# SCHEME & SYLLABUS

# OF

# V & VI SEMESTERS

# B.E. BIO-TECHNOLOGY

# 2017-18

## VISION AND MISSION OF THE DEPARTMENT

**VISION:**

To provide self-reliant skilled manpower required to meet the challenges in large scale application of Biotechnology, research and development in the areas of environment, healthcare and industry for socio-economic improvement.

**MISSION:**

The Department is committed to develop proficient professionals by offering necessitate based curriculum in Biotechnology Engineering areas like plant-, animal-, microbial-, environmental- nano-biotechnology and computational biology, promoting research and innovation, centre of excellence and to train the students for higher study, life-long learning and societal responsibility. The department is also committed to provide work-ready biotech engineers and entrepreneurs, excellent learning environment to inculcate professional ethics and skills in our students and to provide engineering services to the society.

**PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)**

Within three to five years after graduation, the Biotechnology graduates will be able to achieve the following objectives.

**PEO#1**. Graduates of the program will practice Engineering profession as competent professionals using state-of-the-art knowledge and technical skills

***[Theme: Practice engineering profession as capable professionals]***

**PEO#2**. Graduates of the programme will apply the Bioengineering concepts for development of industrial applications and entrepreneurship skills to start biotech industries.

***[Theme: Team work and Entrepreneurship]***

**PEO#3.** Graduates of the programme will excel in higher education on applied science subjects and to engage in life-long learning process with effective communicative and analytical skills.

***[Theme: Higher education, Life-long learning and Communicative skills]***

**PEO#4**. Graduates of the programme will practice their profession with social and ethical responsibilities.

***[Theme: Initiated to Society and ethical practice]***

**PROGRAMME OUTCOMES (POs)**

The following is the list of programme outcomes that describes what graduates are expected to know and be able to do at the time of graduation. Graduates at graduation:

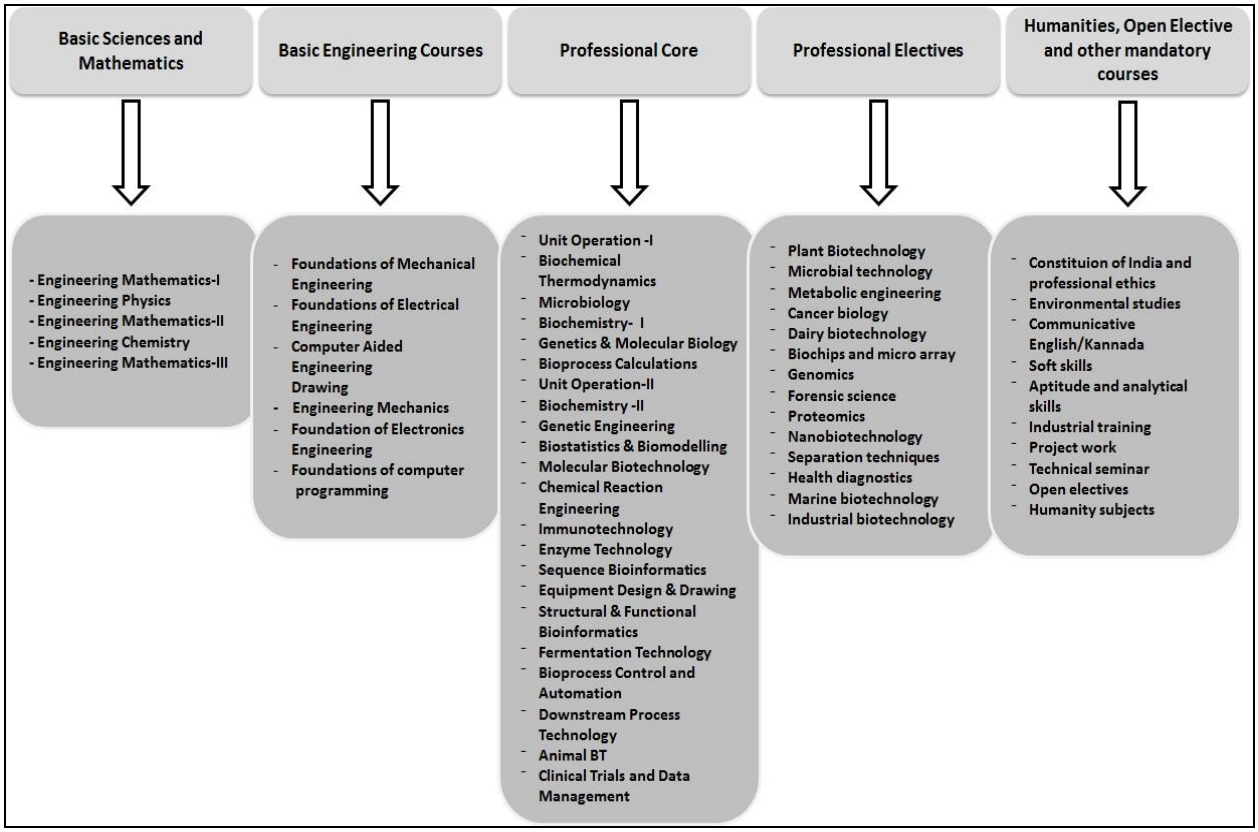
| | |
|---|---|
| **Programme Outcome I a** | Will have in depth knowledge of mathematics (through differential equations; probability and statistics; calculus) Science (physics; and general chemistry) and fundamentals of Engineering and Student will be able apply this knowledge to solve Engineering problems and design of components **[short title: Mathematics, Science and Engineering knowledge]** |
| **Programme Outcome I b** | Will be able to design and conduct experiments and to critically analyze and interpret experimental data on biotechnological components/systems **[short title: Bio Experiments]** |
| **Programme Outcome I c** | Will be able to design an engineering component/system, to meet the needs as well as constraints related to economy, environment, safety and sustainability through design experiences acquired through the curriculum **[short title: Design]** |
| **Programme Outcome I d** | Will be able to function as an individual and as a team member on multi-disciplinary tasks, that must integrate contributions from different areas of engineering towards the solution of multi-disciplinary projects **[short title: Teams]** |
| **Programme Outcome I e** | Will be able to identify, research, formulate, analyze, model and solve bio engineering problems. **[short title: Bio Engineering Problems]** |
| **Programme Outcome I f** | Will have an understanding of professional and ethical practice issues in biotechnology |

