BE CGPA pattern syllabus

B.E. Biotechnology

Semester-VII

Faculty of Engineering and Technology
North Maharashtra University, Jalgaon

Course Outline

Bio Process Equipment Design	**BPED**	**BTL-701**
Course Title	Short Title	Course Code

Lecture	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Semester Credits**
	03	15	40	03

Course Description:

The aim of this course is to introduce the fundamentals followed in the design of Bioprocess equipments and basic understanding of design parameter.

Prerequisite Courses: Heat transfer, Mass transfer and Chemical reaction engineering.

General Objectives:

1. To study the safety measures in equipment design.
2. To study design of various Bioprocess Equipments.
3. To study to design the suitable equipment for a desired bioprocesses.
4. To study the mechanical design of various bioprocess equipments.

Learning Outcomes:

At end of the course Student will able to

1. Use basic standard equipment symbols in bioprocess industry.
2. To perform the task by identifying, formulating, designing and providing the solution to various biochemical engineering problems.
3. Design various bioprocess equipments used in bioprocess industries.
4. Show the capacity of designing the equipment to meet economical and societal requirements.
5. Learn software for equipment design.

Course Outline

Bio Process Equipment Design	**BPED**	**BT-701**
Course Title	Short Title	Course Code

Course Description:

This course is aimed at introducing the fundamentals followed in the design of Bioprocess equipments and basic understanding of design parameter.

	Hours per Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Lecture	03	15	40	03

Prerequisite Courses: SE and TE Biotechnology Subjects

General Objectives:

1. To study the safety measures in equipment design.
2. To study design of various Bioprocess Equipments.
3. To study to design the suitable equipment for a desired bioprocesses.
4. To study the mechanical design of various bioprocess equipments.

Learning Outcomes:

At end of the course Student should able to

1. Use basic standard equipment symbols in Bioprocess industry.
2. To perform the task by identifying, formulating, designing and providing the solution to various biochemical engineering problems.
3. Design various bioprocess equipments used in bioprocess industries.
4. Show professional and ethical responsibilities formally and informally.
5. Show the capacity of designing the product to meet economical and societal requirements.

Course Content

BE Biotechnology Semester – VII

Bioprocess Equipment Design

Teaching Scheme

Theory : 3 hours/ week

Examination Scheme

End Semester Examination (ESE) : 80Marks:
Paper Duration (ESE) : 03 Hours
Internal Sessional Examination (ISE) : 20 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Process Hazards and Safety Measures in Equipment Design: Introduction, Hazards in Process Industries, Hazards Analysis, Safety Measures, Safety Measures in Equipment Design, Pressure relief Devices.

UNIT-II **No. of Lect. – 08, Marks: 16**

Process Design of Reaction Vessels: Introduction, Materials of Construction, Agitation, Classification of Reaction Vessels, Design of batch bioreactor.

UNIT-III **No. of Lect. – 08, Marks: 16**

Process Design of Evaporator: Introduction, Types of Evaporator, Methods of Feeding of Evaporator, Design of Calendria type Evaporator.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Heat exchange equipment : Introduction , Working and Construction and Design of Shell and tube Heat Exchanger.

UNIT-V **No. of Lect. – 08, Marks: 16**

Process Design of Rotary Dryer: Introduction, Types of Dryer, Design of Rotary Dryer, Design of Sieve Tray and Bubble Cap for Distillation Column.

Textbooks:

1. M.V. Joshi, V.V. Mahajani Process Equipment Design, Macmillan Publishers India Ltd.
2. S.D. Dawande, Process Equipment Design (Vol. I),Denett & Co., Nagpur.
3. R. S. Khurmi, J.M. Gupta, A Text Book of Machine Design, S. Chand & Company Ltd, New Delhi.

Reference book:

1. Bioprocess Engineering Principles (1995) Doran PM, Academic Press Ltd, USA
2. B.C. Bhattacharya, Introduction to Chemical Equipment Design (Mechanical Aspects), CBS Publisher and Distributors, New Delhi.
3. Coulson & Richardson Chemical Engineering (Vol. VI), Butterworth- Heinmann Elsevier.

Bioinformatics

Course Outline

Bioinformatics	Bioinfo.	BTL-702
Course Title	**Short Title**	**Course Code**

Lecture	Hours per week	No. Of weeks	Total hours	Semester credits
	03	15	40	03

Course Description:
This course aims to provide students with a practical and hands-on experience with common bioinformatics tools and databases.

Prerequisite Course(s): Microbiology, Genetic engineering &Molecular Biology.

General objective :

1. To introduce students to the fundamentals of evolution, molecular biology, and molecular evolution.
2. These principals underlie much of modern bioinformatics, and students will be shown how they apply to the basic predictive methods that are of common use in the field.
3. Students will be trained in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, prediction of protein function, and building phylogenetic trees. Specific types of analysis discussed in the course will include but is not limited to: Detection of homology with BLAST, prediction of transmembrane segments, multiple alignment of sequences, prediction of protein domains, prediction of protein localization, and building phylogenetic trees.

Learning outcomes:
By completion of this course students will able:

1. To understand the theoretical basis behind bioinformatics.
2. Search databases accessible on the WWW for literature relating to molecular biology and biotechnology.
3. Manipulate DNA and protein sequences using stand-alone PC programs and programs available on the WWW. Find homologues, analyse sequences, construct and interpret evolutionary trees.
4. View and interpret these structures.
5. Understand homology modelling and computational drug design.
6. Students will be able to query biological data, interpret and model biological information applies this to the solution of biological problems in any arena involving molecular data.
7. Explore the options for bioinformatics in higher study.

Course content

BE Biotechnology Bioinformatics semester VII

Teaching Scheme	Examination scheme
3hrs/week	End Semester Examination (ESE) : 80 Marks
	Paper Duration (ESE) : 03.00 hr
	Internal Sessional Examination (ISE) : 20Marks

Unit -I

Introduction: **No. of Lecture: 8 Hours, Marks: 16**

Introduction to bioinformatics, bioinformatics and internet, Databases:Introduction, primary and secondary databases, format v/s contents, the Genbank flat files and its format, database at NCBI, Databases : DDBJ, EMBL, Genbank, submitting DNA sequence to database; Structure database: PDB, Molecular modelling database at NCBI, structure file format.

Unit-II **No. of Lecture: 8 Hours, Marks: 16**

Sequence alignment:

Introduction, types of sequence alignment, Algorithms for sequence alignment: Needlemen-Wunsch and Smith-Waterman algorithm, Methods of pair wise sequence alignment, Database similarity searching: FASTA, BLAST, Substitution Score and Gap penalties, PAM matrix, Multiple sequence alignment, Hidden markov models and threading methods.

Unit-III **No. of Lecture: 8 Hours, Marks: 16**

Phylogenetic analysis:

Introduction, Elements of phylogenetic models, Phylogenic data analysis, Relation between Phylogenetic analysis and multiple sequence alignment, Evolutionary trees, Methods for Phylogenetic prediction: Maximum Parsimony method, Distance methods, Phylogenetic software.

Unit-IV **No. of Lecture: 8 Hours, Marks: 16**

Gene prediction:

Introduction, Open reading frame based gene prediction, Procedure for gene prediction, Gene prediction in microbial genomes, Gene prediction in eukaryotes, Promoter prediction in E.Coli, Promoter prediction in eukaryotes, Gene finding methods: GRAIL, GENSCAN, PROCRUSTES, Gene parser.

Unit-V

Structure prediction: **No. of Lecture: 8 Hours, Marks: 16**

Prediction of RNA structure:

Introduction, Sequence and base pairing patterns for structure prediction, Methods predicting RNA structure: Energy minimization and identification of base covariation, Prediction of protein structure :- Introduction, Protein structure description, Protein structure classification in databases, Structural alignment methods, Protein structure prediction by amino acid sequence: use of sequence patterns, Prediction of secondary structure, Prediction of 3D structure.

REFERENCES:

1. Andreas D. Boxevanis, Bioinformatics, Wiley International.
2. David W. Mount, Bioinformatics: Sequence and Genome analysis, Cold Spring Harbour.
3. T.K.Attwood and Parry . Smith D.J, Introduction to Bio Informatics, Pearson Education Ltd, South Asia.
4. Vittal.R.Srinivas, Bioinformatics: A Modern Approach, PHI.
5. S.C.Rastogi, N.Mendiratta, P.Rastogi, Bioinformatics: Methods and Applications, PHI.

Downstream Processing

Course Outline

Downstream Processing	**DSP**	**BTL-703**
Course Title	Short Title	Course Code

Lectures	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Credits**
	03	15	40	3

Course Description:

This course is aimed to develop the basic knowledge and operations of recovery processes to undergraduate students. The background expected includes a prior knowledge of SE and TE Biotechnology courses. The goals of the course are to understand the basic principles of downstream processes and their applications in engineering trade.

Prerequisite Course(s): Unit operation and Fermentation technology.

General Objective:

- To develop the basic knowledge and skills of recovery processes, including the filtration, centrifugation, chromatographic separations and their role in Fermentation Technology.

Learning Outcomes:

After completion of the course, students will be able to:

1. Apply the mathematical and engineering terms for designing the best suitable method for biomolecule separation.
2. Apply the basic principle by studying the characteristics of biological mixtures for designing and conduct the experiments.
3. Able to recognize the need of separation technique of biomolecules and methodology involved, will helpful for lifelong learning.
4. Apply the skills and engineering strategy in the separation technique of biomolecules that is meant for societal welfare.
5. Apply the knowledge of engineering principle to living entities for societal welfare.

COURSE CONTENT

BE Biotechnology Downstream Processing Semester –VII

Teaching Scheme
Lectures -3 Hrs/week

Examination Scheme
End Semester Exams (ESE): 80 Marks.
Paper Duration: 3 Hours.
Internal Sessional Exam (ISE): 20 Marks.

Unit: I

Introduction and Separation of Particles: No. of Lecture: 8 Hours, Marks: 16

Role and importance of downstream processing in biotechnology, Characteristics of biological mixtures (broth), Filtration, Filter media, Theory of filtration, Types of filters (vacuum filter, plate and frame filter, leaf filter),Centrifugation, Theory of centrifugation, Types of centrifuge (tubular bowl centrifuge, basket centrifuge, ultra centrifuge), Sedimentation, Precipitation and flocculation.

Unit: II

Cell disruption methods: No. of Lecture: 8 Hours, Marks: 16

Introduction, Types of intracellular products and importance, Methods of cell disruption, Physico-mechanical cell disruption: liquid shear (high pressure homogenizer), Solid shear agitation and abrasives (bead mill, kinetics of bead mill), Freezing - thawing, Ultrasonication (ultrasonic vibrators), Thermal shock, Osmotic shock, Chemical treatment: alkali treatment, Detergent solubilization, Lipid solubilization, Enzymatic method.

Unit: III

Extraction and Concentration: No. of Lecture: 8 Hours, Marks: 16

Extraction, modes of extraction, Liquid-liquid extraction, Two phase aqueous extraction, Super critical extraction, Solvent recovery, Extraction application.

Concentration of products:

Evaporation, Types of evaporation, Membrane process, Ultrafiltration, Reverse osmosis, Dialysis, Nanofiltration, Sorption, Sorption mechanism, Modes of operation in sorption process, Adsorption.

Unit: IV

Purification of product: No. of Lecture: 8 Hours, Marks: 16

Fractional precipitation, Chromatography: Types of chromatography: Adsorption, Ion exchange, Gel permeation, Affinity, Molecular Exclusion, High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC), Crystallization, Drying, Types of drying (spray drying, vacuum drying, freeze drying), High performance thin layer chromatography. Electrophoresis: Theory of electrophoresis, Gel electrophoresis, Isoelectric focusing.

Unit: V

Formulation and Case studies: No. of Lecture: 8 Hours, Marks: 16

Introduction, Importance of formulation, Formulation of baker's yeast, Enzymes (glucose isomerase, detergent enzymes), Formulation of pharmaceutical products, Application research, Granulation: wet granulation, Dry granulation or slugging Case studies of recovery process of penicillin, Nuclease, Citric acid, Proteins.

Reference Books:

1. Sivasankar.Separation processes in Biotechnology
2. Paul A Belter, E L Cussler, Wei-shouHu,Bio-separations- Downstream Processing for Biotechnology- Wiley Inter-science Publications, 1988.
3. P. F. Stanbury, A. Whitaker and S. J. Hall, Principles of Fermentation Technology, Aditya Books (P) Ltd, New Delhi.
4. Belter P.A. and Cussier E, Bioseparations, Wiley, 1985.

Interdisciplinary Elective
1.Biotechnology of Waste Treatment

Course Outline

Biotechnology of Waste Treatment	**BWT**	**BTL- 704**
Course Title	Short Title	Course Code

Lectures	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Credits**
	03	15	40	3

Course Description:

This course is aimed to develop the basic knowledge and operations of waste water treatment processes to undergraduate students. The goals of the course are to understand the basic principles of treatment processes and their applications in engineering trade.

Prerequisite Course(s): Bioseparation process, Microbiology and Biochemistry.

General Objective

- To develop the basic knowledge and skills of waste treatment processes, Including Nitrification, Denitrification, activated sludge process, anaerobic digestion.

Learning Outcomes:

After completion of the course, students will be able to:

1. Implement Engineering strategy for designing the models for waste treatment programmes.
2. Apply the theoretical concepts for designing the experiments for studying the metabolism of various compounds present in waste water.
3. Apply the knowledge for modeling the systems for waste water treatment which will be beneficial for environment and human kind.
4. Explain the advantages behind utilization of waste water treatment via biological way rather than chemical method.
5. Identify, formulate and solve the problems arises due to waste.

COURSE CONTENT

BE Biotechnology **Biotechnology of Waste Treatment** **Semester – VII**

Teaching Scheme
Lectures -3 Hrs/week

Examination Scheme
End Semester Exams (ESE): 80 Marks.
Paper Duration: 3 Hours.
Internal Sessional Exam (ISE):20 Marks.

Unit: I
Introduction: **No. of Lecture: 8 Hours, Marks: 16**

Introduction to waste treatment, Site surveys for waste treatment programme, Strengths of fermentation waste, Disposal of effluents, Treatment process(physical, chemical and biological), Bacterial growth and factors affecting growth kinetics, Important biological reactions: Aerobic heterotrophic reaction, Nitrification, Denitrification, Anaerobic digestion.

