B.E. BIOTECHNOLOGY
2008 Course

SEMESTER I

Structure for
B. E. Biotechnology (2008 Course)

TERM – I

Subject Code No.	Subject	Teaching Scheme			Examination Scheme				**Total marks**
		Theory	Practical	TW/ Drawing	Paper	Practical	Oral	TW	
415461	Elective I	4	2		100			50	150
415462	Elective II	3			100		50		150
415463	Bioseparation II	4	2		100	50		50	200
415464	Instrumentation and Process Control	3	2		100		50		150
415465	Bioprocess Equipment Design	4		2	100				100
415466	Project			4					
		18	6	6	500	50	100	100	**750**

TERM – II

Subject Code No.	Subject	Teaching Scheme			Examination Scheme				**Total marks**
		Theory	Practical	TW/ Drawing	Paper	Practical	Oral	TW	
415467	Elective III	4	2		100		50	50	200
415468	Elective IV	3			100			50	150
415469	Bioprocess Modeling and Simulation	4			100				100
415470	Plant Engineering & Project Costing	4			100			50	150
415471	Project			6			50	100	150
		15	2	6	400		100	250	**750**

LIST OF ELECTIVE SUBJECTS FOR FINAL YEAR BIOTECHNOLOGY

Semester I

Elective I

1. Environmental Biotechnology
2. Chemoinformatics and Structural Biology
3. Bio-therapeutics Technology

Elective II

1. Bioenergy and Renewable Resources
2. Biomaterials
3. Stem Cell Biology and Regenerative Medicine

Semester II

Elective III

1. Food Biotechnology
2. Agricultural Biotechnology
3. Introduction to Systems Biology

Elective IV

1. Management and Entrepreneurship
2. IPR, Bioethics and Regulations
3. Industrial Organization and Management

BIOSEPARATION II (415463)

Teaching Scheme:
Theory: 4 hr/week
Practical: 2hr/week

Exam Scheme:
Paper: 100 Marks
Practical: 50 Marks
Term Work: 50 Marks

UNIT 1 **[6 Hrs]**

Downstream Processing in Biotechnology

Role and importance of downstream processing in biotechnological processes, Problems and requirements of bio-product purification, Characteristics of biological mixtures, Process design criteria for various classes of bio-products - high volume, low value products and low volume, high value products

UNIT 2 **[8 Hrs]**

Spectrophotometry

Introduction, Beer-Lambert's law, Instrumentation
Spectrofluorometry – Principle, Instrumentation, Applications, Case studies, Quantitative spectrophotometeric analysis, Basic principles of spectroscopy, Introduction to atomic absorption spectroscopy and NMR

UNIT 3 **[8 Hrs]**

Chromatography – Types and applications

Principles, retention, procedures, materials and applications of – Gel permeation chromatography, Ion exchange chromatography, Chromatofocussing, affinity chromatography, Reversed phase and hydrophobic interaction chromatography

UNIT 4 **[6 Hrs]**

Chromatography – Types and applications

Gas Chromatography, Liquid chromatography, Introduction to GC-MS and LC-MS, Instrumentation: Pumps, degasser, mixer, guard column, column and detectors, Chromatograms

UNIT 5 **[8 Hrs]**

Other separation techniques

Zone refining, Molecular sieves, Adductive crystallization, Supercritical fluid extraction, Reactive extraction, Precipitation, Aqueous two phase systems, Introduction to SEP box and Hyphenated techniques.

UNIT 6 **[6 Hrs]**

Applications of Bio-separations – Case studies

Health care products - Production of penicillin, peptide antibiotics
Food and Beverages – Beer, Citric acid
Bio-chemicals – Butanol
Specialty products – Microbial polysaccharides

Practicals (Any 8):

1. Verification of Beer Lambert's law
2. Determination of λ_{max} for proteins
3. Determination of protein concentration in fermentation broth
4. Separation of casein protein from milk
5. Study of tangential flow filtration
6. To study gel filtration chromatography
7. Separation of compounds using column chromatography
8. Demonstration of Liquid chromatography (HPLC)
9. Demonstration on SEP BOX

Text Books:

1. Belter, P. A., Hu, W. S. and Cussler, E. L., "Bioseparation: Downstream processing for Biotechnology", Wiley, New York
2. Belter, P. A. and Cussler, E., "Bioseparations", Wiley, New York 1985
3. Siva Shankar, "Bioseparations", PHI publications

Reference Books:

1. McCabe, W. L., Smith, J. C. and Harriott, P., "Unit Operation of Chemical Engineering", McGraw Hill
2. Seader, J. D. and Henley, E. J., "Separation Process Principles", Wiley
3. "Product Recovery in Bioprocess Technology", BIOTOL Series, VCH, 1990
4. Asenjo, J. M., "Separation processes in Biotechnology", Marcel Dekkere Inc., 1993
5. "Biosepration Engineering: Principles, practice and economics", Wiley, Interscience
6. Wankat, P. C., "Rate controlled separations", Elsevier, 1990

INSTRUMENTATION AND PROCESS CONTROL (415464)

Teaching Scheme: **Exam Scheme:**
Theory: 3 hr/week **Paper: 100 Marks**
Practical: 2 hr/week **Oral: 50 Marks**

UNIT 1 **[8 Hrs]**

Instrumentation in Process Industries

Need for measurement of different process parameters, Instruments used for measurement : Pressure – Mechanical and electric transducers, Low pressure - McLeod Gauge and Pirani Gauge, Temperature - bi-metal thermometers, resistance thermometer, thermistors, thermocouples, Radiation and optical pyrometers, Flow – Hot Wire anemometer and magnetic flow meters, Flow measurement by Visualization by shadow-graph and interferometer, Liquid level measurement in open vessels and in pressure vessels, Thermal conductivity measurement of solids, liquids and gases, Measurement of diffusivity in gases.

UNIT 2 **[8 Hrs]**

Dynamics of First Order Systems

Introduction

Need for studying process dynamics and control, Laplace transforms and its application to process dynamics, characteristics of ideal forcing functions (step, ramp, pulse, impulse, frequency)

Linear open loop Systems – First Order Systems

Definition, characteristics and physical examples of first order systems such as thermometer, liquid tank, CSTR etc., model transfer function and significance of time constant, Dynamic behavior/ Response of first order systems to different forcing functions, linearization of non-linear systems (for single variable systems only)

UNIT 3 **[8 Hrs]**

Dynamics of Second Order Systems

Definition, characteristics and physical examples of second order systems such as manometer, interacting and non-interacting tank systems, model transfer function, Dynamic behavior of second order systems to different forcing functions, Response of Second order system – underdamped, critically damped and overdamped, Transportation lag, Processes with complex dynamics

UNIT 4 **[8 Hrs]**

Linear Closed Loop Systems

Control systems, components of a control system, Concept of feedback control, Controller and final controlling element, pneumatic control valve, control system hardware

Different types of control actions – P, PI, PD, PID; transfer functions, open and closed loop response, advantages and limitations of each controller,

Block diagram of a control system, servo and regulatory operations, open and closed loop transfer function, overall transfer function, transfer function for change in load and set point, multi-loop control system transfer function

UNIT 5 **[8 Hrs]**

Stability Analysis and Frequency Response Analysis

Concept of stability in control systems, stability criterion, Routh's test for stability, root locus analysis, root locus design and plots, frequency response analysis and stability criterion (Bode plots), controller tuning - Ziegler Nichols and Cohen-Coon methods

UNIT 6 **[8 Hrs]**

Advanced Control Systems and Industrial Applications

Introduction to advanced control systems: Cascade, feed forward, selective, ratio, over ride and split range control strategies; fuzzy logic and neural networks

Application to fermentation industries: Speed control, Temperature control, Control of gas supply, Control of pH, Control of dissolved oxygen, Antifoam control;

Practicals (Any 8):

1. Calibration of a thermocouple
2. Calibration of pressure gauge using dead weight tester
3. Dynamic Response of I^{st} order system.
4. Dynamic Response of II^{nd} order system.
5. Characteristics of On-Off Controller.
6. Characteristics of P, PI, PD, PID Controller.
7. Root locus analysis
8. MATLAB exercise of Control System
9. Study of Computer Aided control System.
10. Cascade Control.