| | |
|---|---|
| | engineering. **[short title: professional and ethical responsibility]** |
| **Programme Outcome I g** | Will communicate effectively **[short title: Communication]** |
| **Programme Outcome I h** | Will have the broad understanding of the possible impact of biotechnology engineering solutions on the regional/global scenario in the context of global, environmental and sustainable issues. **[short title: Global, environmental and Sustainable problems]** |
| **Programme Outcome I i** | Will recognize the need for life-long learning. **[short title: life-long learning]** |
| **Programme Outcome I j** | Will have the knowledge of contemporary issues such as societal, legal, cultural, safety and health and their impact on biotechnological profession as they relate to biotechnology engineering problems and solutions. **[short title: Contemporary issues and Societal problem]** |
| **Programme Outcome I k** | Will be able to adopt/use the techniques, skills, and modern tools necessary for biotechnology engineering practice. **[short title: Biotechnology techniques, skills, and modern tools]** |
| **Programme Outcome I l** | Will have the knowledge of principles of project management and finance and will be able to apply this to biotechnology engineering projects **[short title: Project management]** |

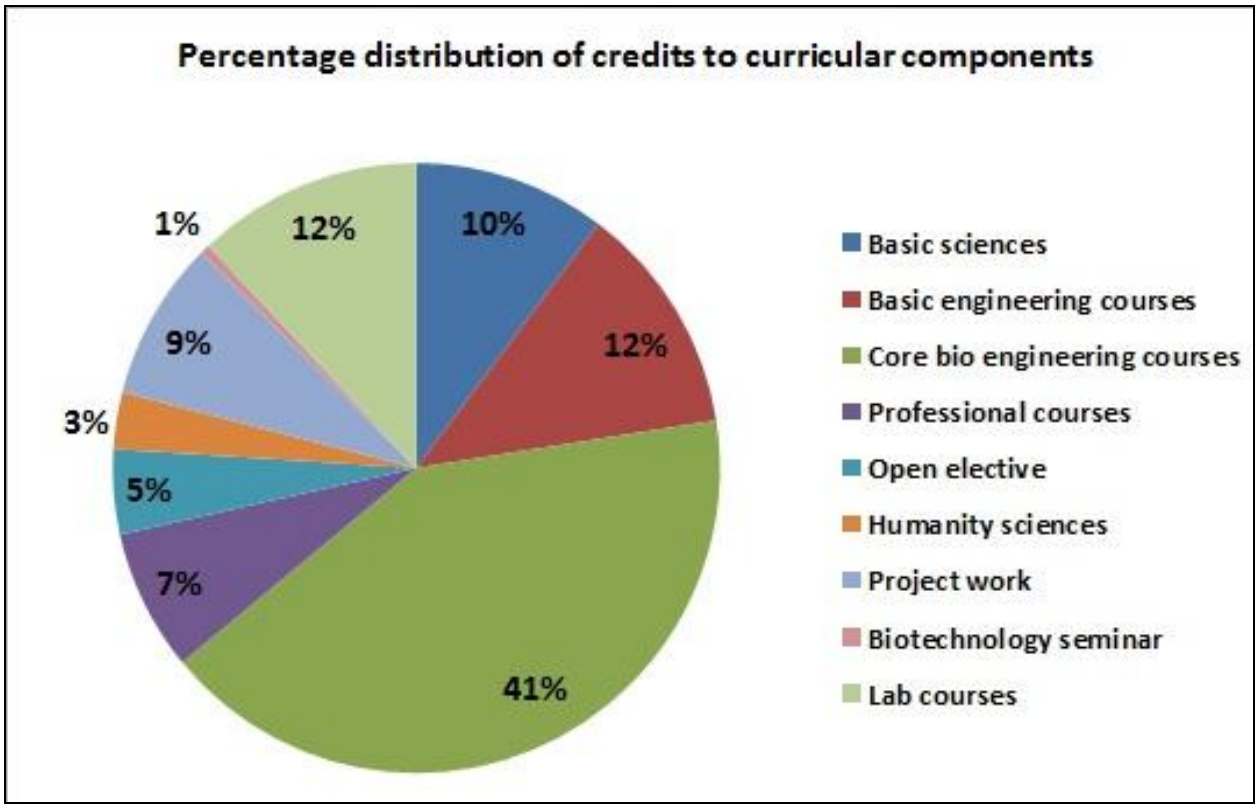
**Mapping of Programme Educational Objectives (PEOs) with Programme Outcomes (POs)**