Unit: II
Biochemistry of Waste Treatment: **No. of Lecture: 8 Hours, Marks: 16**
Introduction, Oxygen uptake, Dissolved oxygen, Enzymes, Nitrogen metabolism, Phosphorus and sulphur, Elements and growth factors, Fate of individual chemicals, Structure activity relationships, Multisubstrate and species interactions, Biochemical indicators, Precipitation in waste treatment, Coagulation in waste treatment.

Unit: III
Waste Treatment Processes: **No. of Lecture: 8 Hours, Marks: 16**
Characteristics of activated sludge, Theory of activated sludge process, Design, Operation and control, Operation and design features of trickling filters, Rotating biological contractor, Aerated lagoons, Anaerobic digestion, Packed beds, Land farming.

Unit: IV **No. of Lecture: 8 Hours, Marks: 16**
Nitrification and Denitrification and Anaerobic Treatment:
Introduction, Forms of nitrogen, Nitrifying and denitrifying bacteria, Stoichiometry of nitrification and denitrification, Process variables in nitrification and denitrification process, Nitrification processes: Plug flow v\s complete mix, Single stage v\s two stage systems, Biofilm nitrification, Denitrification using methanol, Organic matter and thiosulfate and sulfide, Anaerobic reactor system.

Unit: V
Biological Degradation: **No. of Lecture: 8 Hours, Marks: 16**
Introduction, Determination of biological degradability, Pilot studies: PCB (polychlorinated biphenols) biodegradation, Methylethyl ketone, Aerobic biodegradation: TCE (trichloro ethane) Degradation, Polycyclic aromatic hydrocarbon degradation, Oil degradation, phenanthrene degradation.

Reference Books:

1. Bruce E Rittmann, Rurry L.Mc carty, Environmental Biotechnology:Principles and Applications, Mcgraw Hill international.
2. A.K.Chatterji, Introduction to environmental biotechnology,Eastern Economy edition.
3. Nicholas P.Cheremisinoff, Biotechnology for waste water treatment,Eastern Economy edition.
4. Murray Moo - Young, Comprehensive biotechnology, vol 4- Pergamon Press.
5. P. F. Stanbury, A. Whitaker and S. J. Hall, Principles of fermentation technology Aditya book private limited.

Interdisciplinary Elective

2. Biomedical Instrumentation

Course Outline

Biomedical Instrumentation	**BMI**	**BTL-705**
Course Title	Short Title	Course Code

Lecture	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Semester Credits**
	03	15	40	03

Course Description:
This course gives basic knowledge of the principle of operation and design of biomedical instruments.

Prerequisite Courses: Concept of biotechnology.

General Objectives:

1. The analysis of biological systems and the technological advancement for health care.
2. An engineering knowledge should be applied in an ethically responsible manner for the good of society.

Learning Outcomes:

At end of the course Student will be able to:

1. Understand principle, Working and application of biomedical instruments.
2. Understand human physiology.
3. Analyze results related to engineering and biological problems.
4. Use and design variety of software used in various biomedical instrumentations.
5. Develop ability to use the techniques, skill and modern engineering tools.
6. Work on multidisciplinary terms.
7. Explore the options for biomedical instruments in higher study.

Course Content

BE Biotechnology Semester – VIII

Biomedical Instrumentation

Teaching Scheme
Theory : 3 hours/ week

Examination Scheme
End Semester Examination (ESE) : 80 Marks.
Paper Duration (ESE) : 03 Hours.
Internal Sessional Examination (ISE) : 20Marks.

UNIT I **No. of Lect. – 08, Marks: 16**

Electrode-Electrolyte interface, half-cell potential, Polarization- polarisable and non-polarizable electrodes, Ag/AgCl electrodes, Electrode circuit model; motion artifact. Body Surface recording electrodes for ECG, EMG, and EEG, Internal electrodes- needle and wire electrodes, Micro electrodes- metal microelectrodes, Electrical properties of microelectrodes, Electrodes for electric stimulation of tissue.

UNIT II **No. of Lect. – 08, Marks: 16**

Cardiovascular systems, Physiology of heart, ECG lead configuration, Blood Pressure Characteristics of blood flow, Measurement of blood flow and cardiac output.

UNIT III **No. of Lect. – 08, Marks: 16**

Function of kidneys, Artificial kidney, Dialysers, Membranes for Heamo-dialysis Heamo-dialysis Machine, Portable kidney machine, Mechanics of respiration Artificial ventilation, ventilators Types, ventilator terms, classification of ventilators Modern ventilators, HF ventilators, Nebulisers and Aspirators.

UNIT IV **No. of Lect. – 08, Marks: 16**

Cardiac Pacemakers and Defibrillators: Need for pacemakers, external pacemakers, and Implantable pacemakers, recent developments, pacing system analyzer, need for defibrillators, DC defibrillators, Implantable defibrillators, and Defibrillators analyzers, measurement of blood PCO2.

UNIT V **No. of Lect. – 08, Marks: 16**

Nervous system ,Classification of Nervous system, Anatomy of Nervous system, Organisation of Brain Neuronal communication, Neuronal receptors, Sematic and Autonomic nervous system Spinal reflexes ., Neuronal firing measurements, EEG measurement.

Text Book :

1. Cromwell - Biomedical Instrumentation, Pearson / PHI
2. Khandpur - Handbook of Biomedical Instrumentation
3. Vander, Sherman, Human Physiology- The Mechanism of Body Function, TMH Ed.1981
4. Carr & Brown Introduction To Biomedical Equipment Technology

Interdisciplinary Elective.

3.Biomechanics

Course Outline

Biomechanics	**BM**	**BTL-706**
Course Title	Short Title	Course Code

Lectures	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Credits**
	03	15	40	3

Course Description:

Basic Biomechanics is a first course in undergraduate biomechanics that provides background in muskuloskeletal anatomy and principles of biomechanics. The course applies and builds on the concepts of Statics and, Dynamics for human activities, and Mechanics of Materials and tissues.

Prerequisite Course(s): Basic mathematics skills (algebra, geometry), Applied mechanics and Fluid mechanics.

General Objective:

1. Biomechanics is an introductory course designed to educate kinesiology students on the basic principles of biomechanics and their applications to human movement.
2. This course will involve the analysis of efficient movement through a study of mechanical and anatomical principles and their application to human movement.

Learning Outcomes:

After completion of the course, students will be able to:

1. Identify a given bone, ligament or muscle by name, anatomic location, or function.
2. Identify relationships between structure and function in tissues and the implications/importance of these relationships.
3. Analyze the forces at a skeletal joint for various static and dynamic human activities.
4. Analyze the stresses and strains in biological tissues, given the loading conditions and material properties.
5. Identify the appropriate viscoelasticity model for the mechanical behavior of a given biological tissue.
6. Predict the overall creep and stress relaxation behavior for a basic viscoelastic material model.
7. Design orthopedic implant.
8. Work in multidisciplinary stream.
9. Explore the options for biomechnics in higher study.

COURSE CONTENT

BE Biotechnology Biomechanics Semester – VII

Teaching Scheme
Lectures -3 Hrs/week

Examination Scheme
End Semester Exams (ESE) : 80 Marks.
Paper Duration : 3 Hours.
Internal Sessional Exam (ISE) : 20 Marks.

Unit: I
Biomechanics of Joints
Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle.

Unit: II
Biofluid Mechanics
Introduction, viscosity and capillary viscometer, Rheological properties of blood, laminar flow, Couette flow and Hagen-poiseuille equation and turbulent flow.

Unit: III
Hard and Soft Tissues
Hard tissues: Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models – anisotropy.
Soft Tissues: Structure and functions of Soft Tissues: Cartilage, Tendon, Ligament, and Muscle; Material Properties: Cartilage, Tendon, Ligament, and Muscle; Modeling: Cartilage, Tendon, Ligament and Muscle.

Unit: IV
Cardiovascular Mechanics
Cardiovascular system, artificial heart valves, biological and mechanical valves development, testing of valves.

Unit: V
Biomechanics of Implants
Design of orthopedic implant, specifications for a prosthetic joint, biocompatibility, requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants, fixation of implants.

References:

1. Y C Fung, Biomechanics: Mechanical Properties of Living Tissues, Springer, 2nd edition, 1993.
2. N. Ozkaya and M. Nordin, Fundamentals of Biomechanics-Equilibrium, Motion and Deformation, Springer-verlag, 2nd edition 1999
3. J. G Webster, Medical instrumentation –Application & design, John Wiley and sons Inc. 3rd ed. 2003.
4. D. J. Schneck and J. D. Bronzino, Biomechanics- Principles and Applications, CRC Press, 2nd Edition, 2000.

Elective-I

1. Food Biotechnology

Course Outline

Food Biotechnology	FB	BTL-707
Course Title	**Short Title**	**Course Code**

Lecture	Hours per week	No. Of weeks	Total hours	Semester credits
	03	15	40	03

Course Description:
This course is introduced to understand the constituents of food. This course deals with the study of microorganism present in food and the principles to control them.

Prerequisite Course(s): Microbiology, Unit operations and Biochemistry.

Objective of the Subject:

1. To understand the various constituents of the foods and their role.
2. To understand the different microorganism present and their role in causing food poison.
3. To give the knowledge to students how to preserve the food.
4. It will help in production of different food products.
5. To make brief introduction regarding the different unit operation involved in food industry.

Learning outcomes:
By completion of this course students will able to:

1. Find out the different microorganism responsible for food spoilage.
2. Different constituents of the food and their role in body.
3. Use their knowledge to preserve the food.
4. Apply their knowledge of unit operation in food industry.
5. Use their knowledge to make food product.
6. Use the techniques, skill and modern engineering tools necessary for engineering practice.
7. Apply the knowledge of engineering principles to living entities for societal welfare.
8. Work in multidisciplinary stream.
9. Explore the options for Food biotechnology in higher study.

Course content

BE Biotechnology **Food Biotechnology** **semester VII**

Teaching Scheme

3hrs/week

Examination scheme

End Semester Examination (ESE) : 80 Marks
Paper Duration (ESE) : 03 hours
Internal Sessional Examination (ISE) : 20Marks

UNIT I: Food Biotechnology **No. of Lecture: 8 Hours, Marks: 16**

Introduction to food biotechnology, Constituents of food, the sources of dietary carbohydrates and their functional property, the sources of protein and their functions, requirements of vitamins, fatty acids in food.

UNIT II: Microorganisms in Food **No. of Lecture: 8 Hours, Marks: 16**

Types of microorganism in food, Microbial examination of foods, Role and significance of micro organism in foods, Factors influencing microbial activity, Food borne diseases: Food infection, Viral infection, Food borne parasites, Food intoxication.

UNIT III: Food Spoilage and Preservation **No. of Lecture: 8 Hours, Marks: 16**

Causes of food spoilage, Spoilage of various foods and food products, Deterioration of food quality, Food preservation using high temperature, Evaporation, Drying, Low temperature and Irradiation

UNIT IV: Food Biotechnology **No. of Lecture: 8 Hours, Marks: 16**

Food fermentation, Important microbial culture in food industry, Fermentation of dairy products, Fermentation for beverage, Single cell proteins, Fermentative production of sauerkraut, Fermentation for production of vinegar and Idali.

UNIT V: Unit operation **No. of Lecture: 8 Hours, Marks: 16**

Unit operations in food industry: Size reduction, Screening, Mixing, Filtration, centrifugation, Extraction, Crystallization, Heat processing.

TEXT BOOK

1. B. Sivashankar, Food Processing and Preservation, Prentice Hall ,India.
2. Powar and Daginawala, General Microbiology (vol 2), Himalaya Publishing House.

REFERENCE BOOK

1. Murray Moo-Young, Comprehensive Biotechnology (Vol: 3), Pergamon Press, An imprint of Elsevier.
2. S.S. Purohit, Microbiology: Fundamentals and Application, Agrobios India.
3. Fraizer, Food Microbiology ,TMH publication
4. Hiller, Genetic Engineering of Food: Detection of Genetic Modifications, Willy Publication.

Elective-I

2.Plant Biotechnology

Course Outline

Plant Biotechnology	PBT	BTL-708
Course Title	Short Title	Course Code

Lectures	Hours per Week	No. of Weeks	Total Hours	Credits
	03	15	40	3

Course Description:

This course is framed to develop the basic knowledge of plant tissue culturing methods to undergraduate students. The goals of the course are to understand the basic principles of plant tissue culturing and their applications in the field of Biotechnology.

Prerequisite Course(s): Bioprocess engineering, genetic engineering and Fermentation Technology.

General Objective :

- To develop the basic knowledge and skills of plant tissue culturing, like explants, callus, anther, ovary, etc. and making genetically modified plants for understanding their role in the field of Biotechnology.

Learning Outcomes:

After completion of the course, students will be able to:

1. Understand the bioethical issues related to plant Biotechnology.
2. Apply the advanced techniques in plant tissue culturing for making the modified varieties of plants.
3. Develop the disease and pest resistant plants.
4. Produce the value added products which are having commercial value by applying the protocols of fermentation technology.
5. Explore the options for plant biotechnology in higher study.

COURSE CONTENT

BE Biotechnology Plant Biotechnology Semester - VII

Teaching Scheme
Lectures -3 Hrs/week

Examination Scheme
End Semester Exams (ESE) : 80 Marks.
Paper Duration : 3 Hours.
Internal Sessional Exam (ISE) : 20 Marks.

Unit: I

Plant Tissue Engineering-I: **No. of Lecture: 8 Hours, Marks: 16**

Introduction to tissue engineering, Media components (micro and macro nutrients) and preparation, Media selection, Cellular totipotency, Practical application of cellular totipotency, Criteria for selection of explant, Classification of tissue culture, callus culture, cell suspension culture, Application of callus culture and cell suspension culture, single cell culture, Meristem culture.

Unit: II

Plant Tissue Engineering-II: **No. of Lecture: 8 Hours, Marks: 16**

Bioprocess consideration in using plant cell cultures, Bioreactors for suspension cultures, Bioreactors for organized tissue, Production of secondary metabolites, Anther culture, Ovary culture, Embryo culture, Protoplast culture, Synthetic seeds and preservations.

Unit: III

Plant transformation Technology: **No. of Lecture: 8 Hours, Marks: 16**

Agrobacterium mediated gene transfer; Agrobacterium based vectors, viral vectors and their application. Direct gene transfer methods; chemical methods, electroporation, microinjection, particle bombardment.