Text Books

1. Coughanowr, D., "Process System analysis and control" Mc-Graw Hill
2. Stanbury, P.F. and Whitaker, A., "Principles of Fermentation Technology", Butterworth-Heinemann

Reference books

1. Nise, N.S.,"Control System Engineering", Wiley
2. Marlin, T., "Process control : Designing processes and control systems for dynamic performance", McGraw-Hill
3. Stephanopoulos, G., "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall
4. El-Mansi, E.M.T. and Bryce C.F.A., "Fermentation Microbiology and Biotechnology", McGraw-Hill

BIOPROCESS EQUIPMENT DESIGN (415465)

Teaching Scheme: **Exam Scheme:**
Theory: 4 hr/week **Paper: 100 Marks**
Drawing: 2 hr/week

UNIT 1 **[8 Hrs]**

Basic Principles of design

Design Factors, Design procedure, Codes and Standards, Optimization, Design Loads, Combined Loading in Equipments, Concept of Stress and Strain, Types of Stress and Strain Curves for Ductile and Brittle Materials, Factor of Safety, Young's Modulus, Stress Concentration, Fatigue, Creep, Endurance Limit, Poisson's Ratio, and Shear Modulus, Resilience, Toughness, Mass Moment of Inertia, Polar Moment of Inertia, Section Modulus, Correlation between Torque and Power, Theories of Failure.

UNIT 2 **[9 Hrs]**

Pressure Vessels and high Pressure Vessels

Pressure vessel subjected to internal pressure: Proportioning of pressure vessels, selection of L/D ratio, Optimum proportions of vessels,

Design of unfired pressure vessels: Types of pressure vessels, material of construction, selection of corrosion allowance and weld joint efficiency, purging of vessels, Design of various types of heads as per IS 2825.

Design of high pressure vessels: Materials of construction, review of design of thick Cylinder, pre-stressing, Analysis and design of high pressure vessels: monoblock and Compound (multilayer).

UNIT 3 **[8 Hrs]**

Agitators and Reaction vessels:

Study of various types of agitators, their selection, applications, baffling, power systems including twisting moment

Reaction vessels - Introduction, classification, heating systems, design of vessels, study and design of various types of jackets like plain, half coil, channel, and limpet oil. Study and design of internal coil reaction vessels, Heat transfer coefficients in coils

UNIT 4 **[9 Hrs]**

Heat Exchange Equipments

Introduction, types of heat exchangers, codes and standards for heat exchangers, Materials of construction, baffles and tie rods, tube joining methods, Design of shell and tube heat exchangers (U tube and fixed tube) as per IS: 4503 and TEMA standards, Evaporators design

UNIT 5 **[8 Hrs]**

Design of distillation column

Design variables in distillation, design methods for binary systems, plate efficiency, approximate column sizing, plate contactors and plate hydraulic design - Plate design, weir dimensions, weep point, hole size, Plate pressure drop, hydraulic

UNIT 6 **[9 Hrs]**

Filtration Equipments

Cartridge filtrations for biotechnology:

Introductions, types of filters, filter applications-fermentation and cell culture, Downstream processing, utilities, steam sterilization procedures, filter integrity testing**,** Validation of filters used in biotechnology manufacturing

Tangential flow filtration systems for clarification and concentration

Introduction, TFF in Biotechnology, TFF system design, TFF operation and its Relationship to design

Text Books:

1. Joshi, M. V., "Process Equipment Design", McMillan India
2. Lydersen, B. K., D'elia, N. A. and Nelson, K. L., "Bioprocess Engineering-Systems, Equipment and Facilities", Wiley Interscience Publication
3. Bhattacharya, B. C., "Introduction to Chemical Equipment Design", C.B.S. Publications

Reference Books

1. Brownell, L. E. and Young, E., "Process equipment design", John Wiley, New York, 1963
2. Coulson, J. M., Richardson, J. F. and Sinott, R. K., "Chemical Engineering Vol. 6", Pergamon Press
3. Coulson, J. M., Richardson, J. F. and Sinott, R. K., "Chemical Engineering Vol. 2", Pergamon Press
4. Uhl, V. W. and Grey, J. B., "Mixing theories and practices", Academic Press, New York, 1967
5. Walas, S. M., "Chemical Process Equipment-Selection and design", McGraw Hill book company, New York
6. Treybal, R. E., "Mass Transfer Operations", McGraw Hill, New York
7. "Indian standards Institution" code for shell and tube heat exchangers, IS – 4503
8. Ludwig, E. E., "Applied Process Design for Chemical and Petrochemical Plants" vol 1 and 2, Gulf publishing co. publishing company

B.E. BIOTECHNOLOGY

SEMESTER II

BIOPROCESS MODELING AND SIMULATION (415469)

Teaching Scheme: **Exam Scheme:**
Theory: 4 hr/week **Paper: 100 Marks**

UNIT 1 **[6 Hrs]**

Introduction to Modeling

Introduction, definition of Modeling and simulation, different types of models - Unstructured and structured models, Deterministic and stochastic models, Segregated and unsegregated models, Compartmental models (two and three), genetically structured models

UNIT 2 **[6 Hrs]**

Fundamental laws

Continuity equation, energy equation, equation of motion, transport equation, equation of state, Phase and chemical equilibrium, chemical kinetics, Model building, application of mathematical modeling, scope of coverage

UNIT 3 **[6 Hrs]**

Classification of mathematical modeling

Classification based on variation of independent variables, classification based on state of the processes, classification based on type of the processes, comparison between rigid and stochastic processes and introduction of boundary conditions

UNIT 4 **[8 Hrs]**

Modeling of fermentation

Batch reactor, Fed batch reactor, Chemostat, chemostat with recycles

Growth kinetics: Model of unlimited growth, modeling a continuous culture - Chemostats, substrate limited growth in chemostat, theory of fed-batch culture control, product inhibition and substrate utilization kinetics

UNIT 5 **[8 Hrs]**

Modeling of fermenters

Modeling of suspended growth reactors, activated sludge systems and attached growth reactors, agitated and sparged bioreactor, tower-aerobic and anaerobic bioreactors

UNIT 6 **[8 Hrs]**

Mass Transfer Equipments

Reactor with mass transfer, Ideal binary distillation column, Multi-component Batch distillation

Text Books:

1. Luyben, W. L., “Process modeling simulation and control for chemical engineers”, McGraw Hill, 2nd Ed.
2. Bailey, J. and Ollis, D., “Biochemical engineering Fundamentals”, McGraw Hill Kogakusha Ltd. Tokyo
3. Balu, K. and Padmanabhan, K., “Modeling and analysis of Chemical Engineering processes”, IK International private limited, 2007

Reference Books:

1. Dunn, I. J., et al., “Biological engineering Principles, Applications and Simulation”, VCH, Weinheim

PLANT ENGINEERING AND PROJECT COSTING (415470)

Teaching Scheme:
Theory: 4 hr/week

Exam Scheme:
Paper: 100 Marks
Term Work: 50 Marks

UNIT 1 **[8 Hrs]**

Introduction

Basic considerations in chemical plant design, Preliminary design, design estimates, Process design aspects, Process flow Diagrams and symbols: Symbols of Process Equipments & their concepts, engineering line diagram (flow diagram, Utility block diagram, Process flow diagram, P & ID presentations relevant to chemical engineering processes, Pilot Plant: Importance of laboratory development to pilot plant, scale up methods

UNIT 2 **[9 Hrs]**

Detailed process design

Basic engineering in process, thermodynamic and kinetic feasibility, process feasibility, capacity identification and selection, process specification, equipment specification material selection, role of design office and technical data management, process design plant engineering, plant safety operation and maintenance, Plant location and layout: Factors affecting site selection, factors affecting both planning and layouts, drawing of plant layout, plant elevation drawing and complete engineering flow sheet drawings