| | PEOs | Programme Outcomes | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ia | Ib | Ic | Id | Ie | If | Ig | Ih | Ii | Ij | Ik | Il |
| PEO#1 | [Theme: Practice Engineering profession as capable professionals] | H | H | H | | H | | | | | L | H | |
| | | | | | | | | | | | | | |
| PEO#2 | [Theme: Team work and entrepreneurship] | H | H | H | H | H | L | | | | | | L |
| | | | | | | | | | | | | | |
| PEO#3 | [Theme: Higher education, Lifelong learning and Communication skills] | | | | | H | | H | | H | L | L | |
| | | | | | | | | | | | | | |
| PEO#4 | [Theme: Initiated to society and ethical practice ] | | | L | | | H | | H | | | | |
| PEO#4 | [Theme: Initiated to society and ethical practice ] | | | L | | | H | | H | | | | |

## Flowchart of core competencies:




## Distribution of credits in percentage to curricular components



**Siddaganga Institute of Technology**

**Department of Biotechnology**

**Scheme of Teaching and Examination for 2015 batch onwards**

**V Semester**

| Sl. No. | Sub Code | Title | Teaching Dept. | Teaching hours/week | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Duration (Hrs.) | C.I.E. Marks | S.E.E Marks | Total Marks | |
| 1 | HS | Humanity subject | HD | 3 | --- | --- | 3 | 50 | 50 | 100 | 3.0 |
| 2 | OE | Open Elective | OE | 3 | --- | --- | 3 | 50 | 50 | 100 | 3.0 |
| 3 | 5CCB1 | Project Engineering, Finance & Management | Che | 3 | 1 | --- | 3 | 50 | 50 | 100 | 3.5 |
| 4 | 5CCB2 | Chemical Reaction Engineering | Che | 3 | 1 | --- | 3 | 50 | 50 | 100 | 3.5 |
| 5 | 5BT05 | Bioinformatics | BT | 4 | -- | --- | 3 | 50 | 50 | 100 | 4.0 |
| 6 | 5BT06 | Industrial Biotechnology | BT | 3 | 1 | --- | 3 | 50 | 50 | 100 | 3.5 |
| 7 | 5BT07 | Biodegradation of Xenobiotics | BT | 4 | --- | 0 | 3 | 50 | 50 | 100 | 4.0 |
| 8 | 5BTP01 | Mini Project | BT | --- | --- | 2 | 2 | 50 | 50 | 100 | 0 |
| 9 | 5BTL04 | Bioinformatics Laboratory | BT | --- | --- | 3 | 3 | 50 | 50 | 100 | 1.5 |
| 10 | MC06 | Soft Skills | --- | --- | --- | --- | --- | 50 | 0 | 100 | 0 |
| | | | **Total** | **23** | **3** | **5** | | | | | **26** |

**Siddaganga Institute of Technology**
**Department of Biotechnology**
**Scheme of Teaching and Examination for 2015 batch onwards**
**VI Semester**

| Sl. No. | Sub Code | Title | Teaching Dept. | Teaching hours/week | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Duration (Hrs.) | C.I.E. Marks | S.E.E Marks | Total Marks | |
| 1 | HS | Humanity subject | HD | 3 | --- | --- | 3 | 50 | 50 | 100 | 3.0 |
| 2 | OE | Open Elective | OE | 3 | --- | --- | 3 | 50 | 50 | 100 | 3.0 |
| 3 | 6BT04 | Immunotechnology | BT | 4 | --- | --- | 3 | 50 | 50 | 100 | 4.0 |
| 4 | 6BT05 | Bioreactor Design and Analysis | Che/BT | 4 | --- | --- | 3 | 50 | 50 | 100 | 4.0 |
| 5 | 6BT08 | Research Methodology, Biosafety and Bioethics | BT | 4 | --- | --- | 3 | 50 | 50 | 100 | 4.0 |
| 6 | 6BTE01._ | Professional Elective | BT | 3 | --- | --- | 3 | 50 | 50 | 100 | 3.0 |
| 7 | 6BTP01 | Mini Project | BT | --- | --- | 3 | 3 | --- | --- | --- | 2.0 |
| 8 | 6BTL03 | Chemical Reaction Engineering Laboratory | BT | --- | --- | 3 | 3 | 50 | 50 | 100 | 1.5 |
| 9 | 6BTL04 | Bioanalytics Laboratory | BT | --- | --- | 3 | 3 | 50 | 50 | 100 | 1.5 |
| 10 | 6BTIT | Industrial Training | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | | **Total** | **21** | **0** | **9** | | | | | **26** |

Professional Elective:

6BTE011 Marine Biotechnology 6BTE012 Dairy Biotechnology 6BTE014 Enzyme Technology