Unit: IV **No. of Lecture: 8 Hours, Marks: 16**

Plant Tissue culture, Genetic Engineering for Productivity and Performance-I:

Somatic embryogenesis, organogenesis; Protoplast isolation culture and fusion, Production of haploids, Somaclonal variations, Germplasm conservation (Cryopreservation), Herbicide resistance, Insect resistance plants, Disease resistance plants, virus resistance plants.

Unit: V **No. of Lecture: 8 Hours, Marks: 16**

Molecular farming & Industrial products, Genetic Engineering for Productivity and Performance-II and Metabolic Engineering:

Abiotic stress tolerance; Drought, temperature, salt, Metabolic engineering for plant primary metabolites and secondary metabolites, Application of Plant biotechnology for the production of quality oil, Industrial enzymes, Therapeutic Proteins, Antigens (edible vaccine) and plantibodies.

Reference Books:

1. B.D.Singh, Biotechnology: Expanding Horizons, Kalyani Publishers, New Delhi, Second Revised Edition, 2008.
2. J.Hammond,P.McGarvey and V.Yusibov (Eds.), Plant Biotechnology New Products and Applications, Springer.
3. S.S.Purohit, Biotechnology: Fundamentals and Applications, Agrobios (India), 4th Edition, 2005.
4. R.A.Dixon and Gonzales, Plant Cell Culture : A Practical Approach, IRL Press.
5. Roberta Smith, PlantTissue Culture:Techniques and Experiments. 2nded., Academic Press,2000.
6. Bhojwani, S.S.and Rajdan, Plant Tissue Culture: Theory and Practice,2004.

Elective-I

3. Animal Biotechnology
Course Outline

Animal Biotechnology	**ABT**	**BTL-709**
Course Title	Short Title	Course Code

Lectures	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Credits**
	03	15	40	3

Course Description:

This course is framed to develop the basic knowledge of animal tissue culturing methods in undergraduate students. The background expected includes a prior knowledge of BE Biotechnology courses. The goals of the course are to understand the basic principles of animal tissue culturing and their applications in the field of Biotechnology.

Prerequisite Course(s): Fermentation technology, Bioprocess engineering, Genetic Engineering and Molecular Biology.

Course objective

1. To develop the basic knowledge and skills of animal tissue culturing, production of antibodies, hormones, making of genetically modified animals.
2. Production of value added products having commercial value for understanding their role in the field of Biotechnology.

Learning Outcomes:

After completion of the course, students will be able to:

1. Describe the structure of animal genes and genomes.
2. Describe basic principles and techniques in genetic manipulation and genetic engineering.
3. Describe gene transfer technologies for animals and animal cell lines.
4. Describe techniques and problems both technical and ethical in animal cloning.
5. Explore the options for Food biotechnology in higher study.

COURSE CONTENT

BE Biotechnology Animal Biotechnology Semester - VII

Teaching Scheme
Lectures -3 Hrs/week

Examination Scheme
End Semester Exams (ESE) : 80 Marks.
Paper Duration : 3 Hours.
Internal Sessional Exam (ISE) : 20 Marks.

Unit: I **No. of Lecture: 8 Hours, Marks: 16**

Laboratory requirements for animal cell culture:
Sterile handling area, Sterilization of different materials used in animal cell culture, Aseptic concepts, Instrumentation and equipments for animal cell culture.

Culture medium: natural media, synthetic media, introduction to balanced salt solutions and simple growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, role of carbon dioxide, serum and supplements.

Unit: II

Types of Cell Cultures: **No. of Lecture: 8 Hours, Marks: 16**

Different types of cell cultures, Trypsinization, Cell separation, Continuous cell lines, Suspension culture, Organ culture, Development of cell lines, Characterization and maintenance of cell lines, Cryopreservation, Common cell culture contaminants.

Unit: III

Stem cell research: **No. of Lecture: 8 Hours, Marks: 16**

Current status and application in medicine, Application of animal cell culture for *in vitro* testing of drugs; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins, Production of recombinant hemoglobin, blood substituent's, artificial blood.

Unit: IV **No. of Lecture: 8 Hours, Marks: 16**

Gene transfer technology in animals:
Viral and non-viral methods, Production of transgenic animals and molecular pharming, current status of production of transgenic animals, Animal cloning: Techniques, relevance and ethical issues.

Unit: V **No. of Lecture: 8 Hours, Marks: 16**

Commercial applications of cell culture:
Tissue culture as a screening system; cytotoxicity and diagnostic tests. Mass production of biologically important compounds (e.g. Vaccines), Harvesting of products, purification, and assays, Three dimensional cultures and tissue engineering.

Reference Books:

1. B.D.Singh, Biotechnology: Expanding Horizons, Kalyani Publishers, New Delhi, Second Revised Edition, 2008.
2. S.S.Purohit, Biotechnology: Fundamentals and Applications, Agrobios (India), 4th Edition, 2005.
3. Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005.
4. Ed. John R.W. Masters, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press, 2000.
5. Ed. Martin Clynes, Animal Cell Culture Techniques., Springer, 1998.
6. B.Hafez, E.S.E Hafez, Reproduction in Farm Animals, 7th Edition, Wiley- Blackwell, 2000.
7. Louis-Marie Houdebine, Transgenic Animals: Generation and Use, 1st Edition, CRC Press, 1997.

Elective-1
4.Environmental Biotechnology

Course Outline

Environmental Biotechnology	**EBT**	**BTL-710**
Course Title	Short Title	Course Code

Lectures	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Credits**
	03	15	40	3

Course Description:

This course is framed to develop the basic knowledge of Environmental Engineering to undergraduate students. The goals of the course are to understand the basic principles of Environmental Engineering and their applications in the field of Biotechnology.

Prerequisite Course(s): Microbiology and Bioprocess engineering.

General objective:

- To develop the basic knowledge and skills of Environmental Biotechnology, like Bioremediation, xenobiotics, Bioleaching & understanding their role in the field of Biotechnology.

Learning Outcomes:

After completion of the course, students will be able to:

1. Analyze a research problem and write clear, step-by-step instructions for conducting experiments or testing hypothesis.
2. Provide examples of current applications of biotechnology and advances in the different areas i.e. environmental, bioremediation, bioleaching and xenobiotics etc.
3. Identify the role of microorganisms in biological waste treatment.
4. Describe methods used to detect and identify microorganisms in the environment.
5. Contrast various approaches to anaerobic digestion of wastes and solve related problems.
6. Explore the options for Environmental biotechnology in higher study.

COURSE CONTENT

BE Biotechnology Environmental Biotechnology Semester-VII

Teaching Scheme
Lectures -3 Hrs/week

Examination Scheme
End Semester Exams (ESE) : 80 Marks.
Paper Duration : 3 Hours.
Internal Sessional Exam (ISE) : 20 Marks.

Unit: I **No. of Lecture: 8 Hours, Marks: 16**

Environmental Pollution & Environmental Safety Regulations:
Water, air, noise and radiation (introduction, source and effects of pollutions): Types of waste, properties, global warming, Environment Protection Act- Air, Water and Forest Conservation, Methanogenesis-Methanogenic, acetogenic and fermentative bacterial processes and conditions.

Unit: II
Microbial Biodiversity: **No. of Lecture: 8 Hours, Marks: 16**
Diversity on earth:
Extent and importance, recovery problem, Finding New diversity, biodiversity of bacteria: level of bacterial diversity, isolation strategies, Fungal biodiversity: isolation and identification, Recovering biodiversity using environmental DNA, accessing uncultured microbes, Environmental genomics: Screening environmental libraries, barriers and challenges.

Unit: III
Bioremediation: **No. of Lecture: 8 Hours, Marks: 16**
Introduction, constraints and priorities of Bioremediation, Biostimulation of Naturally occurring microbial activities, Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation, Solid phase bioremediation -land farming, prepared beds, soil piles, Phytoremediation, Composting, Bioventing & Biosparging; Liquid phase bioremediation - suspended bioreactors, fixed biofilm reactors.

Unit: IV **No. of Lecture: 8 Hours, Marks: 16**
Hazardous Waste Management& Biological Control:
Introduction - Xenobiotic compounds, recalcitrance, hazardous wastes - biodegradation of Xenobiotics , Biological detoxification, Biological control of foliar pathogens and pests with bacterial biocontrol agents: biocontrol agents, ecology of the plant pathogen or pest, source of antagonist, Empirical approaches to select biocontrol agents

Unit: V
Treatment of Industrial Wastes: **No. of Lecture: 8 Hours, Marks: 16**
Waste water characteristics; biological waste treatment; kinetic models, unit operations, design, principle and modelling of activated sludge process. Trickling filters, fluidized reactor, up flow anaerobic sludge blanket reactor, contact process, packed bed reactor, hybrid reactors, sequential batch reactors; Bioconversions of agricultural and organic waste material into gainfully utilizable products- cellular hydrogen, food and feed stocks.

Reference Books:

1. Metcalf Eddy – Waste water Engineering – 3rd Ed., THM publications.
2. R.S. Ramalho, - Introduction to Waste Water treatment.
3. S.K.Agarwal, Environmental Biotechnology.
4. Martin Alexander, Biodegradation & Bioremediation (1999), Academic press.

LAB BIOINFORMATICS

Bioinformatics	**Bioinfo**	**BTL-711**
Course Title	Short Title	Course Code

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	02	**15**	**16**	**01**

Course description:
This course deals with the application of informatics tools and software to solve the problems related to biotechnology.

Prerequisite Course(s): Biochemistry, Molecular Biology and Genetic Engineering.

General Objective:

1. To develop the basic knowledge and practical skills in the field of bioinformatics.
2. To make students familiar with various tools of bioinformatics

Learning Outcomes:

At the completion of this course the students will be able to:

1. Apply practical knowledge for information retrieval.
2. Apply the basic knowledge for developing and using tools for sequence analysis of biomolecules.
3. Apply the basic knowledge for developing and using tools for structure analysis of biomolecules.
4. Explore the options for Bioinformatics in higher study.

Lab Bioinformatics

Teaching Scheme	**Examination Scheme**	**Semester-VII**
Practical - 2 Hrs/week	External Sessional Exams (ESE)/Oral (OR) : 25 Marks.	
	Internal Continuous Assessment (ICA) : 25 Marks.	

Minimum 08 experiments shall be performed from the following

1. Databases search: NCBI, EMBL
2. Basic Local Alignment Search Tool
3. Multiple sequence alignment.
4. Rasmol
5. Swiss PDB Viewer
6. Homology modelling
7. DS Visualizer
8. ArgusLab
9. Modeller
10. Chemsketch
11. Comparative docking of different HIV Protease inhibitors.
12. Pair wise alignment using Align / EMBOSS
13. Restriction Mapper.
14. Chou-Fasman Structure prediction.

Reference Books:

1. Andreas D. Baxevanis and B. F. Francis Ouellette, Bioinformatics A Practical Guide to the Analysis of Genes and Proteins by, Second Edition, a john wiley & sons, inc., publication
2. Arthur M. Lesk, Introduction to Bioinformatics , Oxford University Press Inc., New York
3. Janusz M. Bujnicki, Practical Bioinformatics, SPRINGER (SIE)
4. S. C. Rastogi, Bioinformatics Concepts, Skills and Applications by , CBS; 2 edition.

Downstream Processing Lab
LAB COURSE OUTLINE

Downstream Processing	DSP	BTL-712
Course Title	**Short Title**	**Course Code**

Practical	Hours per Week	No. of Weeks	Total Hours	Semester Credits
	02	15	16	1

Downstream Processing Lab

Course Description:
In this laboratory, course emphasis is on the understanding of basics techniques of recovery processes. The learner can use this knowledge and apply in allied branches of Biotechnology as required.

Prerequisite Course(s): Unit Operation and Biochemistry.

General Objective:
The objective of the laboratory is to impart the fundamental knowledge of recovery processes at the research level to the students and to develop their ability to apply the analytical techniques for interpreting experimental results.

Learning Outcomes:
After successful completion of this lab student will be able to:

1. Isolate the biomolecules/bioproducts from the fermentation broths.
2. Recover the intracellular products from the microbial cells by applying the cell disruption techniques.
3. Precipitate the soluble bioproducts from the fermentation broths such as proteins and enzymes.
4. To identify the recovered product quantitatively and qualitatively by applying the analytical techniques on them.
5. Study and estimate the concentration of the recover bioproducts.

Downstream Processing Lab

Semester-VII

Teaching Scheme
Practicals -2 Hrs/week

Examination Scheme
External Sessional Exams (ESE)/Oral (OR) :25 Marks.
Internal Continuous Assessment :25 Marks.

Minimum eight experiments from the following

1. Cell Disruption by Ultrasonication.
2. Cell Disruption by Enzymatic Reaction.
3. Aqueous Two-phase Extraction.
4. Centrifugal Separation- Ultra Centrifugation.
5. Separation & identification of amino acids by paper chromatography.
6. Separation & identification of sugars by paper chromatography.
7. Separation & identification of lipids by thin layer chromatography.
8. Ammonium Sulphate Precipitation of biomolecules.
9. Isoelectric Precipitation.
10. Crystallisation of biomolecules.

Reference books:

1. David Plummer , An introduction to Practical Biochemistry III edition, John Wiley & Sons.
2. Keith John Walker, Principles and Techniques of Biochemistry and Molecular Biology by Cambridge University Press; 6 edition (2005).
3. By J. Jayaraman, Kunthala Jayaramanj, Laboratory Manual in Biochemistry, New Age International

Lab Elective-1
1. Food Biotechnology Lab

LAB COURSE OUTLINE

Food biotechnology	**FB**	**BTP-713**
Course Title	**Short Title**	**Course Code**

Laboratory	**Hours/week**	**No.of weeks**	**Total hours**	**Semester credits**
	02	**15**	**16**	**01**

Course Description:
This course is introduced to give practical knowledge of the food science. This course will give insight of practical techniques to produce food products as well as techniques to prevent them from microorganisms.
Prerequisite Course(s): Microbiology and Fermentation Biotechnology.

General Objective:
1. To understand fundamentals of food biotechnology technique.
2. To devise protocols to list the major food spoilage microorganisms.
3. To develop the skills to examine the food for presence of microorganism.
4. To make the learner familiarize with the productions of different food products.
5. To analyze methods used to control or destroy micro organism commonly found in food.