UNIT 3 **[9 Hrs]**

Piping Design & Layout

Hydraulic design consisting pipe size estimation, Pressure loss determination thrust in pipeline water hammer design of gas pipelines transportation of solids in pipeline pipe support, Pipe routing, Isometric of piping material selection for pipe and pipe fitting, expansion and contraction of piping and its compensation thermal insulation of piping heating and cooling, color code of pipeline, bill of material of piping

UNIT 4 **[8 Hrs]**

Project scheduling and Financial Management

CPM/PERT techniques, project engineering, project planning, plant erection, testing and commissioning

Financial Management

Investment and factors affecting, Capital structure analysis., fixed capital, working capital, cost of finance, interest, calculations, Methods of raising finance i.e. shares, debentures and financial institution

UNIT 5 **[8 Hrs]**

Profitability analysis

Cash flow statement, Discount cash flow**,** Need for expansion and diversification of concept of marginal additional investment, Capitalized cost, payout period rate of return, discounted cash flow, Introduction to taxes, sales tax, excise and octroi etc., Break even analysis

UNIT 6 **[8 Hrs]**

Depreciation

Concept of depreciation, various methods of determination of depreciation - straight line, reducing balance, sinking fund, sum of year's digit, MACRS etc., Problems related to above methods, obsolesce

Term work:

Drawing of following preferably on Auto CAD (Minimum six)

1. Process flow diagram
2. Piping and instrumentation diagram
3. Plant layouts and elevations
4. Piping GA drawing
5. Piping isometrics

Text Books:

1. Timmerhaus, P., "Plant design and Economics for chemical engineers", McGraw Hill
2. Philips, M. J., "Project Engineering with CPM and PERT", Rheinhold publishers

Reference Books:

1. Grossman, Biegler and Vesterberg, "Systematic design of chemical process plants"
2. Turton et al, "Analysis synthesis and design of chemical processes", Prentice-Hall
3. Happel, J. and Jordon, D. G., "Chemical Process Economics"

ELECTIVE I: ENVIRONMENTAL BIOTECHNOLOGY (415461)

Teaching Scheme:	**Exam Scheme:**
Theory: 4 Hrs/week	**Paper: 100 Marks**
Practical: 2Hrs/week	**Term work: 50 Marks**

UNIT 1 **[8 Hrs]**

Introduction to water and waste water management

Domestic and industrial wastewater, types, sources and effects of water pollutants, Waste water characteristics–DO, BOD, COD, TOC, total suspended solids, colour and odour, bacteriological quality, oxygen deficit, determination of BOD constants, heavy metals, Water quality standards: ICMR, WHO, MPCB and CPCB, Principles of primary treatment and secondary treatment, process design and basic operating principles of activated sludge (suspended growth) process, sludge treatment and disposal,

UNIT 2 **[8 Hrs]**

Methods of waste water treatment

Aerobic & Anaerobic systems - Trickling filters and their biological principle, different T.F media and their characteristics; rotating biological contactors(RBC); aerated lagoons their principle, advantages and disadvantages; oxidation ditches their principle, advantages and disadvantages; Fluidized bed reactor (FBR), packed bed reactors air-sparged reactors; UASB, photo catalytic reactors, wet-air oxidation

UNIT 3 **[6 Hrs]**

Industrial waste waters

Introduction, Pollution Control: Governing bodies, Policies and Amendments, disposal standards; Treatment of industrial effluents: neutralization, proportioning, effluent sampling and characterization, treatment strategies and disposal standards for different industries: paper and pulp, sugar, distillery, textile, tannery

UNIT 4 **[10 Hrs]**

Air Pollution- Sources, Effects and Measurement

Definition, sources of air pollutants, Effects of air pollutants on human health, plants, animals, materials, Sampling and measurement of air pollutants, Air pollution control standards: WHO, MPCB, CPCB, Air Pollution Control Methods and Equipment, Particulate pollution: cleaning methods, collection efficiency, particulate collection systems, Basic design and operating principles of settling chamber, cyclone separator, fabric filter, electrostatic precipitator, Operating principles of spray tower, centrifugal scrubber, venturi scrubber, Selection of particulate collector, Gaseous pollution: Principles of control by absorption, adsorption, combustion or catalytic oxidation, removal of SOx, NOx. CO_2 sequestration by algae

UNIT 5 **[8 Hrs]**

Hazardous and Solid Waste Management

Xenobiotic compounds, recalcitrance; Hazardous Waste Management, Sources & Classification, physicochemical properties, Hazardous Waste Control & Treatment; Concept of Waste minimization: benefits and technologies to hazardous waste reduction; Hazardous Waste Management & Handling rules, Hospital Waste Management, Solid Waste Management Plan: Sanitary land filling, Recycling, Composting, Incineration, Biotechnology application to hazardous waste management - Biodegradation and Biological detoxification; examples of cyanide and phenols

UNIT 6 **[10 Hrs]**

Bioremediation

Constraints and priorities of Bioremediation; Biostimulation and Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation, Bioremediation Case studies: Oil pollution – treatment with micro-organisms, Recovery of metals from waste water and sludge, Xenobiotics – degradative capabilities of microorganisms with reference to toxicology, pesticides, herbicides, polyaromatic hydrocarbons; Solid phase bioremediation – land farming, prepared beds, soil piles; Phytoremediation, Composting – Anaerobic and aerobic, Bioventing & Biosparging; Wormicomposting, Wetland Management, Liquid phase bioremediation - suspended bioreactors, fixed biofilm reactors Membrane based waste water treatment processes

Practical (any 8):

1. To study microbial flora of waste water
2. Determination of potability of water by MPN Test
3. Characterization of coliforms
4. To study quality of air
5. To study BOD
6. To study COD
7. Conductivity measurement of water
8. Effect of treatment method on coliform/ microbial content
9. To study TDS

Text books:

1. Metcalf and Eddy, “Wastewater Engineering: Treatment and Disposal”, Second edition, Tata McGraw-Hill publishing Company, New Delhi, 1987
2. Metcalf and Eddy, “Wastewater Engineering: Treatment and Disposal”, Fourth edition, Tata McGraw-Hill Companies, 2002
3. Peavy, R., “Environmental engineering”, Mc Graw Hill Publications

Reference books:

1. Arciwala, S. J., “Waste water treatment for pollution control” **,** Tata McGraw-Hill Publications, New Delhi

2. Manual Sewerage and Sewage Treatment – Public Health Department, Govt. of India.
3. Dr. Modi, “Sewage disposal and treatment”, Standard Publications, NewDelhi
4. Rao, M. N. and Dutta, A. K., “Wastewater Treatment”, Oxford and IBH Publlishing Co Pvt Ltd, New Delhi, 1987
5. Rao, C. S., “Environmental Pollution Control Engineering”, New Age International (P) Ltd., 1991
6. Punmia, B. C. and Jain, A. K., “Wastewater Engineering”, Second edition, Laxmi Publications (P) Ltd, New Delhi, India, 1998
7. Arora, S., “Fundamentals of Environmental biology”, Kalyani Publishers, New Delhi, 2008

ELECTIVE I - CHEMOINFORMATICS & STRUCTURAL BIOLOGY (415461)

Teaching Scheme:	**Exam Scheme:**
Theory: 4 hrs/week	**Paper: 100 Marks**
Programming: 2 hrs/week	**Term Work: 50 Marks**

UNIT 1 **[8 Hrs]**

Macromolecular Structure as Protein - Primary, Secondary, Supersecondary, Tertiary and Quaternary structure Nucleic acid–DNA and RNA, Carbohydrates, 3D Viral structures, Protein–protein interactions, protein–DNA interactions, DNA binding proteins, Different forces involved in the interactions