## PROJECT ENGINEERING AND FINANCIAL MANAGEMENT

| | | | |
|---|---|---|---|
| Contact Hours/ Week | : 3 (L) + 1 (T) | Credits : | 3.5 |
| Total Lecture Hours | : 39 | CIE Marks : | 50 |
| Total Tutorial Hours | : 13 | SEE Marks : | 50 |
| Sub. Code | : 5CCB1 | | |

**Prerequisites:** Mathematics

**Course objectives:**

- To Learn function and success of project management.
- To Know the financial management and financial systems.
- To understand the analysis of cost estimation.
- To know the time value of money, tames and fixed charges.
- To understand probability, alternative investments and replacements

**Course Outcomes**:

On completion of this course students will be able to:

- List the different project site considerations [L1].
- Outline the functions and organization of the financial system [L2].
- Estimate fixed and working capitals and operating costs for process plants [L5].
- Evaluate the profitability of process industry projects using different measures [L4].

### UNIT – I

**Projects and Project Management:** The function of project management, Projects – management, initiation, risks, objectives, and success. **Project Site Considerations:** Plant location and site selection, Site layout, Plant layout, Utilities, Environmental considerations.

**7 Hrs**

### UNIT – II

**Financial Management:** Forms of business organization, financial decisions in a firm, Goal of financial management, Building blocks of modern finance, Organization of finance function.

**The Financial System:** Functions, Financial assets, financial markets, financial market returns, financial intermediaries, Regulatory infrastructure, Growth and trends in the Indian financial system. Numerical Conceptuals.

**8 Hrs**

**UNIT – III**

**Analysis of Cost Estimation:** Cash flow for industrial operations, Factors affecting investment and production costs, Capital investment, Estimation of capital investment, Cost indexes, Cost components in capital investment, Methods for estimating capital investment, Estimation of revenue, Estimation of total production cost, Gross profit, Net profit, and Cash flow, Contingencies. Numerical Conceptuals

**8 Hrs**

**UNIT – IV**

**Interest, Time Value of Money, Taxes, and Fixed Charges:** Interest, Cost of capital, Time value of money, Cash flow patterns, Compounding and discounting factors, Income taxes, Fixed charges.

**Analysis of Financial Statements:** Financial ratios, DuPont analysis, standardized financial statements, Applications of financial statement analysis. Numerical Conceptuals

**8Hrs**

**UNIT – V**

**Profitability, Alternative Investments, and Replacements:** Profitability standards, Methods for calculating profitability, Alternative investments, Replacements, Practical factors in alternative investment and replacement analysis. Numerical Conceptuals

**8 Hrs**

**TEXT BOOKS:**

| | | |
|---|---|---|
| **1.** | Peters, M.S., Timmerhaus, | K.D., & West, R.E. (2003) Plant Design and Economics for Chemical Engineers, Fifth Edition. Tata McGraw-Hill Education Private Limited, New Delhi. |
| **2.** | Prasanna Chandra | 2015 Financial Management: Theory and Practice, Ninth Edition. McGraw-Hill Education (India) Private Limited, New Delhi. |

**REFERENCE BOOKS:**

| | | |
|---|---|---|
| **1.** | Smith, N.J. | 2002 Engineering Project Management, Second Edition. Blackwell Science Limited, Oxford, UK. |
| **2.** | Mahajani, V.V. & Mokashi S.M | 2015 Chemical Project Economics, Second Edition. Trinity Press, New Delhi. |

**CHEMICAL REACTION ENGINEERING**

| | | | |
|---|---|---|---|
| Contact Hours/ Week | : 3 (L) +1 (T) | Credits : | 3.5 |
| Total Lecture Hours | : 39 | CIE Marks : | 50 |
| Total Tutorial Hours | : 13 | SEE Marks : | 50 |
| Sub. Code | : 5CCB2 | | |

**Prerequisites:** Transport process, Process calculations, Thermodynamics

**Course objectives:**

- To understand the rate mechanism of reactions
- To learn rate kinetics of various types of reactions
- To design of isothermal reactors for single and multiple reactions
- To know nonisothermal reactor

**Course Outcomes**

At the end of the course the students will be able to:

- Develop rate expressions from elementary step mechanisms using steady-state and quasi-equilibrium approximations [L4].
- Determine rate expressions by analyzing reactor data including integral and differential analysis on constant- and variable-volume systems [L3].
- Derive batch, CSTR, and PFR performance equations from general material balances and to size and do performance calculations on single, isothermal plug-flow, CSTR, and batch reactors for a single homogeneous reaction given either rate data cor a rate expression [L5].
- Explain the kinetics of multiple reactions and their influence on product yield and selectivity and select and size isothermal reactors for series and/or parallel systems of reactions and to design systems of multiple isothermal reactors [L2].
- Apply the concepts of heat capacity, latent heat, heat of reaction, heat of combustion, and heat of formation [L3].
- Design the reactors for non-isothermal operating conditions [L6]

**UNIT – I**

**Kinetics of Homogeneous Reactions: Concentration-dependent term of a rate equation:** (Single and Multiple reactions, Elementary and Nonelementary Reactions, Molecularity and order of reaction, Rate Constant, Representation of elementary reaction, Representation of