Learning Outcomes:
After successful completion of this lab student will be able to:
1. Isolate the microorganism in food and calculate the numbers.
2. Control the microorganism in food by using physical methods.
3. To produce various products of food biotechnology.
4. Apply their knowledge for analysis of mycotoxin.
5. Use the techniques, skill and modern engineering tools necessary for engineering practice.
6. Apply the knowledge of engineering principles to living entities for societal welfare.
7. Work in multidisciplinary stream.
8. Explore the options for Food biotechnology in higher study.

Lab Food Biotechnology

Teaching Scheme	**Examination Scheme**	**Semester-VII**
Practical - 2 Hrs/week	External Sessional Exams (ESE)/Oral (OR) : 25 Marks.	
	Internal Continuous Assessment (ICA) : 25 Marks.	

Minimum 08 experiments shall be performed from the following

1. Standard plate count.
2. Structural straining-spore straining.
3. Microbial examination of water by multiple tube fermentation test.
4. Vinegar production.
5. Wine making.
6. Microbial examination of canned foods.
7. Assay of quality of milk by methylene blue reduction test.
8. Sauerkrant fermentation.
9. Control of microbial growth by physical methods-heat.
10. Analysis of mycotoxin (Aflatoxin) in fungus contaminated food material.

REFFERENCES:

1. Frederick J. Post : Laboratory Manual for Food Microbiology and Biotechnology Edition 2,Star Publishing Company.

2. Neelima Garg: Laboratory Manual of Food Microbiology March 6, 2010.

2.Plant Biotechnology Lab
LAB COURSE OUTLINE

Plant Biotechnology	PTB	BTL-714
Course Title	**Short Title**	**Course Code**

Practical	Hours per Week	No. of Weeks	Total Hours	Semester Credits
	02	15	16	1

Course Description:
In this laboratory, course emphasis is on the understanding of basics plant tissue culturing. The learner can use this knowledge and apply in allied branches of Biotechnology as required.

Prerequisite Course(s): Bioprocess engineering, Genetic engineering.

General Objective:
1. The objective of the laboratory is to impart the fundamental knowledge of plant tissue culturing at the research level in the students.
2. To develop their ability to apply the various techniques for developing the new varieties of plants.

Learning Outcomes:
After successful completion of this lab student will be able to:
1. Study the various techniques of explants sterilization.
2. Grow the number of plant copies using the single part of the plant.
3. Develop the new varieties of plants consisting of different characteristics.
4. Produce the genetically modified plants.
5. Produce value added plant products having commercial value at large scale level.
6. Use the techniques, skill and modern engineering tools necessary for engineering practice.
7. Apply the knowledge of engineering principles to living entities for societal welfare.
8. Work in multidisciplinary stream.
9. Explore the options for Plant Tissue Culture in higher study.

Plant Biotechnology Lab

Semester-VII

Teaching Scheme
Practicals -2 Hrs/week

Examination Scheme
External Sessional Exams (ESE)/Oral (OR):25 Marks.
Internal Continuous Assessment: 25 Marks.

Minimum eight experiments from the following

1. Preparation of Media
2. Surface sterilization
3. Callus induction
4. Organ culture
5. Protoplast isolation, culture and Cytological examination
6. Agrobacterium mediated gene transfer.
7. Artificial seed production.
8. Shake flask studies of plant cell culture.
9. regeneration of plant from callus culture
10. Anther culture.
11. Ovary culture.

Reference books:

1. C.C.Giri & Archana Giri, Plant Biotechnology: PracticalManual, IK International,2007.

Lab Elective-I
3.Animal Biotechnology Lab

LAB COURSE OUTLINE

Animal Biotechnology	**ATB**	**BTL-715**
Course Title	Short Title	Course Code

Practical	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Semester Credits**
	02	15	16	1

Course Description:
In this laboratory, course emphasis is on the understanding of basics animal tissue culturing. The learner can use this knowledge and apply in allied branches of Biotechnology as required.

Prerequisite Course(s): Microbiology, Bioprocess engineering, Fermentation technology, Genetic engineering.

General Objective:

1. The objective of the laboratory is to impart the fundamental knowledge of animal tissue culturing at the research level in the students.
2. To develop their ability to apply the various techniques for developing the modified animals.

Learning Outcomes:
After successful completion of this lab student will be able to:

1. Study the various techniques of sterilization.
2. Develop & optimize various types of Medias.
3. Study the Cell Counting and Viability.
4. Perform the Staining of Animal Cells.
5. Use the techniques, skill and modern engineering tools necessary for engineering practice.
6. Apply the knowledge of engineering principles to living entities for societal welfare.
7. Work in multidisciplinary stream.
8. Explore the options for animal biotechnology in higher study.

Animal Biotechnology Lab

Semester-VII

Teaching Scheme
Practicals -2 Hrs/week

Examination Scheme
External Sessional Exams (ESE)/Oral (OR):25 Marks.
Internal Continuous Assessment: 25 Marks.

Minimum eight experiments from the following

1. Sterilization Techniques.
2. Preparation of Media.
3. Preparation of Sera.
4. Primary Cell Culture.
5. Preparation of established Cell lines.
6. Cell Counting and Viability.
7. Staining of Animal Cells.
8. Preservation of Cells.
9. Culture of Virus in Chick Embryo.
10. Adaptation of Virus in Animal (in vitro) Cell Culture.

Reference books:

1. R. Pollack, Readings in Mammalian cell culture. Cold Spring Harbour Laboratory (1981). 2.
2. R. Pollack and S. Pfeiffer, Animal Cell Culture. Cold Spring Harbour Laboratory (1971).
3. R.Crowe., H. Ozer and Dr. Rifkin, Experiments with Normal and Transformed cells, Cold Spring Harbour Laboratory, (1978).
4. D. J. Merchant., R.H. Kahn and W. H. Murphy, Hand Book of cell and organ culture, Burgess Publishing Company, (1969).
5. R. Ian Freshney and R. Alan, Culture of Animal Cells, Liss. Inc. (1987).
6. Microcarrier culture: Principles and Methods, Pharmacia Fine chemicals.
7. R.E. Spier and J. B. Griffiths, Animal cell biotechnology, Vol. I and II, Academic Press (1985).

Lab Elective-I

4.Environmental Biotechnology Lab

LAB COURSE OUTLINE

Environmental Biotechnology	**EBT**	**BTL-716**
Course Title	Short Title	Course Code

Practical	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Semester Credits**
	02	15	16	1

Course Description:
In this laboratory, course emphasis is on the understanding of basics environmental engineering. The learner can use this knowledge and apply in allied branches of Biotechnology as required.

Prerequisite Course(s): Biochemistry and Microbiology.

General Objective:

1. The objective of the laboratory is to impart the fundamental knowledge of environmental engineering at the research level to the students
2. To develop their ability to apply the various techniques for developing the new technology for waste management.

Learning Outcomes:
After successful completion of this lab student will be able to:

1. Design and execute new environmental science experiments.
2. Communicate their understanding of environmental science to a lay audience.
3. Demonstrate through presentation an understanding of the global character of environmental problems and ways of solving them, including collaborative efforts spanning local to global scale.
4. Use the techniques, skill and modern engineering tools necessary for engineering practice.
5. Apply the knowledge of engineering principles to living entities for societal welfare.
6. Work in multidisciplinary stream.
7. Explore the options for environmental biotechnology in higher study.

Environmental Biotechnology Lab

Semester-VII

Teaching Scheme
Practicals -2 Hrs/week

Examination Scheme
External Sessional Exams (ESE)/Oral (OR):25 Marks.
Internal Continuous Assessment: 25 Marks.

Minimum eight experiments from the following

1. Analysis of water for colour, turbidity, solids, hardness, alkalinity, acidity, iron, sulphate, chloride, fluoride, nitrate etc.
2. Physical analysis of wastewater sample
3. Analysis of samples for DO.
4. Analysis of samples for BOD of waste water.
5. To determine the COD of waste water.
6. To determine the nitrogen contents of waste water.
7. Biological examination of water: Algae, bacteria and Protozoa
8. Bacterial water quality: Measuring quality of water by using coli form organisms (MPN method and membrane filter).
9. Biochemical activities of bacteria: hydrolysis of polysaccharides, Bacteria in waste water.
10. Determination of Biodiversity index.

Reference books:

1. Mathur: Water and Wastewater Testing.
2. Sawyer, Mc Carty & Parkin Chemistry for Environmental Engg. Standard Methods P.A, H.A New York.
3. Sirockin and Cullimore: Practical Microbiology.

PROJECT-I

Project-I	**P-I**	**BTP-717**
Course Title	Short Title	Course Code

Course Description:
The course explores the knowledge of design, experiment and analysis of data. The course develops ability to work on multidisciplinary teams, Identify, formulate, and solve engineering problems in view of economic, environmental and societal context.

	Hours per Week	**No. Of Weeks**	**Total Hours**	**Semester Credits**
Laboratory	**2**	**15**	**28**	**2**

Prerequisite Course(s): Knowledge of science, mathematics, computer programming and core subject of engineering.

General Objectives: The objectives of project are to develop ability to work in group. The scope of work is design and conduct experiments, as well as to analyze and interpret data within realistic constrain such as economic, environmental, social, safety and manufacturability. The project work provides plate form for planning, material procurement, preparing specification and execution of work. The project also develop to work on multidisciplinary teams, communicate effectively and Knowledge of contemporary issues.

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

1. Apply knowledge of mathematics, science, and engineering.
2. Design and conduct experiments, as well as to analyze and interpret data.
3. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. Function on multidisciplinary teams, communicate effectively and Knowledge of contemporary issues.
5. Identify, formulate, and solve engineering problems by understanding professional and ethical responsibility.
6. Understand the impact of engineering solutions in a global, economic, environmental, and societal context.
7. Recognition of the need for, and an ability to engage in life-long learning.
8. Use the techniques, skills, modern engineering tools and software necessary for engineering practice.

Project-I

(Lab Course Contents)

Semester-VII **Examination Scheme:**
Teaching Scheme: **Internal Continuous Assessment: 25 Marks**
Practical : 2 Hrs/Week **End Semester Examination OR :25Marks**

- Every student of BE shall undertake the Project-I in semester VII. It is expected that the broad area of Project-I shall be finalized by the student in the beginning of the VII semester and Minor project undertaken may be of Project-I.
- Each student shall work on an approved project, a group of **05 students (maximum)** shall be allotted for the each Project-I and same group for Project-II.
- Project-I may involve some investigation work or design problem or experimental set up of some developmental work or prototype equipment or dissertation related to field of biotechnology, biochemical engineering and allied fields. The project work shall involve sufficient work so that students get acquainted with different aspects of fabrication, design or analysis. The project topics shall consist either some investigate work or design problem or experimental set up of some development work or prototype equipment or dissertation related to field of Biotechnology, Biochemical engineering and allied fields.
- The students are required to carry out one of the following projects:
    1. Processes based Project: Manufacture of Bioproduct.
    2. Equipment based Project: Detailed design and fabrication of the equipment for a given capacity.
    3. Experimental based Project: Experimental investigation of basic or applied research problem in the field of Microbiology, Immunology, Molecular biology, Bioprocess, Biochemistry, Genetic Engineering, Bioinformatics, Enzyme technology and Environmental Biotechnology.
    4. Industrial Problems: Any problem or project directly related to existing plants for modification of process or equipment or regarding pollution control and energy conservation.
- Each student group is required to maintain log book for documenting various activities of Project-I.
- The students shall submit the report to the corresponding guide, present their work in due time based on following points,
    1. Introduction.
    2. Literature survey.
    3. Experimental setup and procedure.
    4. Extent of project completed.

- Presentation can be performed with OHP slides / LCD.
- The three-member committee appointed by Head of the department shall be constituted for finalizing the topics of Project-I. Maximum four Project-i groups shall be assigned to one teaching staff.
- **Guide lines for ICA :** Assessment of the project for award of ICA marks shall be done jointly by the guide and departmental committee as per the guidelines given below:

Assessment of Project-I

Name of the Project: _____

Name of the Guide: _____

SN	Exam Seat No	Name of Student	Project Selection based on literature survey	Documentation	Experimentation/ Design/ Fabrication.	Presentation	Total
			10	5	5	5	25

SEMINAR -II

Teaching Scheme:
Practical: 2 Hrs./ Week

Examination Scheme:
Internal Continuous Assessment: 25 Marks

Course Description: The course explores the knowledge of presentation and effective communication. The course develops ability to work on multidisciplinary teams, Identify, formulate, and solve engineering problems in view of economic, environmental and societal context.

	Hours per Week	No. Of Weeks	Total Hours	Semester Credits
Practical	**2**	**14**	**28**	**2**

Prerequisite Course(s): Knowledge of science, mathematics, computer programming and core subject of engineering.

General Objectives: The objectives of Seminar –II are to develop ability express our view, presentation and effective communication. The scope of seminar-II is study various national and international journal for design, experiments conduct, as well as to analyze and interpret data within realistic constrain such as economic, environmental, social, safety and manufacturability.

Course Outcomes:

Upon successful completion of this course the students will be able to:

1. Understand literature survey for selection of seminar topics.
2. Apply knowledge of mathematics, science, and engineering for effective presentation of selected topic.
3. Function on multidisciplinary teams, communicate effectively and Knowledge of contemporary issues.
4. Identify, formulate, and solve engineering problems by understanding professional and ethical responsibility.
5. Understand the impact of engineering solutions in a global, economic, environmental, and societal context.
6. Practice the use of various resources to locate and extract information using offline & online tools, journals.
7. Practice the preparation and presentation of scientific papers and seminars in an exhaustive manner.

Seminar-II

(Course Contents)

Semester-VII **Examination Scheme:**
Teaching Scheme: **Internal Continuous Assessment: 25 Marks**
Practical : 2 Hrs/Week

1. For Seminar-II every student will individually study a topic assigned to him / her and submit a report and shall deliver a short lecture / Seminar on the topic at the end of term.
2. The three-member committee appointed by Head of the department shall be constituted for finalizing the topics of Seminar-II. Seminar shall be related state of the art topic of his choice approved by the committee.
3. Seminar topic should not be repeated however the innovativeness of topic may be considered and registration of the same shall be done on first come first serve basis.
4. Topic of Seminar shall be registered within a two week from commencement of VII Semester and shall be approved by the committee.
5. Maximum six seminar supervision shall be allotted to each teacher.
6. student shall deliver a seminar as per scheduled and submit the seminar report (paper bound copy)in following format:
    a. Size of report shall be of minimum 25 pages.
    b. Student should preferably refer minimum five reference books / magazines/standard research papers.
    c. Format of report
        i. Introduction.
        ii. Literature survey.
        iii. Theory 1) Implementation 2) Methodology
        3) Application 4) Advantages, Disadvantages.
        iv. Future scope.
        v. Conclusion.