UNIT 2 **[8 Hrs]**

Methods to study 3D structure - Principles of crystallography, Principles of protein folding and methods to study protein folding, Mass spectrometry and computational approaches in structural biology

UNIT 3 **[8 Hrs]**

Introduction to cheminformatics, History and evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular modeling and structure elucidation

UNIT 4 **[8 Hrs]**

Chemical Database Design, Basic database theory, Types of database system, Relational model, Object based model, Structure databases, Reaction databases, Chemical abstracts file, Crystallographic databases, Inorganic Crystal Structure Database (ICSD), Cambridge Structural Database (CSD)

UNIT 5 **[8 Hrs]**

Structure representation systems, 2D and 3D structures, General introduction to chemical structure-hybridization, tetrahedron geometry etc, Wiswesser Line Notation and Applications ROSDAL and Applications, the SMILES coding and Applications, Reaction transformations notation like SMIRKS

UNIT 6 **[8 Hrs]**

Characterization of chemicals by Class & by Pharmacophore, application in HTS Analysis as Introduction to pharmocophore, Identification of pharmacophore features Building pharmacophore hypothesis, Searching databases using pharmocophores, Introduction to Quantitative Structure Activity Relationship

Practicals:

1. DrugBank: Search and retrieval of data from databases.
2. PubChem: Search and retrieval of data from databases.

3. SMILES: Importance of storing chemical in the form of notations and to study molecular representation using SMILES.
4. Swiss PDB Viewer: Study of Homology Modeling using Swiss PDB Viewer.
5. Chemsketch: 2D Structure Generation using ChemSketch
6. CORINA and CONCORD: Importance of 3D structure and methods available for 3D structure generation- CORINA and CONCORD.
7. HEX: Study of Molecular Docking using HEX.
8. ISIS Base: A brief introduction to database (ISIS Base) with special emphasis on the storage of chemical in the database format.

Textbooks:

1. Branden, C. and Tooze, J., "Introduction to Protein Structure", Garland Publishing, 1991.
2. Gasteiger, J. and Engel T., "Chemoinformatics", 2004
3. Leach, A. R. and Gillet, V. J., "An introduction to Chemoinformatics", Kluwer Academic Publisher, 2003

Reference books:

1. Lavine, B. K., "Chemometrics and Chemoinformatics", ACS Symposium series 894
2. Dieter, H. and Rognan, D., "Molecular Modeling: Basic Principles and application", Wiley VeH Gmbh and Co. KGA, 2003

ELECTIVE I: BIO-THERAPEUTICS TECHNOLOGY (415461)

Teaching scheme:	**Exam Scheme**
Theory: 4 hr/week	**Paper: 100 Marks**
Practical: 2 hr/week	**Term work: 50 Marks**

UNIT 1 **[8 hrs]**

Introduction to Biotherapeutics development

Overview of the pharmaceutical and biopharmaceutical industry, Definition of the terms: traditional pharmaceutical product, 'biologic' and 'biopharmaceutical', Advantages of producing biopharmaceuticals by recombinant means: availability and scale of production, prevention of accidental transmission of disease, development of altered product forms via protein engineering, Overview of biopharmaceutical products now approved for use, Overview of the drug development process; pre-clinical studies and clinical trials

UNIT 2 **[8 hrs]**

Various systems used for production of Biotherapeutics: Recombinant Proteins

Developing a recombinant therapeutic protein; Cloning in expression vector, Choices of vectors like for Bacterial cells, insect cell lines, Mammalian cell lines, Transfection methods for Bacterial cells, insect cell lines, Mammalian cell lines, Signal Processing of recombinant Production of recombinant proteins

UNIT 3 **[8 hrs]**

Various systems used for production of Biotherapeutics: Recombinant Proteins

Hybridoma technique, Production of recombinant proteins, monoclonal antibodies, vaccines, Identification of potential biopharmaceutical products, generation of suitable recombinant expression systems, characterization of the expressed protein, recombinant production in bacterial/animal cells, Plants and transgenic animals as potential sources of recombinant biopharmaceuticals

UNIT 4 **[8 hrs]**

The biopharmaceutical manufacturing process

The manufacturing process; master and working cell banking systems, clean rooms, decontamination and sanitation, Generation of water for pharmaceutical/biopharmaceutical processing, Product flow through the facility and associated documentation, The QA function, Range and significance of biopharmaceutical product impurities like microorganisms, viruses, contaminant proteins, DNA and pyrogens, The range of QC tests carried out on typical biopharmaceutical products, Biopharmaceutical validation, Principles of validation, validation of chromatographic systems used in biopharmaceutical manufacture

UNIT 5 **[8 hrs]**

Formulation and drug delivery system of Biotherapeutics and Biopharmaceuticals

Formulation Introduction, Types of formulation: Oral, Topical, slow release, parentral, etc., Degradation Routes, Physical Stability Issues and Chemical Stability Issues, Understanding the Routes of Chemical Instability, and Modeling for Streamlining Accelerated stability, real time stability, agents aiding increase in stability, Advanced drug Delivery Systems: Liposomes, PEGyaltion, microparticles and Nanoparticles, biodegradable drug delivery system (hydrogel based)

UNIT 6 **[8 hrs]**

Biopharmaceutical regulation

Regulatory requirements for Biotech product development, Hierarchal structure in Indian biotechnology, Current GMP, Role of DCGI, National& International guidelines, Toxicity, clinical trials, studies, clinical research & clinical data management, IPR patents, trademarks, trade secrets, Export, Import of product, Rules & Regulations for start up companies

Practicals (any 8)**:**

1. Seperation of protein of interest using Ultrafiltation (amicon Filters)
2. Stability study of proteins at 37°C, check integrity using SDS PAGE.
3. Stability study of proteins at 55°C, check integrity using using SDS PAGE
4. Stability study of proteins at 65°C, check integrity using using SDS PAGE
5. Study of effect of temperature on efficacy of lysozyme:enzyme assay
6. Formulations: Ointment
7. Formulations: Tablet
8. Formulations: syrup
9. HPLC : demonstration practical

Text Books

1. Elmer, G. W., Farland, L. V. and Surawicz, C. M., "Biotherapeutic Agents and Infectious Diseases", Humana Press Inc., Totowa, NJ, USA, 1999
2. Grewal, I. S., "Emerging Protein Biotherapeutics"

Reference Books

1. Hillery, A. M., Lloyd, A. W. and Swarbrick, J., "Drug Delivery and Targeting: For Pharmacists and Pharmaceutical Scientists"
2. Walsh, G., "Biopharmaceuticals: Biochemistry and Biotechnology", 2nd Edition, Blackwell, USA

ELECTIVE II - BIOENERGY AND RENEWABLE RESOURCES (415462)

Teaching scheme:
Theory: 3 hr/week

Exam Scheme:
Paper: 100 Marks
Orals: 50 Marks

UNIT 1 **[6 Hrs]**

Energy resources and their utilization

Indian and global energy sources, Energy demand, Energy exploited, Energy planning, Energy parameters (energy intensity, energy-GDP elasticity), Environmental impacts of the conventional and renewable sources, Renewable Energy**:** Introduction to various sources of energy, Solar thermal, Photovoltaic, Water power, Wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy, Hydrogen energy systems, Fuel cells, Decentralized and dispersed generation

UNIT 2 **[6Hrs]**

Wind and Geothermal energy

Wind energy, Characteristics of wind: Effect of density, Frequency variances, Angle of attack, Wind velocity, Principles of wind turbine: operation, siting and control, Process of electricity generation and supply to the grid - wind energy farms, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill, Availability of wind energy in India

Geothermal: Uses of geothermal energy and the geothermal power plants, Mechanisms for deep geothermal heat extraction and power generation, Dry-steam Flash-steam and Binary-cycle, Shallow geothermal and heat-pumps, Wave and Tidal