Nonelementary reactions, Kinetic Models of Nonelementary Reactions, Testing Kinetic Models) **Temperature-dependent term of a rate equation** (Temp. dependency from Arrhenius law, Collision theory, Transition state theory, Thermodynamic approach, Activation Energy) **10 Hrs**

**UNIT – II**

**Interpretation of Batch Reactor Data: Constant-Volume batch Reactor**: Analysis of Total pressure data , Integral Method of Analysis of Data(Irreversible I order Reactions, II order, nth order, Zero-order, Overall order of Irreversible reactions from the half-life, Irreversible Reactions in parallel, Homogeneous catalyzed reactions, Auto catalytic reactions, Irreversible Reactions in series, First order reversible reactions, Reactions of shifting order) Differential method of analysis of data. **Varying-Volume batch Reactor** (Zero order, First order, Second order Reactions) **11 Hrs**

**UNIT – III**

**Ideal Reactors for a Single Reaction:** Ideal Batch Reactor, Space-Time and Space-Velocity, Mixed flow reactor, Plug flow Reactor, Holding time and space time for flow reactors. General features of reactors. **Design for Single Reactions:** Size comparison of single reactors, Multiple-Reactor systems (PFR in series and/or in parallel, Equal size MFR in series, Reactors of different types in series), Recycle Reactor **11Hrs**

**UNIT – IV**

**Multiple Reactions:** Design for Parallel Reactions Qualitative Discussion about product distribution, Contacting patterns for reactions in parallel, Operating conditions for parallel reactions. **Design for Series Reactions** First order irreversible reactions in series, Qualitative discussion about product distribution, Quantitative treatment, Plug flow or batch reactor, Quantitative treatment, mixed flow reactor. **Design for Series-Parallel Reactions** Two-step irreversible series-parallel reactions, Quantitative treatment, plug flow or batch reactor, Quantitative treatment, mixed flow.

**10Hrs**

**UNIT – V**

**Temperature and Pressure effects**: Single reactions- heats of reaction from thermodynamics, heats of reaction and temperature, equilibrium constants from thermodynamics, equilibrium conversion, general graphical design procedure, optimum temperature progression, heat effects, adiabatic operations, non adiabatic operations, comments and extensions.

**10Hrs**

**TEXT BOOKS**

| | | |
|---|---|---|
| 1 | Octave Levenspiel | Chemical Reaction Engineering, 3e Wiley Publisher |
| 2 | J.M. Smith | Chemical Engineering Kinetics, McGraw Hill |

**REFERENCE BOOK**

| | | |
|---|---|---|
| 1 | Fogler H Scott | Elements of chemical Reaction Engineering, PHI, new Delhi |
| 2 | Ronald, Charles, Bradley | Introduction to Chemical Reaction Engineering and kinetics-Wiley Publisher |

## BIOINFORMATICS

| | | | | | |
|---|---|---|---|---|---|
| Contact Hours/ Week | : | 4 | Credits | : | 4 |
| Total Lecture Hours | : | 52 | CIE Marks | : | 50 |
| Subject Code | : | 5BT05 | SEE Marks | : | 50 |

**Prerequisites**

- Knowledge in Cell biology, Molecular biology and Genetics are an added advantage.
- The students must be good in Computers and Information Technology

**Course Learning Objectives**

- To learn about bioinformatics and gain understanding lab and research techniques using molecular biology methods
- To become knowledgeable about storage, retrieval, sharing and using biological data, information and tool
- To understand algorithms, Mathematical and statistical models for sequence analysis.
- To study the principles underlying Protein secondary and tertiary structure prediction in computational approach.
- To study the various applications of Structural and Functional Bioinformatics and Bioinformatics in agriculture, industry, medicine and environmental protection

**Course outcomes**

A student who has met the objectives of the course will be able to:

- **Describe** the various types of biological database and tools (L2)
- **Develop** algorithms of sequence alignment (pair-wise and multiple) and understating the scoring algorithms (L5)
- **Employ** the information in gene prediction and phylogenetic Analysis (L3)
- **Analyse** and understating of protein structure prediction and validation. (L3)
- **Describe** the applications of bioinformatics in life sciences (L2)

### UNIT – I

**Introduction to bioinformatics and biological database**

Introduction to Bioinformatics: Goal, Scope and Application. Introduction to Database: Types of database (Object-Oriented Databases and RDBMS). Biological Database: Need of biological database, Sequence and Structure database – (NCBI, EMBL, DDBJ, and PDB), other databases -KEGG, PubMed, OMIM, PubChem, NCI, ZINC, Drug Bank. Format of Databases: GenBank and PDB flat file. Protein Structure

Visualization: RasMol, PyMol, Jmol, CN3D, Swiss PDB viewer, Chimera and Discovery Studio visualizer. Protein Structure Comparison: Intra-molecular Method, Intermolecular method. Protein Structure Comparison: SCOP and CATH.