7. ASSESSMENT OF SEMINAR-II

Guide lines for ICA : Assessment of the Seminar-I for award of ICA marks shall be done by the guide and a departmental committee jointly, as per the guidelines given below:

Title of Seminar: _____
Name of Guide: _____

SN	Name of Student	Topic Selection	Literature survey	Report writing	Depth of understanding	Presentation	Total
		5	5	5	5	5	25

INDUSTRIAL VISIT

Industrial Visit	IV	BTP-817
Course Title	**Short Title**	**Course Code**

Course Description: The course explores the knowledge industry organization, new trends in manufacturing, maintenance and safety. The industrial visit will provide the practical visualization of theoretical study of various engineering subject.

	Hours per Week	No. Of Weeks	Total Hours	Semester Credits
Practical	**-**	**-**	**-**	**1**

General Objectives: The main objective behind these visits is student should get insights of industrial processes and they should get familiar with the working environment of industry. This also helps for strengthen industry institute interaction.

Course Outcomes:

Upon successful completion of this course the students will be able to:

1. Understand organizational set up of an industry.
2. Understand manufacturing, material handling, maintenance, safety standard and environmental consideration in industry.
3. Function on multidisciplinary teams, communicate effectively and Knowledge of contemporary issues.
4. Identify, formulate, and solve engineering problems by understanding professional and ethical responsibility.
5. Understand the impact of engineering solutions in a global, economic, environmental, and societal context.
6. Get industrial exposure.
7. Get encouraged becoming an entrepreneur and setting up their own industrial unit.

Industrial Visit

(Course Contents)

Semester-VII **Examination Scheme:**

Teaching Scheme: **Internal Continuous Assessment: 25 Marks**

1. During B.E. First Term /During vacation after TE Second Term every student shall visit minimum industries arranged by colleges and accompanied by teachers. There shall be at least one teacher for a group of 20 students, lady teachers for girls and at least one non-teaching staff accompanied with the students.
2. If due to some reason student is unable to accompany with other students, Individual student can visit minimum three industries.
3. Students should submit written report about the visits individually at the end of B.E. First term.
4. The report should contain information about the following points:
   a. The organization - activities of organization and administrative setup technical personnel and their main duties.
   b. The project/ industry brief description with sketches and salient technical information.
   c. The work/processes observed with specification of materials, products, equipments etc. and role of engineers in that organization.
   d. Suggestions (if any) for improvement in the working of those organizations.
   e. The evaluation of the report of technical visits will be made by panel of three teachers appointed by principal based on following points:
      i. Coverage aspect: All above points should be covered.
      ii. Detailed observations: System *I* Process / Product explained with data, diagram specifications.
      iii. Quality of presentation: Report should be very objective and should consist of clear and systematic organization of topics and information.
      iv. Viva - voce: A viva -voce shall be conducted on the technical visit report by the teachers to assess the specific knowledge gained by the students for technical applications.

BE CGPA pattern syllabus

B.E. Biotechnology

Semester-VIII

Faculty of Engineering and Technology
North Maharashtra University, Jalgaon

Bioprocess Modeling and Simulation.
Course Outline

Bioprocess Modeling and Simulation	BPMS	BTL-801
Course Title	**Short Title**	**Course Code**

Lectures	Hours per Week	No. of Weeks	Total Hours	Credits
	03	15	40	3

Course Description:

This course is aimed to introduce the different aspects of modeling in bioprocess system and to familiarize the simulation of bioprocess modeling to undergraduate students.

Prerequisite Course(s): Chemical reaction engineering, Heat transfer, Microbiology, Molecular biology.

General objective:

- The course builds upon the foundation of bioprocess design principles and modeling and focuses on actual computer aided design projects.

Learning Outcomes:

After completion of the course, students will be able to:

1. Do mathematical modeling of bioprocess engineering system.
2. Do computer aided design of various equipments used in bioprocess industries.
3. Do mathematical modeling of biological system.
4. Do simulation of bioprocess equipment.
5. Learn the software for modeling and simulation.

COURSE CONTENT

BE Biotechnology Bioprocess modeling and Simulations Semester-VIII

Teaching Scheme
Lectures -3 Hrs/week

Examination Scheme
End Semester Exams (ESE) : 80 Marks.
Paper Duration : 3 Hours.
Internal Sessional Exam (ISE) : 20 Marks.

Unit: I

Introduction to modeling. **No. of Lecture: 8 Hours, Marks: 16**

Introduction: Role of process dynamics and control, Laws and Languages of process control, Mathematical Modeling of Bioprocess Engineering System: Fundamentals uses of mathematical model, scope of coverage, Principles of formulation; Fundamental Laws of Modeling: continuity equation, Energy equation, Equation of motion, Transport equation, equation of state, Phase and chemical equilibrium.

Unit: II **No. of Lecture: 8 Hours, Marks: 16**

Study of mathematical models of Biochemical Engineering Systems.

Introduction, Modeling of CSTRs (isothermal, constant hold up, variable hold up), Batch reactors, Non isothermal CSTR, Plug flow reactor.

Unit: III **No. of Lecture: 8 Hours, Marks: 16**

Computer aided design of heat and mass transfer equipment.

Batch distillation with hold up, Ideal binary distillation column, Design of shell and tube heat exchangers, Design of rotary dryer, Design of single effect evaporator.

Unit: IV

Biological Models. **No. of Lecture: 8 Hours, Marks: 16**

Modeling of gene regulation, Modeling of signal transduction in prokaryotes and eukaryotes, Models for inheritance, Genetic inbreeding model, Simple logistic models, Simple prey predator models, Microbial population models (growth model, product formation), Pharmaceutical models.

Unit: V

Simulation. **No. of Lecture: 8 Hours, Marks: 16**

Introduction, Computer programming, Computational methods, Advantage and limitation of simulation techniques, Simulation of ammonia production system, Runga-Kutta method, Newton Raphson method; Simulation of Three CSTR in series, Non isothermal CSTR.

Reference Books:

1. Luyben W.L., Process Modeling Simulation and Control for Chemical Engineers., McGraw Hill, 1988.
2. Chapra S.C., R.P. Canale, .Numerical Methods for Engineers., Tata-McGraw Hill Publications.
3. Franks R.E.G., .Modeling and Simulation in Chemical Engineering., Wiely Instscience, NY
4. John Ingam, Irving J. Dunn., .Chemical Engineering Dynamic Modeling with PC simulation., VCH Publishers.
5. J.R. Leigh, Modeling and Control of Fermentation Processes, Peter Peregrinus, London, 1987.
6. J.N.Kapur, Mathematical Models in Biology and Medicine.
7. Cooney and Humphery, Comprehensive Biotechnology,Volume-2,Elsevier Publication.
8. James E. Bailey, David F. Ollis, Biochemical Engineering fundamental, Mcgraw Hill, International edition.
9. Pevzner, Computational Molecular Biology- An Algorithmic Approach, PHI, New Delhi.
10. Setubal, Introduction to Computational Molecular Biology, Cengage Learning PVT.
11. Vose, Simple Genetic Algorithms, The- Foundations and Theory, PHI, New Delhi.

Bioprocess Industries.
Course Outline

Bioprocess Industries	**BPI**	**BTL-802**
Course Title	Short Title	Course Code

Lectures	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Credits**
	03	15	40	3

Course Description:

This course is aimed at introducing the fundamentals of industrial bioprocess engineering. The basics of bioreactor designing have also been incorporated in the course.

Prerequisite Course(s): Fermentation technology, Bioprocess engineering, Genetic engineering.

General Objectives:
The objective of the course is to provide the basic knowledge of bio processes and its industrial application. This course helps to familiarize various aspects of bioreactors, to understand the media requirements and working conditions for profitable run of bioprocess industries with the help of data analysis.

Learning Outcomes:

After completion of the course, students will be able to:

1. Apply knowledge of chemical and mechanical engineering for design of biological system in biotech industries.
2. To get the knowledge of properties of materials and its view in designing bioprocess equipment within the standards prescribed by regulating authority in India and world.
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
4. An ability to work in an industrial or research position within the bioprocess or related fields.

COURSE CONTENT

BE Biotechnology Bioprocess Industries Semester - VIII

Teaching Scheme
Lectures -3 Hrs/week

Examination Scheme
End Semester Exams (ESE) :80 Marks.
Paper Duration : 3 Hours.
Internal Sessional Exam (ISE) :20 Marks.

Unit: I

Pilot plant units **No. of Lecture: 8 Hours, Marks: 16**

General aspects regarding purpose and function, size and location, organization personnel, programming operation, sampling reporting of results and safety costs budgeting.

Unit: II

Pilot plant operations **No. of Lecture: 8 Hours, Marks: 16**

Pilot plant designs, ducts and flow pass as age, Power per unit volume of liquid, Volumetric mass (oxygen)- transfer coefficient, mixing time concept, design example of scale-up.

Unit III

Bioreactor Operation **No. of Lecture: 8 Hours, Marks: 16**

Choosing the cultivation method, design and operation of a typical aseptic, aerobic fermentation process, alternate bioreactor configurations, Environmental requirements for animal cell cultivations, reactors for large scale production using animal cell, plant cell cultivation and bioreactor considerations in immobilized cell.

Unit IV

Biopharmaceuticals and Biotransformation: **No. of Lecture: 8 Hours, Marks: 16**

Production of penicillin, B-Lactum antibiotics, Streptomycin, Cephalosporins, Aminoglycoside, Tetracyclines, Steroid Biotransformation.

Unit V

Important products through r-DNA technology: **No. of Lecture: 8 Hours, Marks: 16**

Hepatitis B, vaccine, interferons, Insulin, somatotrophic hormone, therapeutic proteins Vaccines.Production of biodiesel and biogas, Biological production of hydrogen and biofuel cellsBiological waste treatment (utilization of mixed culture).

Reference Books:

1. Johnstone and Thring: Pilot Plant Models and Scale up Methods in Chemical Engineering. McGraw Hill Book Co.1987.
2. Aiba.S, Humphery A.E and Millis.N.F, Biochemical Engineering,Academic Press,1965.
3. Shuler, M.L. and Kargi,F. Bioprocess Engineering - Basic concepts – 2 nd ed., Prentice Hall of India Pvt. Ltd., 2005
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, 2 nd ed., Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2005.
5. Bailey and Ollis, "Biochemical Engineering Fundamentals", 2 nd ed.,McGraw Hill, 1986.
6. Pauline M. Doran, "Bioprocess Engineering Calculation", Blackwell Scientific Publications.

Elective-II
1.Genomic and Proteomics
Course Outline

Genomics and proteomics	G&P	BTL-803
Course Title	**Short Title**	**Course Code**

Lecture	**Hours per week**	**No. Of weeks**	**Total hours**	**Semester credits**
	03	15	40	03

Course Description:
This course is introduced for learning the science of genomics and proteomics to understand the entire DNA sequence of organisms in order to improve human health or advance agricultural technology and applying the techniques of molecular biology, biochemistry, and genetics to analysing the structure, function, and interactions of the proteins produced by the genes of a particular cell, tissue, or organism, with organizing the information in databases, and with applications of the data.

Prerequisite Course(s): Biochemistry, Molecular biology, Genetic engineering.

Objective of the Subject:

1. To make student understand the DNA sequence of organism.
2. To study the different techniques used for the sequencing of DNA.
3. To study the various techniques used for the protein sequencing.

Learning outcomes:
After completion of this course students will able to:

1. Sequence the DNA of various organisms.
2. Apply their knowledge in order to improve human health by studying genome sequence.
3. Understand the interactions of proteins.
4. Use modern techniques of protein sequencing such as MALDI-TOF.

Course content

BE Biotechnology Genomics and proteomics semester VIII

Teaching Scheme
Theory: 3 hours/ week

Examination Scheme
End Semester Examination(ESE): 80Marks.
Paper Duration (ESE): 03 Hours.
Internal Sessional Examination (ISE): 20 Marks.

UNITI: Introduction to Genomics **No. of Lecture: 8 Hours, Marks: 16**

New science of genomics, orientation and structure of genomes, Introduction to Structural and Functional genomics, assembling a physical map of a genome, Features of prokaryotic eukaryotic & organellar genomes, Genome sizes- C value paradox, Gene counting.

UNIT II: DNA sequencing technique **No. of Lecture: 8 Hours, Marks: 16**

Principles of DNA sequencing, Methods of preparing genomic DNA for sequencing, Early sequencing efforts, DNA sequencing: Sanger Dideoxy method, Automated DNA sequencing, Shotgun sequencing- contig assembl, Fluorescence method.

UNIT III: **Sequence of organism** **No. of Lecture: 8 Hours, Marks: 16**

Genome projects on *E.coli*., Arabidopsis and rice; Human genome project and the genetic map. Functional genomics studies with model systems such as Drosophila, Yeast, *C. elegans*.

UNIT IV: Proteomics **No. of Lecture: 8 Hours, Marks: 16**

Proteomics and Proteomes, Various tools used in proteomics, Mining proteomes, protein expression profiling, identifying protein – protein Interactions and protein complexes, mapping- protein identification, new directions in proteomics**.**

UNIT V: Techniques in Proteomics **No. of Lecture: 8 Hours, Marks: 16**

Protein level estimation – Edman protein microsequencing, Protein cleavage,2D gel Electrophoresis, Metabolic labelling, Detection of proteins on SDS gel, Pattern analysis, Mass spectrometry, Principles of MALDI-TOF, Tandem MS-MS, Peptide mass Fingerprinting.

TEXT BOOKS

1. Primrose, S.B. and Twyman, R.H., "Principles of Genome Analysis and Genomics"Blackwell Publishing Co., 2003.
2. Liebler, D.C., "Introduction to Proteomics", Humana Press, 2002
3. Arthur M Lesk, Introduction to Genomics Oxford University Press.
4. Sabesan, Genomics & Proteomics, Ane Books.

REFERENCES

1. Pennington, S.R. and Dunn, M.J., "Proteomics", BIOS Scientific Publishers, 2001.
2. Hunt, S.P., Livesey, R. and Livesey, F.J., "Functional Genomics: A Practical Approach" Oxford University Press, 2000.
3. Suhai S., "Genomics and Proteomics: Functional and Computational Aspects", Springer 2000.
4. Cantor, C.R. and Smith, C.L., "Genomics: The Science and Technology Behind the Human Genome Project", Wiley and Sons, 1999.

