disaggregating primary cultures, primary tissue explantation technique.

Module-V

Organ Culture: Methods, behavior of organ explants and utility of organ culture, whole embryo culture.

Module-VI

Methods in Cell Culture: Micro carrier cultures, cell immobilization, animal cell bioreactor, large scale cell cultures for biotechnology, somatic cell fusion, flow cytometry, transfection.

Module-VII

Applications of Animal Cell Culture: Use in gene therapy, cloning from short-term cultured cells, cloning from long-term cultured cells, Cloning for production of transgenic animals, cloning for conservation.

Books Recommended:

Freshney, Animal cell culture – a practical approach

N. Jenkins, Animal Cell Biotechnology: methods and protocols.

BT7035 IPR,Biosafety and Bioethics

ELECTIVE- II[OPEN: To be offered by other depts]

BT7022 ENVIRONMENTAL BIOTECHNOLOGY LAB

1. Physico-chemical and biological characterization of wastewater.
2. Determination of total solids, total dissolved solids, total suspended solids, volatile solids, fixed solids/ash content and moisture content in solid waste and wastewater.
3. Determination of MLVSS.
4. Determination of sludge volume index and food to microorganisms.
5. Determination of Kjeldahl nitrogen, nitrate and nitrite nitrogen.
6. Determination of inorganic phosphates by Technicon analyzer.
7. Determination of organic carbon,
8. Determination of various metals present in waste and wastewater samples.
9. Determination of BOD of wastewater samples.
10. Determination of COD of wastewater samples.
11. Enumeration of contaminating pathogenic organisms.
12. Various sampling techniques for collecting air samples.

BT7024 Bioinformatics Lab I

Exercise based on bioinformatics course.

BT7050 Dept. Project I

8th Semester

BT8021Biotechnology Management

Module-I

Introduction to Biotechnology Management: Introduction to Biotechnology Management, Designing a Manuscript, Grant Experimental Protocols and Experimental Methods, Selection of a Biotechnology company. Setting up of a Unit, Laboratory Administration of a unit, Collaborations, Inventories and Inspections, Personnel, Recruitment, Hiring, Mentoring, Promoting and Terminating.

Module-II

Biostatistics: Pure and Applied Research, Types of Research, (Experimental, Causal, Exploratory, Conclusive, Descriptive), Data Interpretation and Tabulation, Measures of Central Tendency - Mean Arithmetic's, Harmonic and Geometric Median and Mode; Measures of Dispersion - Standard Deviation and Standard Error; Correlation Coefficient, Simple Linear Regression, Basic Idea of Significance Test, Hypothesis Test. Level of Significance, T test, 'Chi' Square and Goodness of Fit Graphics. Bioprocess Development; Instruments and Biotechnological Products, Innovation of Biotechnological Products.

Module-III

Biotechnology Marketing: Marketing of Products, Brand Imaging, Market segmentation, Marketing Application, Cost and Benefit Analysis, Quality Standardization, Advertising and Sales Strategy of Biomedical Products. Implication of Marketing Strategy in Biotechnological Industries.

Module-IV

Manufacturing and Materials Management Ensuring Biosafety: Bio-safety regulations Good laboratory practices, Good manufacturing practices in industry. Storage and disposal of hazardous wastes, Radioactive Materials, Pathogenic Strains.GMO's and their Release in Environment Experimental Protocol Approvals - Levels of Containment-Environmental Aspects of Biotech Applications. Importance of Logistics to Biotechnological Products, Supply Chain Management of Biotechnological Products: an Overview. Reprocessing of Bioformulations.

Module-V

Globalization and Biotechnology: Global Landscape of Pharmaceutical and Biotechnological Industries, Indian Biotechnological and Pharmaceutical Industries and Biotechnology Industry, Management of Biotechnology for Global Sustenance.

Module-VI

Biosafety and Legal Aspects: Environmental Aspects to Biotechnology, Legal Implication to Pharmaceutical and Biotechnology, Safety Management in Biotechnological and Pharmaceutical Industry.

Module-VII

Case Studies of Biotechnological and Pharmaceutical Industries.

Books Recommended:

Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.

Molecular Cloning : A laboratory manual Vol. I - III by Sambrook et al., (2001) Cold Spring Harbor Laboratory

Essentials of management – Koontz and Odonell

Cost Accounting: Horrngren.

Marketing Management: Analysis, Plannning and Control - Philip Kotler

Research Methodology – By C. R. Kothari (Vikash Publishing).

BT8040 Industrial Training (To be evaluated with Dept. Project II)

BT8050 Dept. Project II