**9 Hrs**

**UNIT – II**

**Sequence alignment and motif, domain prediction**

Pairwise Alignment: Dot Matrix Method, Dynamic programming - (Local and Global Alignment), POA Alignment. Scoring Matrices: Amino acid scoring matrices, PAM, BLOSUM. Database Similarity Searching: FASTA and BLAST, BLAST variants, BLAST output format. Multiple Sequence Alignment: Scoring function, Exhaustive algorithms, and Heuristic algorithms. PSSM, Hidden Markov Model. Protein Motif and Domain Prediction: Motif and Domain Databases PROSITE. Sequence Logos and Web-logo.

**11 Hrs**

**UNIT – III**

**Gene and promoter prediction and phylogenetic**

Gene Perdition in Prokaryotes: Conventional determination of Open Reading Frames (ORF), Markov model and HMM. Gene Prediction in Eukaryotes: An Initio based program, Neural Networks. Promoter and Regulatory Element Prediction: Prokaryotes and Eukaryotes. Introduction to Phylogenetic: Phylogenetic Basics, Terminologies. Phylogenetic Tree construction Methods: Distant based method - (UPGMA, NJ) Character Based Method – (MP and ML), Phylogenetic Tree Evaluation: Bootstrapping.

**11 Hrs**

**UNIT – IV**

**Protein structure prediction and molecular dynamics**

Secondary Structure predication: Globular Proteins: Ab-Inition, Homology Based, Neural networks method. Transmembrane Proteins: Prediction of Helical membrane, β-barrel membrane proteins. RNA Structure Prediction: Ab Initio approach, dot matrices. Tertiary Structure predication: Homology modeling: Model refinement, model evaluation, homology model databases. Threading and fold recognition, CASP. Introduction of Molecular Modeling: Coordinate system, potential energy. Force Filed: Types of force fields: Amber force field, CHARMM force field. Introduction about Molecular Dynamics (GROMACS).

**11Hrs**

**UNIT – V**

**Application of bioinformatcs**

Bioinformatics in pharmacy: Drug Discovery Process, Structure based and Ligand based drug design (CADD). Pharmacokinetics: Absorption, Distribution, Metabolism, Excretion and Toxicity of drugs. Bioinformatics in Genomics: Human Genome Project, software's for Genomics. Bioinformatics in Metabolomics: Online databases and pipelines for metabolomics, software for metabolomics. Bioinformatics in agriculture: Meta Genomics: Crops, Insect Resistance, Nutritional Quality and Abiotic Stress Tolerance.

**10Hrs**

**TEXT BOOKS:**

| | | |
|---|---|---|
| **1.** | David W Mount | "Bioinformatics sequence and Genome analysis", Second Edition, Cold Spring Harbor Laboratory Press, 2013. |
| **2.** | Jin Xiong | Essentials Bioinformatics, Cambridge university press, 2006 |

**REFERENCES:**

| | | |
|---|---|---|
| **1.** | Neil C. Jones and Pavel A. Pevzner | "An Introduction to Bioinformatics Algorithms", MIT Press, 2005. |
| **2.** | Steffen Schulze-Kremer | "Molecular Bioinformatics: Algorithms and Applications", Walter de Gruyter, 1996 |
| **3.** | Attwood T K, D J Parry-Smith | "Introduction to Bioinformatics", Pearson Education, 2005. |

## INDUSTRIAL BIOTECHNOLOGY

| | | | |
|---|---|---|---|
| Contact Hrs./ Week | : 3 +1 (L+T) | Credits : | 3.5 |
| Total Lecture Hrs. | : 39 | CIE Marks : | 50 |
| Total Tutorial Hours | : 13 | | |
| Sub. Code | : 5BT06 | SEE Marks : | 50 |

**Prerequisites:** Biochemistry, Microbiology

**Course objectives:** The course will help to:

- Introduce the concept of Biotechnology industry and the players involved
- Highlight the importance and methods involved in screening of industrial important microorganisms.
- Give an insight to manage metabolic processes at both molecular, cell and engineering level.
- Provide a knowledge on mechanisms enabling microorganisms to produce useful industrial products of microbial origin
- Discuss the concepts of environmental biotechnology.
- Give an insight to Biofuels, production and scope
- Understanding of Genetically modified organisms (GMO)

**Course outcomes**: Upon completion of this course, the students will be able to:

- Understand the methods involved in isolation and screening of potential microorganisms to produce industrial bioproducts. (L2)
- Analyze the different metabolic pathways and its metabolism to produce desired processes. (L4)
- Evaluate appropriate mechanism of microbiological processes to produce microbiological products. (L5)
- Apply the principles of Biofuel production.(L3)
- Analyze the need for GMO products and scope. (L4)

### UNIT-I

**Introduction to Industrial Biotechnology:** Introduction to Biotechnology industry, history of industrial biotechnology, the scope and impact of industrial biotechnology. The shift from antibiotics to pharmacological agents, the biopharmaceutical revolution, recombinant hosts, genome sequencing and functional genomics. Market drivers for industrial biotechnology. Global market: size and growth rate. Case studies: Biocon Limited and SciGenom Labs.

**Introduction to fermentation process:** An introduction to fermentation processes - the range of fermentation processes. Microorganisms used in industrial microbiological processes - the isolation, preservation, Screening for Productive Strains and Strain Improvement in Biotechnological Organisms – Manipulation of the genome of industrial organisms. Use of recombinant system for the improvement of industrial microorganisms. Media and materials required for industrial microbiological processes - sources, formulation, antifoams and optimization.