Elective-II

2.GOOD MANUFACTURING PRACTICES

Course Outline

Good manufacturing practices	GMP	BTL-804
Course Title	**Short Title**	**Course Code**

Lecture	Hours per week	No. Of weeks	Total hours	Semester credits
	03	15	40	03

Course Description:
This course is introduced to understand basic good manufacturing practices to maintain the product quality.

Prerequisite Course(s): Microbiology, Unit operations, Biochemistry.

Course Objective:

1. Develop the basic knowledge of GMP.
2. Develop the basic knowledge regarding good practices in production and quality control.
3. Understand the basics of Good manufacturing practices.

Learning Outcomes

After the completion of this course the students will be able to:

1. Demonstrate their understanding of the roles of Quality Assurance and Quality Control in a GMP environment.
2. Demonstrate their understanding good practices in production
3. Follow proper documentation procedures.
4. Use modern techniques, skill and modern engineering tools in GMP for better product quality.

COURSE CONTENT

BE Biotechnology Good Manufacturing Practice semester VIII

Teaching Scheme	Examination scheme
3hrs/week	End Semester Examination (ESE) :80 Marks.
	Paper Duration (ESE) :03 hours.
	Internal Sessional Examination (ISE) :20Marks.

Unit I:

Introduction to GMP **No. of Lecture: 8 Hours, Marks: 16**

Introduction, Quality system, Quality risk management, Good manufacturing practices for pharmaceutical products, Sanitation and hygiene, Qualification and validation, Complaints, Product recalls, Product quality review, The Indian GMP Regulations.

Unit II:

Contract production, analysis and other activities Self-inspection, quality audits and suppliers' audits and approval: **No. of Lecture: 8 Hours, Marks: 16**

The contract giver, The contract accepter, Items for self-inspection, Self-inspection team, Frequency of self-inspection, Self-inspection report, Follow-up action, Quality audit Suppliers, audits and approval.

Unit III:

Training, Personal Hygiene, Equipment & Materials **No. of Lecture: 8 Hours, Marks:16**

Introduction, Starting materials, Packaging materials, Intermediate and bulk products, Finished products Rejected, recovered, reprocessed and reworked materials, Recalled products, Returned goods, Reagents and culture media, Reference standards, Waste materials, Miscellaneous.

Unit IV:

Personnels & Good practices in production. **No.of Lecture: 8 Hours, Marks: 16**

Introduction, Key Personnels, Prevention of cross-contamination and bacterial contamination during production, Processing operations, Packaging operations.

Unit IV:

Good practices in quality control & Premises. **No. of Lecture: 8 Hours, Marks: 16**

Introduction, Ancillary areas, Storage areas, Weighing areas, Production areas, Quality control areas, Control of starting materials and intermediate, bulk and finished products Test, requirements Batch record review, Stability Studies.

Reference Books:

1. Mindy J. Allport-Settle,Good Manufacturing Practice (GMP) Guidelines: The Rules Governing Medicinal Products in the European Union, EudraLex Volume 4 Concise Reference PharmaLogica, Inc.
2. Joseph D. Nally Good Manufacturing Practices for Pharmaceuticals, Sixth Edition (Drugs and the Pharmaceutical Sciences), edited, CRC Press.
3. Mindy J. Allport-Settle, Current Good Manufacturing Practices: Pharmaceutical, Biologics, and Medical Device Regulations and Guidance Documents Concise Reference CreateSpace Independent Publishing Platform.

Elective-II
3.Pharmaceutical Biotechnology
Course Outline

Pharmaceutical Biotechnology	**PBT**	**BTL-805**
Course Title	Short Title	Course Code

Lectures	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Credits**
	03	15	40	3

Course Description:

This course is aimed to develop the basic knowledge of application of Biotechnology procedures in the field of Pharmacy to undergraduate students. The course aims exposing students to various topics in biotechnology, including the pharmacist's role in biotechnology, criteria for regulatory approval for biotechnology drugs, technology in genetic engineering and its application to pharmacy.

Prerequisite Course(s): Immunology, Genetic engineering.

General objective:

1. The basic background knowledge gained in immunology and biochemistry; to enable the student to advance the skills necessary in the understanding of biotechnology derived drugs and drug therapy.

Learning Outcomes:

After completion of the course, students will be able to:

1. Evaluate different pharmaceutical parameters of current biotechnology products.
2. Determine parameters related to stability and formulation of biopharmaceutical products.
3. Discuss quality control procedures related to biopharmaceutical products.
4. Discuss novel formulation methods for better delivery of biotechnology derived drugs.
5. Discuss the delivery of biopharmaceutical products by the parenteral, oral, transdermal and nasal routes of administration.

COURSE CONTENT

BE Biotechnology Pharmaceutical Biotechnology Semester – VIII

Teaching Scheme
Lectures -3 Hrs/week

Examination Scheme
End Semester Exams (ESE) : 80 Marks.
Paper Duration : 3 Hours.
Internal Sessional Exam (ISE) : 20 Marks.

Unit: I

Introduction

Defintition of biotechnology, the different aspects of biotechnology, pharmaceutical biotechnology and its role in producing therapeutics and diagnostics and in health care.

Unit: II

Animal and plant cell culture

Brief introduction to cell culture with respect to the properties of animal and plant cells, Media requirements, Typical media used, Typical methods for setting up primary culture, Cell strains vs cell lines, Use of plant/animal cell culture for production of pharmaceuticals, Therapeutic proteins.

Unit: III

Genomics in Clinical Diagnostics

Restriction fragment length polymorphism, Gel electrophoresis techniques (PAGE, SDS-PAGE and agarose gel electrophoresis), Immunoblotting, Southern blotting, Northern blotting, Western blotting, PCR and RT PCR, Sanger dideoxy method of sequencing.

Unit: IV

Immunology

Immunity, Methods of immunization, Antigen antibody reactions, Generation of immune response, Polyvalent antibodies, Hypersensitivity responses, Preparation and characterization of immune sera, allergenic extracts, Monovalent antibodies or monoclonal antibodies, hybridoma technology, Humanization of monoclonal antibodies, Application of monoclonals in therapeutics and diagnostics RIA and ELISA diagnostic methods.

Unit: V

Vaccines

Preparation and standardization of vaccines, Discussion of different types of vaccines, different approaches for vaccine preparation and their quality control parameters, pharmacogenomics.

Reference Books:

1. Gray Walsh & B. Murphy, Biopharmaceuticals and industrial prospective., Kluwer publishers (1999).
2. Gray Walsh, Biopharmaceuticals., Wiley John & Sons, Inc. (2003).
3. Camille G. Wermuth, The practice of Medicinal chemistry., Academic Press, (2003).
4. Dann, J.A, Crommelin & Robert D., Sindelar, Pharmaceutical Biotechnology, Oct. 2002, Taylor & Francis.
5. Dubey, R.C., A Textbook of Biotechnology. 4th ed., S. Chand & Co. P Ltd, New Delhi, p. 732. ISBN 81-219-2608-4.
6. U. Satyanarayana, Biotechnology, Books and Allied (P) Ltd, Kolkata (2005)

Elective-II
4.Nanobiotechnology

Course Outline

Nanobiotechnoloy	NBT	BTL-806
Course Title	**Short Title**	**Course Code**

Lecture	Hours per week	No. Of weeks	Total hours	Semester credits
	03	15	40	03

Course Description:
This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment. The goal of this course is to provide an insight into the fundamentals of nanotechnology in biological and biomedical research.

Prerequisite Course(s): Microbiology, Biochemistry, Molecular biology

General Objective:

1. To understand the essential features of nanotechnology and biology that are converging to create the new area of nanobiotecnology.
2. To recognize the structural and functional principles of Nanobiotechnology.
3. To employ bionanomaterials for analysis and sensing techniques.
4. To apprehend and explain the biomedical applications of nanotechnology.

Learning outcomes:

After completion of this course students will able to:

1. It will also guide the students to understand how nanomaterials can be used for a diversity of analytical and medicinal rationales.
2. Students will be able to synthesize and characterise the Nanomaterials.
3. Apply their knowledge of drug delivery by using Nanomaterials.
4. Access the toxicity of nanomaterial.
5. Apply knowledge in medical and agriculture field, waste treatment.

COURSE CONTENT

BE Biotechnology Nanobiotechnology Semester- VIII

Teaching Scheme
Theory: 3hours/week

Examination scheme
End semester examination (ESE) : 80 marks.
Paper duration : 3 hours.
Internal sessional examination (ISE) : 20 marks.

UNIT I: **No. of Lecture: 8 Hours, Marks: 16**

Introduction to nanotechnology, Nanobiotechnology definition and concept, Cellular Nanostructures: S-layers, Nanopores, Biomolecular motors, rhodopsin, Criteria for suitability of nanostructures for biological applications, Bottom-up versus top-down models.

UNIT II: **No. of Lecture: 8 Hours, Marks: 16**

Methods of preparation of nanoparticles, properties of nanomaterials; nanoparticle synthesis using microbes, Basic characterization techniques**,** Electron microscopy (SEM, TEM and STM); Atomic force microscopy; Photon correlation spectroscopy and others, Introduction to BioMEMS; Recent developments in bioMEMS.

UNIT III: **No. of Lecture: 8 Hours, Marks: 16**

Concepts and advantages of microfluidic devices, Materials and methods for the manufacture of microfluidic component, Fluidic structure,Nanostructures for drug delivery (Nanovesicles; Nanospheres; Nanocapsules, Magnetic nanoparticles; Liposomes; Dendrimers), concepts, targeting, routes of delivery and advantages.

UNIT IV: **No. of Lecture: 8 Hours, Marks: 16**

Fluorescent nanomaterials for Biosensors and Biolabelling, Quantum dots, imaging and biosensors; Nanodevices for sensor development, Antimicrobial activity and wound healing, Artificial implants, Tissue engineering, Identification of pathogenic organisms by magnetic nanoparticle-based techniques.

UNIT V: **No. of Lecture: 8 Hours, Marks: 16**

Effect of nanomaterials on human health, environment and safety, Recent progress and challenges in the risk assessment of Nanomaterials, Assessment of the toxic effects of nanoparticles based on *in-vitro* laboratory tests.

Text Books/References

1. Niemeyer C. M., Nanobiotechnology: Concepts, Applications and Perspectives, Wiley – VCH, 2006.
2. David S Goodsell, Bionanotechnology, John Wiley & Sons, 2004.
3. Debasis Bagchi, Manashi Bagchi, Hiroyoshi Moriyama, Fereidoon Shahidi
4. Buddy D. Ratner, Allan S. Hoffman , Frederick J. Schoen , Jack E. Lemons,

Elective-III

1.System Biology

Course Outline

System Biology	SB	BTL-807
Course Title	**Short Title**	**Course Code**

Lecture	Hours per week	No. Of weeks	Total hours	Semester credits
	03	15	40	03

Course description:
This course deals with basics of system biology. It also introduces various softwares involved in modelling and simulation. This course has also been dealt with various mathematical model constructions of biological pathways.

Prerequisite Course(s): Biochemistry, Molecular biology, Genetics.

Course objectives:
To introduce the students with the basics of both theoretical and practical aspects of system biology approach. This course gives a introduction Systems Biology. This course will cover the basics of mathematical modelling part of Systems Biology.

Learning objectives:
After completion of this course students will be able to:

1. Apply a network biology analysis approach to a wide range of molecular biology problems.
2. Critically assess the quality of high-throughput protein-protein interaction data.
3. Apply basics of biological networks.
4. Describe basic computational methods for biological networks based on high-throughput data.
5. Describe and apply basic algorithms.

COURSE CONTENT

BE Biotechnology System Biology Semester VIII

Teaching Scheme
Theory: 3 hours/ week

Examination Scheme
End Semester Examination(ESE): 80Marks.
Paper Duration (ESE): 03 Hours.
Internal Sessional Examination (ISE): 20 Marks.

Unit I: **No. of Lecture: 8 Hours, Marks: 16**

System Biology

Introduction, System Structure Identification, System Behavior Analysis, System Control, System Design, Measurement Technologies And Experimentalmethods, System Structure Identification, The Systeome Project, Impacts Of System Biology.

Unit II: **No. of Lecture: 8 Hours, Marks: 16**

Reverse Engineering And Data Mining From Gene Expression Data

The Dbrf Method For Inferring A Gene Network From Large-Scale Steady-State Gene Expression Data, Performance Of The Dbrf Method, Application To Yeast Gene Expression Data, The Analysis Of Cancer Associated Gene Expression Matrices, Automated Reverse Engineering Of Metabolic Pathways From Observed Data By Means Of Genetic Programming.

Unit III: **No. of Lecture: 8 Hours, Marks: 16**

Software for Modeling And Simulation

The ERATO Systems Biology Workbench: An Integrated Environment For Multiscale And Multi Theoretic Simulations In Systems Biology, The Systems Biology Markup Language, The Systems Biology Workbench, Automatic Model Generation For Signal Transduction With Applications To MAP-Kinase Pathways, Mapk Pathway With Scaffolds:Experimental Background, Parameter Estimation.

Unit IV: **No. of Lecture: 8 Hours, Marks: 16**

Cellular Simulation

Towards A Virtual Biological Laboratory, Modular Modeling Concept, Computational Cell Biology, The Stochastic Approach, Modeling Bacterial Chemotaxis, Computer Simulation Of The Cell: Human Erythrocyte Model And Its Application.

Unit V: **No. of Lecture: 8 Hours, Marks: 16**

System-Level Analysis

Constructing Mathematical Models Of Biological Signal Transduction Pathways: An Analysis Of Robustness, Robust perfect adaptation and integral feedback control In Bacterial Chemotaxis, Combination Of Biphasic Response Regulation And Positive Feedback As A General Regulatory Mechanism In Homeostasis And Signal Transduction, Regulation Of MAPK Concentration.

Reference Books:

1. Hiroaki Kitano, Foundations of Systems Biology edited; The MIT Press Cambridge
2. Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, First edition; Chapman and Hall/CRC Publications.
3. Eberhard Voit, First Course in Systems Biology; Garland Science.
4. Edda KlippSystems, Biology , Wolfram Liebermeister; First edition Wiley VCH

Course Outline
Molecular Modelling and Drug Design

Molecular Modeling & Drug Design	**MMDD**	**BTL808**
Course Title	Short Title	Course Code

Course Description:

This course is framed to develop the basic knowledge modeling & drug design to undergraduate students. The background expected includes a prior knowledge of BE Biotechnology courses. The goals of the course are to understand the basic principles of drug designing and their applications in the field of Biotechnology.