UNIT 3 **[8Hrs]**

Solar energy and Photovoltaic

Need of solar energy in the world and India, Basics of converting sunlight into electricity, Technologies of producing solar fuels, solar energy collectors, System components, Grid connection and applications, Solar thermal: Technologies and applications of solar thermal energy - Power production and heating applications, Solar heating and solar cooling, Concentrated solar power (CPV and CSP) for utility-scale applications, Domestic and industrial

UNIT 4 **[8Hrs]**

Biodiesel

Definition, advantages of biodiesel, properties of biodiesel, feedstocks - jatropha, Karanja, Neem, plantation, Transesterification, process issues, homogeneous and heterogeneous catalysis, biodiesel from microalgae, algae cultivation, types of photobioreactor, Indian perspective

UNIT 5 **[8Hrs]**

Alcohol fuels

Feedstock for alcohol fuels, common methods for alcohol production, ethanol production from lignocellulosic materials, pretreatment-dilute acid, hot water, steam explosion, Ammonia; enzymatic hydrolysis, detoxification, fermentation, butanol fermentation, challenges in ethanol and butanol production, case studies, concept of biorefinery

UNIT 6 **[6Hrs]**

Gaseous fuels

Biomethanization, microbiological aspects of biogas production, biogas anaerobic fermentation & process, raw materials, factors affecting biodigestion, classification of biogas plants, methods for maintaining biogas production, problem in biogas plants, thermal processes, case study on biogas production, introduction to hydrogen as a fuel

Textbooks:

1. Tiwari, G. N. and Ghosal, M., "Renewable Energy Resources: Basic Principles and Applications", Narosa Publishing House, India, 2004
2. Rai, G. D., "Non-Conventional energy Source", Khanna Publishers, New Delhi, 2004
3. Bansal, Keemann, Meliss," Renewable energy sources and conversion technology", Tata Mc Graw Hill
4. Kothari, D. P., "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd., 2008

Reference books:

1. Twidell, J. and Weir, T., "Renewable Energy Resources", 2nd Ed., New York, 2006
2. Sukhatme, S. P. and Nayak, J. K., "Solar Energy - Principles of Thermal Collection and Storage", Third edition, Tata McGraw Hill Publishing Company Ltd, 2008
3. "Solar Power Engineering"
4. Goswami, D. Y., Kreith, F. and Kreith, J. F., "Principles of Solar Energy", Second edition, CRC press, 2000
5. Mital, K. M., "Non-Conventional Energy Systems", A H Wheeler Publishing Co Ltd , 1999
6. Ramesh, R. and Kumar, K. U., "Renewable Energy Technologies", Narosa Publishing House, New Delhi, 2004
7. Warnmer, S. F., "Progress in Biomass and Bioenergy Research", Nova Publishers, 2006
8. Silveira, S., "Bioenergy: Realizing the Potential", Elsevier Science, 2005
9. Desai, A. V, "Non-Conventional Energy", New Age International (P) Ltd, New Delhi, 2003
10. Rosillo-Calle, P. D. Groot, S. Hemstock, J. Woods, "The Biomass Assessment Handbook: Bioenergy for a Sustainable Environment", Earthscan Publisher, 2006
11. Brenes, M. D., "Biomass and Bioenergy: New Research", Nova Publishers, 2006

ELECTIVE II – BIOMATERIALS (415462)

Teaching scheme: **Exam Scheme**
Theory: 3 hr/week **Paper: 100Marks**
Orals: 50 Marks

UNIT I **[9 Hrs]**

General properties of materials, Classes of materials used in medicine: Metals, Polymers, Hydrogels, Bioresorbable and Biodegradable Materials, Ceramics, Natural materials, composites thin films, grafts, Coatings medical fibers and Biological functional materials, Smart materials, Pyrolytic Carbon for long-term medical Implants, textured and Porous materials, non-fouling surfaces

UNIT 2 **[9 Hrs]**

Biopolymers: Classification (nucleic acid, protein, polysaccharide), Manufacturing, chemistry and applications of polysaccharide such as dextran, xanthan, gellan, pullalane, chitin, chitosan, etc., structural characterization using protein sequencing by Edman degradation, mass spectrometer, optical tweezer (or atomic force microscopy)

UNIT 3 **[9 Hrs]**

Fermentative production of polyesters with special emphasis on polyhydroxyalkanoates, and biodegradable polymers such as polylactic acid, polyglycolide and polycaprolactone, lactoyllactic acid, Structure, physical and chemical properties including production of the above polymers

UNIT 4 **[9 Hrs]**

Application of biocatalyst such as enzymes and microorganisms in biotransformation process, development of polymer precursors using Biotransformation processes Precursors: aromatic hydrocarbons, biological formation of specialty hydroxylated monomers, L-homophenylalanine production using membrane bioreactor.

UNIT 5 **[9 Hrs]**

Types of bioadhesive, nano biomaterial, composite biomaterial, Evaluation of biocompatibility according to United States Pharmacopoeia, Biodegradable plastic, design, synthesis, characterization and application of nanomterials to biological and biomedical problems, Characterize, predict, and control the biological properties of nanobiomaterials

UNIT 6 **[9 Hrs]**

Applications of materials in medicine, Dentistry and Biology: Cardiovascular medical devices, Nonthrombogenic treatments and Strategies, Dental implantation adhesive and Sealants, Ophthalmologic applications-intraocular lens implants, Orthopedic biomaterials, Artificial organs and tissues.

Text Books :

1. Ratner, B. D., Schoen, F. J., Hoffman, A. S. and Lemons, J. E., “Biomaterials Science: An Introduction to Materials in Medicine”
2. Hench, L. L. and Ethridg, E. C., “Biomaterials, an interfacial approach”, Academic press 1982

Reference Books:

1. Bronzino, J. D., “The biomedical engineering handbook”, CRC Press

ELECTIVE II - STEM CELL BIOLOGY AND REGENERATIVE MEDICINE (415462)

Teaching scheme	**Exam scheme**
Theory: 3hr/ week	**Paper: 100 marks**
	Orals: 50 marks

UNIT 1 **[8 Hrs]**

History and introduction to stem cell biology and regenerative medicine. Terms: stem cell, progenitor cells, precursor cells, transit amplifying cells. General properties of stem cells. Terms: Totipotent, pluripotent, multipotent, unipotent stem cells. Differentiation and transdifferentiation. Stem cell niche, growth and differentiation factors.

UNIT 2 **[8 Hrs]**

Techniques used in stem cell biology. Lineage – tracing technique, gene knock-out and knock-in studies, inducible gene expression or repression, transfection, DNA sequencing, Chromatin immunoprecipitation, fluorescent-activated cell sorting, confocal microscopy. Other techniques.

UNIT 3 **[8 Hrs]**

Stem cell types: embryonic stem cells, somatic cell nuclear transfer, induced pluripotent stem cells, neural stem cells, hematopoietic stem cells, pancreatic stem cells. Isolation and culture of the above stem cell types.

UNIT 4 **[8 Hrs]**

Guidelines for stem cells research and therapy in India: introduction, general mechanisms, aim and scope, categorization of research on stem cells, clinical application of umbilical cord blood stem cells, criteria on use of placental / fetal stem cells for research, approval of procurement. Banking or distribution of hESCs. International collaboration and patent issues.

UNIT 5 **[8 Hrs]**

Degenerative diseases: discussion of degenerative diseases including Parkinson disease, diabetes, burn, retinal replacement therapy, cardiomyopathies, etc.

UNIT 6 **[8 Hrs]**

Understanding of cell replacement and regeneration. Application of stem cells in degenerative medicine. Cells and tissue engineering. Application of different stem cell types for different degenerative diseases including gene therapy.