**10 Hrs**

**UNIT -II**

**Metabolic Pathways for the Biosynthesis of Industrial Product**s: The Nature of Metabolic Pathways, Industrial Microbiological Products as Primary and Secondary Metabolites, Trophophase-idiophase Relationships in the Production of Secondary Products, Role of Secondary Metabolites in the Physiology of Organisms, Pathways for the Synthesis of Primary and Secondary Metabolites of Industrial Importance. Carbon Pathways for the Formation of Some Industrial Products Derived from Primary Metabolism. Case study and numerical concepts.

**10 Hrs**

**UNIT-III**

**Industrial Biotechnology in the Chemical and Pharmaceutical Industries**:

Carbon pathways for the formation of products of microbial secondary metabolism. Mechanisms enabling microorganisms to avoid overproduction of primary metabolic products through enzyme regulation. Bypassing of regulatory mechanisms for the over-production of primary metabolites. Regulation of overproduction in secondary metabolites. Industrial products produced by microorganisms - enzymes (amylase, proteases), organic acids (lactic acid, citric acid, vinegar), ethyl alcohol. Production of important antibiotics - penicillin, cephalosporins, streptomycin, erythromycin, bacitracin, other beta-lactam antibiotics and tetracyclines. Production of vitamins B12 & Baker's yeast production and hormones. Microbial transformation of Steroids and sterols. Case study and numerical conceptual.

**12 Hrs**

**UNIT-IV**

**Biofuels Industry**

Introduction to Biofuels, Present Conversion Pathways, Biodiesel Production from Vegetable Oils and Fats: Esterification Processes, Properties of Vegetable Oil Esters, Hydrogenation Processes. Ethanol and

ETBE Production: Ethanol Production from Sugar and Starch, ETBE Production, Properties of Ethanol and ETBE. The Need for New Developments, Lignocellulosic Biomass Resources, Production of Ethanol from Lignocellulosic Biomass: Overall Conversion Scheme, Biomass Pretreatment, Enzymatic Hydrolysis, Fermentation of Glucose and Pentoses. Production of Biofuels Through the Thermochemical Pathway: Present Status, Pyrolysis and Torrefaction, Production of Synthesis Motor Fuels from Biomass, Biorefineries, Biofuels and Sustainability. **10 Hrs.**

**UNIT-V**

**Environmental, Economic Aspects and Societal issues**

Introduction, Generic approach: Methodology, Process Design of Industrial Biotechnology Routes, Technology Assumptions for Industrial Biotechnology Routes, Energy Use. Environmental Impacts Methodology: System Boundaries, Allocation and System Expansion, Production of Fermentable Sugar. Life Cycle Inventory, Environmental Indicators, Process Economics, Prices of Fermentable Sugars, Prices of Utilities and Auxiliaries, Overall Results, Results of Environmental Analysis, Results of Economic Analysis.

**Societal Issues in Industrial Biotechnology:** The Impact of Industrial Biotechnology: the influence on society, political, industrial, economic, and scientific drivers and obstacles. Public Perceptions of Industrial Biotechnology: Present Public Perception of Industrial Biotechnology, Public Perception to Policy Development. Industrial Reactions to Labeling of GM Food Products, Development of Public Interaction. Criteria for Communication, Novel Approaches to Communication. A Case Study – Bt cotton and GMO insulin.

**10 Hrs.**

**TEXT BOOKS:**


| | | |
|---|---|---|
| 1 | Prescott and Dunn | Industrial Microbiology Agrobios (India)-First edition, agrobios,2006 |
| 2 | L.E.Casida | Industrial Microbiology- First edition, New age international (p) Ltd. 2007. |
| 3 | Wim Soetaert and Erick J. Vandamme | Industrial Biotechnology. Sustainable Gwoth and Economics. 2nd Edition. Wiely-VCH. April 2010 |
| 4 | P.F.Stanburry and A. Whitaker | Principles of Fermentation Technology, 2nd edition, Elsevier publications, 2007. |

## BIOREMEDIATION OF XENOBIOTICS

| | | |
|---|---|---|
| Contact Hrs./ Week | : 4 | Credits : 4 |
| Total Lecture Hrs. | : 52 | CIE Marks : 50 |
| Total Tutorial Hrs. | : 0 | SEE Marks : 50 |
| Sub. Code | : 5BT07 | |

**Prerequisites**: Microbiology, Molecular Biology

**Course objectives**:

- To recognize the various global and regional environmental concerns due to natural causes and/or human activities, and the impact of these on various forms of life including native biodiversity.
- To enable students to acquire comprehensive knowledge of environmental biotechnological processes for wastewater treatment, bioremediation, bioenergy production and metal recovery.
- To know the basic physiology of a microorganism and how their structure dictates their function in the environment.
- To understand the bases for microbial metabolism of environmental contaminants.
- To know various techniques to modify and augment microorganisms in the laboratory and environment.
- To understand the principles of bioremediation and Phytoremediation.