Lectures	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Credits**
	03	15	40	3

Course Objective

1. To understand the critical relationship among bimolecular structure, function and force field models.
2. To be able to utilize basic modeling techniques to explore biological phenomena at the molecular level.
3. To emphasize modeling drug/receptor interactions in detail by molecular mechanics, molecular dynamics simulations and homology modeling.

Course Outcome:

After completion of the course student will be able to:

1. Students are introduced to the principles and practice of Molecular modeling and modern drug discovery.
2. An awareness of rational drug design, based on understanding the three-dimensional structures and physicochemical properties of drugs and receptors will be created.
3. Understand the impact of engineering solution by drug designing in global economic and societal context.

COURSE CONTENT

Molecular Modeling and Drug Designing Semester - VII

Teaching Scheme
Lectures -3 Hrs/week

Examination Scheme
End Semester Exams (ESE): 80 Marks.
Paper Duration: 3 Hours.
Internal Sessional Exam (ISE):20 Marks

Unit I: **No. of Lecture: 8 Hours, Marks: 16**

Introduction To Molecular Modelling:

Introduction - Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces, Molecular Graphics, Surfaces, Computer Hardware and Software, The Molecular Modelling Literature.

Unit II: **No. of Lecture: 8 Hours, Marks: 16**

Force Fields:

Force Fields, Bond Stretching. Angle Bending, Introduction to Non-bonded Interactions, Electrostatic Interactions, Vander Waals Interactions, Hydrogen Bonding in Molecular Mechanics, Force Field Models for the Simulation of Liquid Water.

Unit III: **No. of Lecture: 8 Hours, Marks: 16**

Energy Minimisation And Computer Simulation:

Energy Minimisation methods, Non-Derivative method, Simple Thermodynamic Properties and Phase Space, Boundaries, Analyzing the Results of a Simulation and Estimating Errors.

Unit IV: **No. of Lecture: 8 Hours, Marks: 16**

Molecular Dynamics & Monte Carlo Simulation:

Molecular Dynamics Simulation Methods, Molecular Dynamics Using Simple Models, Molecular Dynamics with Continuous Potentials, Molecular Dynamics at Constant Temperature and Pressure, Monte Carlo Simulation of Molecules, Molecular Modeling software.

Unit V: **No. of Lecture: 8 Hours, Marks: 16**

Drug Design:

Protein Structure Prediction-Comparative Modeling, Constructing and Evaluating a Comparative Model, Molecular Docking, AUTODOCK and HEX. Structure based DeNovo Ligand design, Drug Discovery –QSAR.

Reference Book:

1. A.R.Leach, "Molecular Modelling Principles and Application", Longman, 2001.
2. J.M.Haile, "Molecular Dynamics Simulation Elementary Methods", John Wiley and Sons,1997.
3. Satya Prakash Gupta, "QSAR and Molecular Modeling", Springer - Anamaya Publishers, 2008.

Elective-III
3.Stem Cell Technology
Course Outline

Stem Cell Technology	**SCT**	**BTL-809**
Course Title	Short Title	Course Code

Lectures	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Credits**
	03	15	40	3

Course Description:

This course is aimed to develop the knowledge of basics of stem cell biology, pluripotency and induced pluripotency, adult, embryonic and cancer stem cells, and the barriers to regenerative medicine, including scientific, ethical, regulatory and proprietary issues to undergraduate students. The goals of the course are to understand the basic principles of modern aspects of stem cell technology and the techniques of stem cell science.

Prerequisite Course(s): Cell Biology, Immunology.

Course objective:
To develop the basic knowledge and skills of stem cell science in research projects.

Learning Outcomes:
After completion of the course, students will be able to:

1. Grow the embryonic stem cell in lab
2. Understand stem cell in regeneration of cells.
3. Perform stem cell therapies.
4. Understand the ethical issues related to stem cell technology.

COURSE CONTENT

BE Biotechnology Stem Cell Technology Semester – VIII

Teaching Scheme
Lectures -3 Hrs/week

Examination Scheme
End Semester Exams (ESE) : 80 Marks.
Paper Duration : 3 Hours.
Internal Sessional Exam (ISE) : 20 Marks.

Unit I
Stem cells
Introduction: Tissue organization, Stem cells, Sources, Unique properties of stem cells, classification, Embryonic stem cells, adult stem cells, similarities and differences between adult and embryonic stem cells, Functional characterization.

Unit II
Embryonic stem cells
Stem cells and their developmental potential, In vitro fertilization-culturing of embryos blastocyst-inner cell mass-isolation and growing ES cells in lab- Identification and characterization of human ES cells-Cloning and controlled differentiation of human embryonic stem cells, Applications of Embryonic stem cells – Gene knock in – Gene knock out

Unit III
Adult stem cells
Somatic stem cells, test for identification of adult stem cells, adult stem cell differentiation, different types of adult stem cells, liver stem cells, skeletal muscle stem cells, bone marrow derived stem cells, Induced pluripotent cells.

Unit IV
Cancer stem cell signaling
Introduction**:** Tumor stem cells, Breast Cancer Stem Cells: Identification - Signalingpathways: Notch signaling – Wnt signaling in stem cells and cancer cells.

Unit V
Stem cells in tissue engineering
Introduction: Biomaterials, Cell and biomaterial interactions, Haematopoietic Stem Cells, Mesenchymal stem cells, Bone tissue engineering, Cartilage tissue engineering, Cardiovascular tissue engineering, Neural tissue engineering, Therapeutic applications, Parkinson's disease, Diabetes: Pancreatic cells regeneration. Stem cell based gene therapy and benefits to human.

REFERENCES:

1. Ariff Bongso, EngHin Lee “Stem Cells: From Bench to Bedside” World Scientific Publishing Company. 2005.
2. C S Potten “Stem Cells” Elsevier,1996.
3. Daniel R. Marshak “Stem cell biology” Cold Spring Harbor Laboratory Press.
4. Robert Lanza “Essentials of Stem Cell Biology” Elevier, 2009.
5. Peter Quesenberry “Stem cell biology and Gene Therapy” Wiley, Liss,1988.

COURSE OUTLINE
Elective-III
4.Biofuel and Alcohol Technology

Biofuel and Alcohol Technology	**BAT**	**BTL-810**
Course Title	Short Title	Course Code

Lectures	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Credits**
	03	15	40	3

Course Description:

This course is aimed to develop the basic knowledge and operations of Biofuel and alcohol technology to undergraduate students. The background expected includes a prior knowledge of BE Biotechnology courses. The goals of the course are to understand the basic principles biofuels production & fermentations for production of organic solvents and Biofuel production processes and their applications in engineering trade.

Prerequisite Course(s): Bioprocess engineering, Fermentation technology, Biochemistry.

General objective:

- To develop the basic knowledge and skills in Biofuels and alcohol production.

Learning Outcomes:

After completion of the course, students will be able to:

1. Have an advanced understanding of biofuel and biomass production.
2. Critically appraise logistical issues associated with implementing large scale biofuel and biomass energy production.
3. Perform technical, economic and environmental comparisons of various energy systems.
4. Implement the various methods of fermentations processes.
5. Explain the alcohol recycling & biochemistry of alcohol.

COURSE CONTENT

BE Biotechnology **Biofuel and Alcohol Technology** **Semester - VIII**

Teaching Scheme

Lectures -3 Hrs/week

Examination Scheme

End Semester Exams (ESE): 80 Marks.
Paper Duration: 3 Hours.
Internal Sessional Exam (ISE):20 Marks.

Unit: I

Introduction to Fuel Technology: **No. of Lecture: 8 Hours, Marks: 16**

Renewable & Nonrenewable energy resources, Useful features of biofuels, Undesirable features of biofuels, Biogas technology, Biodiesel Production, Biohydrogen production.

Unit: II

Bioenergy from biomass: **No. of Lecture: 8 Hours, Marks: 16**

Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion, Biomass conversion to biofuel: thermochemical conversion, syngas fermentation.

Unit: III

Alcohol Technology: **No. of Lecture: 8 Hours, Marks: 16**

Introduction to Alcohol Technology, Raw Material of Alcohol Industry, Storage & handling of Raw material in detail, Study of different yeast strains used in alcohol industries, Study of yeastproduction as single protein cell.

Unit: IV **No. of Lecture: 8 Hours, Marks: 16**

Alcoholic Fermentations:

Study of different alcoholic fermentation techniques, Batch fermentation, Continuous fermentation, Modem techniques of Continuous fermentation, Bio still fermentation, Encillium process Wet milling of grain for alcohol production, Grain dry milling cooking for alcohol production, Use of cellulosic feed stocks for alcohol production, Scaling in distilleries, Fusel oil separation.

Unit: V

Biochemistry & Recycling of Alcohol: **No. of Lecture: 8 Hours, Marks: 16**

Study of different recycling process, Biochemistry of alcohol production, The management of fermentation in the production of alcohol, Alcohol distillation-The fundamental, Parameters & affecting alcoholic fermentations, By product of alcoholic fermentation, Distillery quality control, Alcoholometry.

Reference Books:

1. B.D. Singh, Kalyani Publications.
2. Chmles E. ,Out lines of Chemical Technology.
3. Olaf A Hougen, Kwenneth M. Watson, and Roland A Ragatz, Chemical Process Principles – Part I, Material and Energy Balances by CBS Publishers and Distributors (1995).
4. T. P. Lyons ,Text books of alcohol tech.

Bioprocess Modeling and Simulations Lab
LAB COURSE OUTLINE

Bioprocess Modeling and Simulations	**BPMS**	**BTL-811**
Course Title	Short Title	Course Code

Practical	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Semester Cred1its**
	02	15	16	1

Course Description:
In this laboratory, course emphasis is on the understanding of use of modeling and simulation as an aid to the understanding of biochemical engineering processes and their dynamics with respect to cpp programs.

Prerequisite Course(s): Unit operation, Computer application**.**

General Objective:
The objective of the laboratory is to impart the fundamental knowledge of requirements of a bioprocess to be suited for a laboratory experiment for students, the mathematical models of the chosen process are presented in detail for batch, fed-batch, and continuous mode of operation.

Learning Outcomes:
After successful completion of this lab student will be able to:

1. Distinguish and apply the principles of modelling of bioreaction processes, model classification (structured/ unstuctured, segregated/ non-segregated, etc.)
2. Understand and apply principles of modelling in batch, fed-batch and continuous bioreactor using basic kinetic models.
3. Analyse and interpret experimental data from bioreactors, predict bioreactor operation, monitor it and control.
4. Describe the origin of non-ideal flow behaviour in real reactors and the impact of non-ideal flow effects on process performance, design and modelling.

Bioprocess Modeling and Simulations Lab

Semester-VIII

Teaching Scheme	**Examination Scheme**
Practicals -2 Hrs/week	External Sessional Exams (ESE)/Oral (OR) :25 Marks.
	Internal Continuous Assessment : 25 Marks.

Minimum eight experiments from the following

1) CAD of shell and tube exchanger.

2) CAD of adsorption column.

3) CAD of single effect evaporator.

4) Computer controlled heat exchanger.

5) CAD for rotary dryer.

6) Simulation of temperature on surface catalyst.

7) Simulation of reactor design.

8) Simulation of ammonia production system.

9) Modeling and simulation of protein.

10) Drug designing.

Books:

1. By B.K. Lydersen, N.A. D'Elia & K.L. Nelsen, Bioprocess Engineering Systems, Equipment & Facilities John Wiley and Sons Inc. New York.
2. Luyben W.L. Process Modeling Simulation and Control for Chemical Engineers., McGraw Hill, 1988.
3. Chapra S.C., R.P. Canale, .Numerical Methods for Engineers., Tata-McGraw Hill Publications.

Bioprocess Industries Lab

LAB COURSE OUTLINE

Bioprocess Industries	**BPI**	**BTL-812**
Course Title	Short Title	Course Code

.

Practical	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Semester Credits**
	02	15	16	1

Course Description:
In this laboratory, course emphasis is on the understanding of basics techniques of industrial bio process. The learner can use this knowledge and apply in allied branches of Biotechnology as required.

Prerequisite Course(s): Fermentation Technology, Bioprocess Engineering.

General Objective:
The objective of the laboratory is to impart the fundamental knowledge of industrial bioprocess at the research level to the students and to develop their ability to apply the analytical techniques for interpreting experimental results.

Learning Outcomes:
After successful completion of this lab student will be able to:

1. Demonstrate a detailed knowledge of growth kinetics.
2. Study the effect of substrate and product concentration on biomass yield for bakers yeast production Interpret the significance of Biotechnology in production.
3. Demonstrate a detailed knowledge of therapeutic agents of microbial origin and their production.
4. Demonstrate knowledge of plant tissue culture systems and artificial seed production.

Bioprocess Industries Lab

Semester-VIII

Teaching Scheme
Practicals -2 Hrs/week

Examination Scheme
External Sessional Exams (ESE)/Oral (OR):25 Marks.
Internal Continuous Assessment : 25 Marks.

Minimum eight experiments from the following

1. Growth kinetics of microorganisms using shake flask method.
2. Determination of specific thermal death rate constant (Ka).
3. Determination of Volumetric oxygen transfer coefficient (K_La), effect of aeration and agitation speed.
4. Preparation of Immobilized enzymes and cells and evaluation of kinetic parameters.
5. Kinetics study of Product formation.
6. Effect of substrate and product concentration on biomass yield for bakers yeast production.
7. Studies on settling characteristics of various microbial cultures.
8. Explant preparation and their inoculation on suitable plant growth media.
9. Callus induction technique and regeneration of plant from callus culture.
10. Artificial seed production.
11. Shake flask studies of plant cell culture.

Books:

1. Richards, Introduction to Industrial Sterilization,.
2. S.S.Purohit, Biotechnology: Fundamentals and Applications, Agrobios (India), 4th Edition, 2005.
3. P.F.Stanbury, A.Whitkar and S.J.Hall, Principles of Fermentation Technology, Aditya Book House, New Delhi.

Lab Elective-II
1.Genomics and Proteomics Lab
LAB COURSE OUTLINE

Genomics and proteomics	**G&P**	**BTL-813**
Course Title	Short Title	Course Code

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	02	**15**	**16**	**01**

Course Description:
This course is introduced to emphasis on the insight of the DNA sequences and the protein sequences and the interaction of the proteins.