Text Books:

1. Marshak, D. R., Gardner, R. L. and Gottlieb, D., “Stem Cell Biology”, Cold Spring Harbor Laboratory Press
2. Wilmut, I., “Essentials of Stem Cell Biology”, Elsevier publication

Reference Books:

1. Helgason, C. D. and Miller, C. L., “Methods in Molecular Biology: Basic Cell Culture Protocols”
2. Sell, S., “Stem Cells Handbook”, Humana Press
3. Kiessling, A. and Anderson, S. C., “Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential”, Jones and Bartlett Publishers
4. Chiu, S. and Rao, M. S., “Human Embryonic Stem Cells”, Humana Press
5. Robert Paul Lanza, “Essentials of Stem Cell Biology”, Elsevier Academic Press
6. Lawrence S. B. Goldstein, Meg Schnider, “Stem Cells for Dummies”, Wiley Publication
7. “Insight: Stem Cell Biology”. Nature. 2006; 441:1059-1102.
8. “Insight: Regenerative Medicine”. Nature. 2008; 453:301-352.

ELECTIVE III - FOOD BIOTECHNOLOGY (415467)

Teaching Scheme:
Theory: 4 hr/week
Practicals : 2hr/week

Exam Scheme:
Paper: 100 Marks
Orals: 50 Marks
Term work: 50 Marks

UNIT 1 **[6 Hrs]**

Introduction to Food Biotechnology and Spoilage of Food

Biotechnology in relation to the food industry, classes of industrially important food, Characteristics of food - Nutritional value and sensory characteristics, spoilage of food – Mechanisms and types of spoilage, Intrinsic and extrinsic factors affecting spoilage: water activity, pH, temperature, redox potential etc., major spoilage micro organisms and their growth conditions, effect on food

UNIT 2 **[10 Hrs]**

Introduction to Food Processing

Preliminary processing methods – need and types, Raw material preparation: Cleaning, sorting, grading, peeling etc

Principles and methods of food preservation – Low temperature techniques: Refrigeration, Freezing and freeze drying, High temperature techniques: Blanching, pasteurization, HTST sterilization, canning, UHT treatment, dehydration, drying, extrusion cooking, Irradiation techniques: UV light, microwave processing, gamma rays, hydrostatic pressure cooking, dielectric heating, use of additives, modified atmosphere packaging and storage

UNIT 3

Design of Food Preservation Equipments **[8 Hrs]**

General engineering aspects and processing methods, types of equipments and their design: Refrigerator, freezer, dryer, thermal death kinetics of micro organisms, calculation of pasteurization time, time and temperature calculation for HTST sterilization, calculation of efficiency of irradiation techniques

UNIT 4 **[8 Hrs]**

Microbial and Fermentation Biotechnology

Technologies used for microbial production of food ingredients, Biotechnology of microbial polysaccharides in food, Microbial biotechnology of food flavor production, microbial production of oils and fats, food applications of algae

Process developments in solid state fermentation for food applications, solid state bio-processing for functional food ingredients, Fermentation biotechnology of traditional foods of the Indian subcontinent

UNIT 5 **[6 Hrs]**

Role of Enzymes in Food Processing

Classes of industrially important enzymes in food industry, Role of enzymes in bakery industry, cereal and beverage industry, meat processing, beer mashing and chill-proofing, production and application of pectinases, proteases etc.

UNIT 6 **[8 Hrs]**

Processes for the treatment of food processing waste

Classification and characterization of food industrial waste: solid, liquid and hazardous wastes, Waste disposal methods- physical, chemical and biological, Treatment methods of solid wastes, Treatment methods for liquid wastes from food industry, activated sludge and anaerobic processes for treatment of food processing wastes

Practicals: (Any 8):

1. SPC count of bacteria in Foods (e.g. Chuteny, souce etc.)
2. SPC count of Fungi in Foods
3. MPN test of food for E.coli (e.g. Pedha)
4. MBRT test of Milk.
5. Study of fats and oils
    a) Iodine Value
    b) Peroxide Value
6. Qualitative analysis of
    a) Glucose
    b) Fructose
    c) Starch
    d) Proteins
7. To study effect of pasteurization on Milk
8. Analysis of milk for total solid content.
9. Industrial Visit.

Text Books:

1. Shetty, K., Paliyath, G., Pometto, A. and Levin, R. E., "Food Biotechnology", Taylor and Francis
2. Frazier, "Food Microbiology"
3. Fellows, P. , Ellis, H., "Food Processing Technology Principles and Practice", Wiley, New York

Reference books:

1. Johnson-Green, Perry, "Introduction to Food Biotechnology"
2. Roger, A., Gordan, B. and John, T., "Food Biotechnology", 1989
3. George, J. B., "Basic Food Microbiology", CBS Publishers Distributors, 1987
4. James, M .J., "Modern Food Microbiology", CBS Publishers & Distributors, 1987

5. Lindsay and Willis, “Biotechnology, Challenges for the flavor and food Industries”, Elsevier Applied Science, 1988
6. Desrosier, “Technology of food preservation”, CBS Publishers
7. Jay, “Modern Food Microbiology”, CBS Publishers, 1987
8. Reed, G., “Prescott and Dunn’s Microbiology”, CBS Publishers, 1987

ELECTIVE III - AGRICULTURAL BIOTECHNOLOGY (415467)

Teaching Scheme:
Theory: 4 hr/week
Practicals: 2 hr/week

Exam Scheme:
Paper: 100 Marks
Orals: 50 Marks
Term Work: 50 Marks

UNIT 1 **[8 Hrs]**

Introduction to Agricultural biotechnology

Novel features of plant growth and development, Biodiversity, Conventional methods of crop improvement, Objectives of plant breeding, Types of breeding, Genetic variation and manipulation of variability, Breeding of selected crops-important cereals, pulses, oilseeds, fibre, sugar and cash crops, Plant Biodiversity, Classical deliberate interbreeding, Intraspecific hybridization, Methods of breeding self-pollinated crops and cross- pollinated crops, Methods of breeding asexually propagated crops, self incompatibility and male sterility in crop breeding, mutation breeding, Ploidy breeding, Innovative breeding methods, Hybrid varieties

UNIT 2 **[8 Hrs]**

Plant tissue culture and its application

Principles of plant micropropagation, The totipotency concept, Role & composition of Plant tissue culture media, Micropropagation pathways, Callus induction & culture, organogenesis and embryogenesis, Meristem tip culture, Haploid production, Hardening of plants, Techniques of anther, embryo and ovule culture, Protoplast isolation, Somatic hybridization, Cybrids, Somaclones, Artificial seed Technology(synthetic seed), Embryo rescue Cell line selection using selection pressure, Production of secondary metabolites, Cryopreservation and germplasm storage

UNIT 3 **[8 Hrs]**

Plant molecular biology

Organelle DNA, Satellite-and repetitive DNAs, DNA repair, Regulation of gene expression, Recombinant DNA technology-cloning vectors, restriction enzymes, gene cloning, Methods of gene transfer in plants, Achievements and recent developments of genetic engineering in agriculture, Development of transgenies for biotic & abiotic stress tolerance, Ribozfore Technology, Ti plasmid-based transformation, Agrobacterium biology, crown gall and hairy root disease, Ti and Ri plasmids, T-DNA genes, borders, overdrive, chromosomal and Ti plasmid virulence genes and their functions, vir gene induction, mechanism of T-DNA transfer, Ti pasmid vectors, vir helper plasmid, super virulence and monocot transformation, binary vector, Transgene silencing, Strategies to avoid transgene silencing, Direct transformation of protoplasts using PEG, electroporation, Transformation by particle bombardment, Assembly of particle gun, Microprojectile preparation and bombardment, Chloroplast transformation by particle bombardment.

UNIT 4 **[8 Hrs]**

Advanced technology for crop improvement

Genetic engineering of crops, Commercial status of transgenic plants, Herbicide resistance, glyphosate, sulfonyl urea, phosphinothricin, atrazine, Pest resistance, B.t. toxin, synthetic B.t. toxin, Bt brinjal, Bt cotton, Protease inhibitor, GNA and other lectins, α-amylase inhibitor, nematode resistance, Genetic engineering for male sterility-Barnase-Barstar, Delay of fruit ripening, polygalacturanase, ACC synthase, ACC oxidase, Improved seed storage proteins, Improving and altering the composition of starch and plant oils, Golden rice for β-carotene accumulation, Production of antibodies and pharmaceuticals in plants, Biofertilizers, Gene flow in plants – Development of mapping population – Molecular marker aided breeding-RFLP maps, Linkage analysis, RAPD markers, microsatellites, SCAR (Sequence Characterized Amplified Region), SSCP(Single strand Conformational Polymorphism), AFLP,QTL, map based cloning , Molecular marker assisted selection(MAS), Mapping genes on specific chromosomes, Gene pyramiding, Transcript mapping techniques

Unit 5 **[8 Hrs]**

Ethics and Biosafety

Ethical issues in biotechnology, Biosafety and Risk assessment of GMOs, Public perception. IPR and Trade related aspects, Methods for producing transgenic plants and animals, Important genes of agronomic interest, Current trends in finding useful genes, GMO Act 2004. Traceability, Legislative aspects.Introduction, Historical Backround, Introduction to Biological Safety Cabinets, Primary Containment for Biohazards, Biosafety Levels, Biosafety Levels of Specific Microorganisms, Recommended Biosafety Levels for Infectious Agents and Infected Animals, Biosafety guidelines - Government of India, Definition of GMOs & LMOs, Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture, Environmental release of GMOs, Risk Analysis, Risk Assessment, Risk management and communication, Overview of National Regulations and relevant International Agreements including Cartegana Protocol

Unit 6 **[8 Hrs]**

Animal lifestock breeding

Importance of livestock in agriculture, relationship between plant and animal husbandry, animal breeding, breeds of indigenous and exotic cattle, buffaloes, goats, sheep, pigs and poultries and their potential for milk, egg, meat and wool production, classification of feed and fodder, major contagious diseases affecting cattle and drought animals, poultries and pigs, Sericulture and its applications

Practicals (Any 8) :

1. Isolation of plant DNA
2. RE digestion of Plant DNA
3. Leaf disc method
4. RAPD or RFLP: PCR
5. RAPD/RFLP: agarose gel and scoring bands

6. Study of seed storage proteins
7. PTC facility and set up
8. Preparation of media for PTC
9. Somatic embryogenesis
10. Induction of callus
11. Suspension culture
12. Development of somatic embryos
13. Germination of embryos
14. Visit to PTC facility
15. Biofertilizers

Text books

1. Keshavachandran. R. and Peter, K. V., “Plant Biotechnology: Tissue culture and Genetransfer”. Orient and Longman, (Universal Press) Chennai, 1990
2. Gresshoff, P. M., “Plant biotechnology and development”, 1992
3. Jones, M. G. K. and Lindsey, K., "Plant Biotechnology in Molecular biology and biotechnology”, Walker, JM and Gingold, EB (Eds). 2000
4. Kumar, H. D., “Agricultural Biotechnology”, India ,2005

Reference books:

1. “Esau's Plant Anatomy, Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function, and Developmen”t, 3rd Edition, John Wiley & Sons, 2006
2. Smith, R. H., “Plant Tissue Culture: Techniques and Experiments”, Academic Press, San Diego, 1992
3. Chrispeels, M. J. and Sadava D. F. (eds), “Plants, Genes and Crop Biotechnology”, 2nd Edition, Jones and Barlett Press, 2003
4. Hammond, J. H., Mcgarvey, P. and Yusibov V. (eds), “Plant Biotechnology”, Springer Verlag, Heidelberg, 2000
5. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
6. Kankanala, C., “Genetic Patent Law & Strategy”, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007
7. Encyclopedia of ethics, legal and policy issues in biotechnology. 2000
8. Harrington, R. B., “Animal Breeding: An Introduction”, October 1995
9. Newman, S., Rothschild, M. F., “Intellectual Property Rights in Animal Breeding and Genetics”, Wallingford, Oxon, 2002

ELECTIVE III – INTRODUCTION TO SYSTEMS BIOLOGY (415467)

Teaching Scheme:	**Exam Scheme:**
Theory: 4 hr/week	**Paper: 100 Marks**
Practicals : 2hr/week	**Orals: 50 Marks**
	Term work: 50 Marks

UNIT 1 **[4 Hrs]**

Fundamentals of Systems Biology

Overview of systems Biology, History, Definition, Components of Systems Biology, Bottom up and top down approach, Central Dogma of molecular Biology, Molecular Hierarchy, Human Genome project, Network analysis and mathematical modeling

UNIT 2 **[6 Hrs]**

Genomics

Introduction to genomics, sequencing strategies for whole genome analysis, Sequencing methods, capillary electrophoresis, Next Gen sequencing methods, Comparative genomics, genome annotation, Structural genomics

UNIT 3 **[6 Hrs]**

Functional genomics

Global analysis of gene expression, Transcriptomics and microarray, Microarray-Types, Analysis, Applications, RNA interference, siRNA, miRNA

UNIT 4 **[8 Hrs]**

Epigenetics

Epigenetics: Regulation of Organization & Gene Expression, Epigenetic Mechanisms, Methylation, Acetylation, Histone modifications, DNA methylation, model organisms for epigenetic studies, methods-CHIP on CHIP assays, CpG islands microarrays, Epigenetics and diseases

UNIT 5 **[8 Hrs]**

Pharmacogenomics

Introduction to Pharmacogenomics, Variation in drug response, ADME, Drug Metabolizing enzymes and genes, Slow metabolizers, Extensive metabolizers, Case studies in Pharmacogenomics, Traditional medicine based Pharmacogenomics, Toxicogenomics

UNIT 6 **[8 Hrs]**

Proteomics and Metabolomics

Primary, secondary, tertiary, quaternary structure of Proteins, Strategies in proteomics, Structural/functional proteomics, Proteomics methodologies, protein–protein interactions, Introduction to proteomic technology, 2D gels, mass spectrometry - MALDI TOF analyzers - tandem mass Analyzers - triple quadrople mass analyzer - ms instrument, Proteomics applications: drug development, screening of diagnostic markers,

identification and characterization of novel proteins, Metabolome and techniques used in metabolomics

Practicals: (Any 8)

1. cDNA PCR
2. Genotyping
3. PCR-RFLP
4. Real Time PCR for quantitation of gene expression
5. SDS PAGE
6. DNA polymorphism in DMEs
7. Demonstration of sequencing
8. Detection of miRNA
9. Types of Microarrays and demonstration on data generated
10. Validation of microarray data

Text Books:

1. Benjamin Lewin, "Genes IX"
2. Alberghina, L. and Westerhoff, H., "*Systems Biology: Definitions and Perspectives"*Topics in Current Genetics. 13, Springer Verlag. 2005
3. A. Malcolm Campbell and Laurie J. Heyer , "Discovering Genomics, Proteomics and Bioinformatics" (2nd Edition), 2006

Reference books:

1. Pharmacogenomics in Drug Discovery and Development, Series: Methods in Molecular Biology, Vol. 448, Yan, Qing (Ed.), 2008, XIII, 487 p. 62
2. Creighton, T. E., "Proteins", Freeman WH, Second Ed, 1993
3. Branden, C.and Tooze, R., " Introduction of protein structure ", Garland, 1993
4. Denis Noble, "The Music of Life: Biology beyond the genome", Oxford University Press, 2006
5. Hiroaki Kitano, "Foundations of Systems Biology", MIT Press, 2002
6. "Proteomics Today: Protein Assessment and Biomarkers Using Mass Spectrometry, 2D Electrophoresis,and Microarray Technology", Wiley - Interscience Series on Mass Spectrometry

ELECTIVE IV – MANAGEMENT AND ENTERPRENEURSHIP (415468)

Teaching Scheme: **Exam Scheme:**
Theory: 3 hr/week **Paper: 100 Marks**
Term work: 50 Marks