Prerequisite Course(s): Biochemistry, Molecular Biology, Genetic Engineering.

General Objective:

1) To develop skills of the techniques to sequence the DNA
2) To find the interaction of the two proteins.
3) To develop the skills of the technique to sequence protein

Learning Outcomes:
After successful completion of this course students will be able:

1) To find the sequence of the DNA.
2) To calculate the molecular mass of protein.
3) To find the interaction of the proteins.
4) Apply their knowledge to pharmaceuticals development on the basic of interaction of the proteins.

Lab Proteomics and Genomics

Teaching Scheme	**Examination Scheme**	**Semester-VIII**
Practical - 2 Hrs/week	External Sessional Exams (ESE)/Oral (OR) : 25 Marks.	
	Internal Continuous Assessment (ICA) : 25 Marks.	

Minimum 08 experiments shall be performed from the following

1) Extraction and Solubilization of Proteins for Proteomic Studies.
2) Preparation of Bacterial Samples for 2-D PAGE.
3) 2-D PAGE of High-Molecular-Mass Proteins.
4) Comparing 2-D Electrophoretic Gels Across Internet Databases.
5) Computational Prediction of Protein-Protein Interactions.
6) The Yeast Two-Hybrid System for Detecting Interacting Proteins.
7) Finding Genes in Genomic Nucleotide Sequences by Using Bioinformatics.
8) Sequence-Based Detection of Single Nucleotide Polymorphisms.
9) Mammalian Two-Hybrid Assay for Detecting Protein-Protein Interactions in Vivo.
10) Scanning for DNA Variants by Denaturant Capillary Electrophoresis.

REFFERENCE:

1) Starkey, Mike, Elaswarapu, Ramnath,Genomics Protocols,Springer, 2001, ISBN 978-1-59745-188-8
2) Walker, John M., The Proteomics Protocols Handbook,Springer, ISBN 978-1-59259-890-8,2005
3) Michael P. Starkey, Ramnath Elaswarapu, Methods in molecular Biology:Genomic protocol,Volume 175.

Lab Elective II

2. Lab Good Manufacturing Practices

LAB COURSE OUTLINE

Good Manufacturing Practices	**GMP**	**BTP-814**
Course Title	Short Title	Course Code

.

Practical	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Semester Credits**
	02	15	16	1

Course Description:
This course provides an overview of the quality system of management controls for research laboratories and organizations. To ensure the uniformity, consistency, reliability, reproducibility, quality, and integrity of the final product. This lab course is introduced to understand basic good manufacturing practice to maintain the product quality.

Prerequisite Course(s): SE Biotechnology courses.

General Objective:
The objective of the laboratory is to impart the fundamental knowledge of good manufacturing practices at the research level to the students and to develop their ability to apply and follow good practices in production.

Learning Outcomes:
After successful completion of this lab student will be able to:

1. Follow fundamental compliance requirements for current GMP.
2. Apply compliance protocols in all efforts aimed at generating regulated data for evaluation by the US FDA and regulatory agencies overseas.
3. Demonstrate their understanding good practices in production.

2. Lab Good Manufacturing Practices

Teaching Scheme	**Examination Scheme**	**Semester-VIII**
Practical - 2 Hrs/week	External Sessional Exams (ESE)/Oral (OR) : 25 Marks.	
	Internal Continuous Assessment (ICA) : 25 Marks.	

Minimum 08 experiments shall be performed from the following

1. Introduction to GMP.
2. Product quality review.
3. Starting materials for various industries.
4. Packaging materials.
5. Waste materials management.
6. Prevention of cross-contamination and bacterial contamination during production.
7. Personal hygiene.
8. Labeling.
9. Drafting the device master record.
10. Obtaining information on GMP requirements.

Reference Books:

4. M.K. Satish, Biosafety and Bioethics, I.K. International publishing house.
5. Mindy J. Allport-Settle,Good Manufacturing Practice (GMP) Guidelines: The Rules Governing Medicinal Products in the European Union, EudraLex Volume 4 Concise Reference PharmaLogica, Inc.
6. Joseph D. Nally Good Manufacturing Practices for Pharmaceuticals, Sixth Edition (Drugs and the Pharmaceutical Sciences), edited, CRC Press.
7. Mindy J. Allport-Settle, Current Good Manufacturing Practices: Pharmaceutical, Biologics, and Medical Device Regulations and Guidance Documents Concise Reference Create Space Independent Publishing Platform.

Lab Elective-II
3.Pharmaceutical Biotechnology Lab
LAB COURSE OUTLINE

Pharmaceutical Biotechnology	**PBT**	**BTP-815**
Course Title	Short Title	Course Code

Practical	**Hours per Week**	**No. of Weeks**	**Total Hours**	**Semester Credits**
	02	15	16	1

Course Description:
In this laboratory, course emphasis is on the understanding of basics techniques of pharmaceutical processes. The learner can use this knowledge and apply in allied branches of Biopharmaceutical and Biotechnology as required.

Prerequisite Course(s): Microbiology, Bioprocess Engineering.

General Objective:
The objective of the laboratory is to impart the fundamental knowledge of pharmaceutical processes at the research level to the students and to develop their ability to apply the analytical techniques for interpreting experimental results.

Learning Outcomes:
After successful completion of this lab student will be able to:

1. Isolate the microbes by air microbiology: solid and liquid impingement methods.
2. Apple to use coliform count of water by MPN technique.
3. To identify the sterility as per IP.
4. Studies on selective media: McConkey Agar, Cetrimide Agar, Vogel Johnson, Salt mannitol agar.
5. Study various immunology and biochemical test.
6. Estimate the antimicrobial assay of antibiotic, introduction to zone of inhibition and calculation.
7. Study Immobilization of enzymes/cells by calcium alginate/gelatin/agar.
8. Capable to isolate the DNA.
9. Determination of thermal death time and thermal death point.
10. Determination of effect of Ultra-Violet exposure on growth of E coli.

Pharmaceutical Biotechnology Lab

Semester-VIII

Teaching Scheme
Practicals -4 Hrs/week

Examination Scheme
External Sessional Exams (ESE)/Oral (OR):25 Marks.
Internal Continuous Assessment: 25 Marks.

Minimum eight experiments from the following

1. Air microbiology by solid and liquid impingement methods.
2. Coliform count of water by MPN technique.
3. Test for sterility as per IP (Injection water/ nonabsorbent cotton/soluble powder/ear drops).
4. Microbial limit test on excipients as per I.P. – Hard gelatin, tragacanth, starch, lactose
5. Studies on selective media: McConkey Agar, Cetrimide Agar, Vogel Johnson, Salt mannitol agar.
6. Antibiotic sensitivity test by disc method.
7. Widals test tube agglutination method
8. Biochemical tests (Catalase, Oxidase, Urease, Nitratase, Protease, Amylase and IMVIC).
9. Antimicrobial assay of antibiotic, introduction to zone of inhibition and calculation.
10. Immobilization of enzymes/cells by calcium alginate/gelatin/agar.
11. Isolation of DNA.
12. Selection and isolation of bacteria by replica plating.
13. Determination of thermal death time and thermal death point.
14. Effect of Ultra-Violet exposure on growth of E coli.
15. Demonstration of electrophoresis either by PAGE or Agarose gel electrophoresis.

.

Reference Books:

1. Kanai L. Mukherjee, Medical Laboratory Technology: A Procedure Manual for Routine Diagnostic Tests Tata McGraw Hill Publishing Company Ltd., New Delhi.

2. Desmond S. T. Nicholl, An Introduction to GENETIC ENGINEERING, 2nd Edition, Cambridge University Press.

3. Wulf Crueger & Anneliese Crueger, Panima, Biotechnology: A Textbook of Industrial Microbiology, 2nd Edition, Publishing Corporation, New Delhi/Bangalore.

Lab Elective-II
4.Nanobiotechnology Lab
LAB COURSE OUTLINE

Nanobiotechnology	**Nano tech**	**BTL-816**
Course Title	Short Title	Course Code

Laboratory	**Hours/week**	**No.of weeks**	**Total hours**	**Semester credits**
	02	**15**	**16**	**01**

Course Description:
In this course learner is emphasis production and to give an insight towards the experimental component in the manipulation of biomolecules, nanoparticles and bioconjugates.

Prerequisite Course(s): Biochemistry, Microbiology.

General Objective:
1. To comprehend the fundamentals of nano-bioconjugation techniques.
2. To devise protocols for analyte estimation electrochemically at the nanoscale.
3. To develop the skills in design and development of scaffolds.
4. To make the learner familiarize with designing and functionalizing at the Nanoscale.

Learning Outcomes:
After successful completion of this lab student will be able to:
1. Synthesiz the nanoparticles.
2. Use nanoparticle in drug delivery.
3. Will be able assess the toxicity of the nonmaterial.

Lab Nanobiotechnology

Semester-VIII

Teaching Scheme	**Examination Scheme**
Practical - 2 Hrs/week	External Sessional Exams (ESE)/Oral (OR): 25 Marks.
	Internal Continuous Assessment (ICA): 25 Marks.

Minimum 08 experiments shall be performed from the following:

1. Biosynthesis of Nanoparticles by Microorganisms.
2. Isolation and Bioconjugation DNA structure with Nanoparticles.
3. Determination of electrical conduction of DNA-nano conjugate.
4. Functionalization of nanoparticles for drug delivery.
5. Effect of Nanoparticles on biomolecules.
6. Methods for Studying of Toxicity of Silica-based Nanomaterials to Living Cells.
7. Quantitative estimation of Biomolecule- conjugated Quantum Dots.
8. Methods for Isolating RNA Sequences Capable of Binding to or Mediating the Formation of Inorganic Materials.
9. In Vivo Testing for Gold Nanoparticle Toxicity.
10. Amino Acid Mediated Linear Assembly of Au Nanomaterials.

REFERENCES:

1. Andrew Collins, Nanotechnology Cookbook: Practical, Reliable and Jargonfree Experimental Procedures, Elsevier, 2012.
2. Challa, Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact, Wiley – VCH, 2005.

Industrial Lecture

Industrial Lecture	**IL**	**BTP-817**
Course Title	Short Title	Course Code

Course Description:

The gap between industry's needs and the academic community's aspirations appears to be considerably large. There exists a strong feeling, at least in the academic circles, that unless technology driven initiatives find a surer place in the industrial sector in this country, the academia-industry interaction is likely to remain confined to developmental activities with limited exploratory or research-based content As institutes committed primarily to creation and growth of technological knowledge, technical institutes have an important role to play in the industrial sector of the country's economy. This fact by way of encouraging mechanisms to foster interaction between the academia and industry. Typically, academic interest in the multidimensionality of a problem leads to a tendency to explore a variety of options to arrive at a solution. This industrial lecture develops ability of student for expectations of the industrialists from the fresh engineers.

	Hours per Week	**No. Of Weeks**	**Total Hours**	**Semester Credits**
Lecture	**1**	**15**	**1**	**2**

General Objectives: The domains in which interaction is possible are:

a. Placement and entrepreneurship development.
b. Industry participation in technology development involving some exploratory work.
c. Academic intervention in solving specific industry problems.
d. Laboratory utilization by industry.
e. Continuing education programme.

Course Outcomes:

Upon successful completion of this course the students will be able to:

1. Understand need, requirement and expectation of industry from fresh engineers.
2. Understand importance of laboratory practices throughout carrier of engineer. Design and conduct experiments, as well as to analyze and interpret data.
3. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. Function on multidisciplinary teams, communicate effectively.
5. Identify, formulate, and solve engineering problems by understanding professional and ethical responsibility.
6. Recognition of the need for, and an ability to engage in life-long learning.
7. Use the techniques, skills, modern engineering tools and software necessary for engineering practice.

PROJECT- II

Project-II	**P-II**	**BTP-818**
Course Title	Short Title	Course Code

Course Description:
The course explores the knowledge of design, experiment and analysis of data. The course develops ability to work on multidisciplinary teams, Identify, formulate, and solve engineering problems in view of economic, environmental and societal context.

	Hours per Week	**No. Of Weeks**	**Total Hours**	**Semester Credits**
Laboratory	**4**	**15**	**48**	**6**

Prerequisite Course(s): Knowledge of science, mathematics, computer programming and core subject of engineering.

General Objectives: The objectives of project are to develop ability to work in group. The scope of work is design and conduct experiments, as well as to analyze and interpret data within realistic constrain such as economic, environmental, social, safety and manufacturability. The project work provides plate form for planning, material procurement, preparing specification and execution of work. The project also develop to work on multidisciplinary teams, communicate effectively and Knowledge of contemporary issues.

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

1. Apply knowledge of mathematics, science, and engineering.
2. Design and conduct experiments, as well as to analyze and interpret data.
3. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. Function on multidisciplinary teams, communicate effectively and Knowledge of contemporary issues.
5. Identify, formulate, and solve engineering problems by understanding professional and ethical responsibility.
6. Understand the impact of engineering solutions in a global, economic, environmental, and societal context.
7. Recognition of the need for, and an ability to engage in life-long and self learning.
8. Use the techniques, skills, modern engineering tools and software necessary for engineering practice.

Project-II

(Lab Course Contents)

Semester-VIII **Examination Scheme:**
Teaching Scheme: **Internal Continuous Assessment: 75Marks**
Practical : 2 Hrs/Week **End Semester Examination OR :75Marks**

- Every student of shall undertake the Project-II in semester VIII.
- Each student shall work on an approved project, a group of **05 students (maximum)** shall be allotted for the each Project-II as same group for Project-I.
- Project-II may involve fabrication, design or investigation of a technical problem that may take design, experimental or analytical character or combine element of these areas. The project work shall involve sufficient work so that students get acquainted with different aspects of fabrication, design or analysis, testing, their result and conclusion.
- Each student group is required to maintain log book for documenting various activities of Project-II.
- The three-member committee appointed by Head of the department shall be constituted for finalizing the topics of Project-II. Maximum four Project-i groups shall be assigned to one teaching staff.
- **Guide lines for ICA :** Assessment of the project for award of ICA marks shall be done jointly by the guide and departmental committee as per the guidelines given below:

Name of the Project: _____

Name of the Guide: _____

SN	Exam Seat no	Name of Student	Literature Survey	Design/ Experimentation/ Fabrication	Result and conclusion	Project Report	Presentation	Total Marks
			10	25	20	10	10	75