UNIT 1 **[8 Hrs]**

Management

Introduction – Meaning – Concept and features of Management, Scope and functional areas of management – Management as a science, art or profession – Management and administration – Roles of management, Levels of management, development of management thought – early management approaches – modern management approaches. Decision making – importance of planning – steps in planning

UNIT 2 **[7 Hrs]**

Organizing and Staffing

Nature and purpose of organization, principles of Organizations – Types of organization - Departmentation –Committees Centralization vs. Decentralization of authority and responsibility, span of Control, MBO, and MBE (Meaning only) Nature and importance of Staffing – process of selection and recruitment (in brief)

UNIT 3 **[7 Hrs]**

Directing & Controlling

Meaning and nature of directing – Leadership styles and motivation theories, communication – Meaning and importance – Coordination, meaning and importance and Techniques of Co – ordination

UNIT 4 **[8 Hrs]**

Entrepreneur

Meaning of Entrepreneur, Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Intrapreneur – an emerging Class, Development of Entrepreneurship steps in entrepreneurial process, Role of entrepreneurs in Economic Development: Entrepreneurship in India, Challenges to woman and achievements of woman Entrepreneurs, Identification of Business Opportunities

UNIT 5 **[9 Hrs]**

Small Scale Industry

Meaning, Nature of Support; Objectives, Definition, Characteristics, Need and rationale: Objectives: Scope, role of SSI in Economic Development, Advantages of SSI, Steps to

start in SSI – Government policy towards SSI, Functions, Types of Help, Ancillary Industry and Tiny Industry (Definition only)

UNIT 6 **[7 Hrs]**

Preparation Of Project

Meaning of Project, Project Identification, Project Selection, Project Report, Need and Significance of Report, Contents, formulation, Guidelines by Planning Commission for Project report, Network Analysis, Errors of Project Report, and Project Appraisal

Text Books:

1. Tripathi, P.C. and Reddy, P. N., "Principles of Management", Tata McGraw Hill, 2nd Edition
2. Vasant Desai, "Dynamics of Entrepreneurial Development & Management", Himalaya Publishing House
3. Poornima M Charantimath, "Entrepreneurship Development – Small Business Enterprises", Pearson Education, 2006, 2nd Edition

Reference Books:

1. Robert Lusier – Thomson, "Management Fundamentals - Concepts, Application, Skill Development", 1st Edition
2. Peter F. Drucker, "Innovation and Entrepreneurship", Harpercollins Publication
3. Stephen Robbins, "Management", Pearson Education / PHI -17th Edition, 2003
4. Naidu, N. V. R. and Kirshna Rao, T., "Management and Entrepreneurship", I.K. International, New Delhi – 2008
5. Harold Koontz, "Essentials of Management", TMGH-2010, 2 nd Edition

ELECTIVE IV – IPR, BIOETHICS AND REGULATIONS (415468)

Teaching Scheme:
Theory: 3 hr/week

Exam Scheme:
Paper: 100 Marks
Term work: 50 Marks

UNIT 1 **[8 Hrs]**

Ethics, definition, ICMR guidelines for ethics in biomedical research, consent form, composition of ethics committee, Ethics at workplace, various scenarios, defining the moral standards of right and wrong, morals and laws, an organizational perspective, legal vs ethical, ethics in business, ethics and profits

UNIT 2

Bioethics, Case studies: ethics in life sciences, ethics in medicine, ethics in biotechnology, recombinant DNA, ethics in food biotechnology, agricultural biotechnology, environmental ethics, animal ethics, discuss moral righteous of an action, procedure or policy, moral wrongness of the action

UNIT 3

Patent, objects of patent law, benefits of patenting, remedies against infringement, requirements of patentability, rights of patentee, patent application procedure, patenting in biotechnology, patent search, patents from an international perspective, study of patents

UNIT 4

Domain name and trademark, purpose of trademark, requirements for registration for a trademark, copyright, assignment and transfer of copyright, copyright infringement, registration and piracy

UNIT 5

Regulatory requirements for Biotech. product development, Hierarchal structure in Indian biotechnology, Current GMP, Role of DCGI, National& International guidelines

UNIT 6

Quality Assurance, Quality control requirement for Biotech product, Toxicity, clinical trials, studies, clinical research & clinical data management, Export, Import of product, Rules & Regulations for start up companies

Text Books:

1. Erbisch, F. H. and Maredia, K. M., “Intellectual property rights in agricultural biotechnology”
2. Jonathan Morris, “The ethics of biotechnology”

Reference Books:

1. K. C. Shippey, “A short course in international intellectual property rights”

ELECTIVE IV – INDUSTRIAL ORGANIZATION AND MANAGEMENT (415468)

Teaching Scheme: **Exam Scheme:**
Theory: 3 hr/week **Paper: 100 Marks**
Term work: 50 Marks

UNIT 1 **[8 Hrs]**

Management Science:

Management, its growth, concepts of administration and management of organization, Definition of management, functions, authority and responsibility, Unity of command and direction, Decision making in management by objectives

Business Organization: Different forms of organization, their formation and working, Different organization structure- line organization, functional organization, line and staff organization

UNIT 2 **[8 Hrs]**

Personnel Management:

Manpower planning, sources of recruitment, selection and training of staff, Job evaluation, merit rating, performance appraisal, wage administration and system, of wage payment, incentive, motivations, industrial fatigue, Trade unions – industrial relations

UNIT 3 **[8 Hrs]**

Purchase and stores management

Concepts of quotation, tenders and comparative statement, inspection and quality control, Inventory, carrying cost and fixed cost of inventory, examples of cost of Inventory, Stores management, functions of storekeeper, methods of inventory : LIFO, FIFO

UNIT 4 **[8 Hrs]**

Marketing management:

Concepts of selling, marketing, definition of marketing, market research and of pricing, penetration, pricing, skimming pricing, distribution of product, advertising and promotion

UNIT 5 **[8 Hrs]**

Export and import management

Concepts of international trade, duties, antidumping duty, cost involved in exporting a product, pricing of export product, Government aids for export promotion, export houses, export promotion counsel, MODVAT, patent and patent rights,

Quality Management: TQM, quality circles, ISO systems

UNIT 6 **[8 Hrs]**

Management Laws

Concepts of contract act, offer, and acceptance, types of contracts, Void contract, concept of guarantee and warranty, Introduction of MRTP and FERA

Work study:
Work Measurement, motion and time study flow process chart, flow diagram, sio chart, string chart, therbligs

Practicals :
Seminars on the case studies from Unit 1 to 6

Text Books:

1. Shama and Banga S. C., "Industrial Engineering and Management", Khanna Publishers
2. Khanna, O. P., "Industrial Engineering and Management", Khanna Publishers
3. Tripathi, P.C. and Reddy, P. N., "Principles of Management", Tata McGraw Hill, 3rd Edition

Reference Books:

1. Luthans, F., "Organizational Behaviour", Tenth Edition, Tata McGraw Hill Publications
2. Gulshan, S. S. and Kapoor, G. K., "Business Law & Including Company Law", Fourteenth Edition, New Age International Ltd.
3. Ramaswamy, V. S. and Namakumari, S., "Marketing Management", MacMillan India Ltd
4. Kulkarni, P. V. and Satyaprasad, B. G., "Financial Management", Thirteenth Edition, Himalaya Publishers Ltd.
5. Ebert, R. J. and Everett Adam, "Production & Operations Management", Fifth Edition, Pearson Publication
6. Peterson, Lewis and Jain, "Managerial Economics", Fifteenth Edition, Pearson Publication
7. Jhamb, L. C., "Quantitative Techniques", Sixteenth Edition, Everest Publishing House
8. Mamoria, Mamoria & Gankar, "Dynamics of Industrial Relations", Fifteenth Edition, Himalaya Publishing House
9. Davar, R. S., "Personal Management & Industrial Relations", Tenth Edition, Vikas Publishing House
10. S. P. Jain and K. Jain, "Industrial & Labour Laws", Thirteenth Edition, Dhanpat Rai Publishers