**Course outcomes**:

A student who has met the objectives of the course will be able to:

- Identify the ever-increasing complexity and interrelated nature of current environmental problems as well as the advantages of biotechnological treatment of wastes.(L2)
- Explain recent developments in environmental biotechnologies for monitoring and maintaining the environment and the sustainability of environmental industries.(L2)
- Acquired skills to tackle the problems and apply scientific principles to invent biotechnologies such as biological treatment and bioremediation that would provide solutions to the real-life problems. (L3)
- Recognise and apply environmental biotechnology approaches needed in environmental engineering practice. (L6)

- Address important topics with respect to modern trends in biotechnology, such as treatment and disposal of bio solids, Industrial Wastewater treatment.(L6)

**UNIT I**

Bioremediation – Definition, approaches to bioremediation, environmental modification, microbial seeding. Bioengineering approaches to the bioremediation of pollutants – engineering of bioremediation processes – needs and limitations. Xenobiotics, biodegradation of lignin, hydrocarbons, plastic, biodeterioration of paper, textile, leather, wood, mode of deterioration, organisms involved, mode of prevention.

**12 Hrs**

**UNIT II**

Bioremediation of contaminated soils – diversity and magnitude of soil contaminants, criteria for bioremediation, biological mechanism of transformation strategies for bioremediation, case studies of bioremediation strategies. Biodegradable organic pollutants, aerobic and anaerobic bacterial degradation, cometabolic degradation, degradative capacities of fungi.

**10 Hrs**

**UNIT III**

Bioremediation of various ecosystems – Bioremediation of contaminated water (soil slicks, heavy metals), bioremediation of industrial wastes (sugar, distillery, textile, leather, dyestuff, paper and pulp manufacturing industries), bioremediation of air pollutants.

**8 Hrs**

**UNIT IV**

Bioaerosols, biofiltration, environmental consequences of trace elements, heavy metals, pathogens, odour and volatile organic compounds. Microbial control of environmental pollution – role of genetic engineering in environmental pollution abatement, catabolic plasmids as natural vectors, genetic engineering of genes for augmenting pollution abatement in microbes and plants, use of immobilized microbes for waste recycling, immobilized enzymes in pollution abatement.

**12 Hrs**

**UNIT V**

Exploitation of agricultural wastes for food, feed and fuel, humus formation, sludge composting, vermicomposting, aerobic composting, anaerobic composting. Introduction to phytoremediation, phytoextraction,

phytostabilization, phytoremediation of inorganics, translocation mechanisms for inorganics, plant accumulation.

**10 Hrs**

**TEXT BOOKS**

| | | |
|---|---|---|
| 1 | Surajit Das | Microbial Biodegradation and Bioremediation, 1st Edition, Elsevier |
| 2 | D. K. Maheshwari and R. C. Dubey | Bioremediation of Pollutants Hardcover I K International Publishing House Pvt. Ltd; First Edition edition |
| 3 | Martin Alexander | Biodegradation and Bioremediation, Second Edition 2nd Edition |

**REFERENCE BOOKS**

| | | |
|---|---|---|
| 1 | Ronald L. Crawford and Don L. Crawford | Bioremediation: Principles and Applications (Biotechnology Research) Revised ed. Edition. |
| 2 | Jeffrey Talley | Industrial MicrobiBioremediation of Recalcitrant Compounds 1st Edition |

## MINI –PROJECT

| | | | |
|---|---|---|---|
| Contact Hrs./ Week | : 02 | Credits : | 0 |
| Sub. Code | : 5BTP01 | | |

Mini-project work will be started at the beginning of the semester. The students are doing the literature, prerequired experiments in connected to the projects allotted/selected by them. Students have to give the presentation on progress of Mini-project work once in a month. The progress of the Miniproject will be evaluated by the Department Project Evaluation Committee (DPEC).

## BIOINFORMATICS LABORATORY

| | | | |
|---|---|---|---|
| Lab Hrs./ Week | **: 3** | CIE Marks | **: 50** |
| Sub. Code | **: 5BTL04** | SEE Marks | **: 50** |
| Credits | **: 1.5** | | |

***Course Learning Objectives***

- To learn how to use Entrez search engine to retrieve nucleotide/protein sequence data
- To learn how to retrieve articles from PubMed of NCBI
- To learn how to retrieve structural data of a protein using PDB database
- To study the functional and evolutionary relationships between different sequences
- To visualize the secondary and tertiary structure of a protein.
- To visualize the ligand molecules and understating the biological activates.

***Course outcomes***

A student who has met the objectives of the course will be able to:

- **Describe** the various types of biological database and tools (L2)
- **Employ** the information in gene prediction and protein Analysis (L3)
- **Utilize** Biological information from public databases, given a particular problem in biotechnology, medicine or Biology (L3)
- **Outline** the concepts of Protein Structure prediction techniques (L1)
- **Describe** the applications of Structural and Functional Bioinformatics in Drug Discovery (L2)

LABORATORY EXPERIMENTS

1. Scientific article retrieval from bibliography database and working with referencing format
2. Physicochemical properties of Nucleic acid and Protein using online and commercial software's.
3. Sequence retrieval from Nucleic Acid and Protein databases and Pair wise sequences comparison.
4. Sequence (FASTA and BLAST) searches – Analysis of parameters affecting alignment.
5. Multiple sequences alignment and Protein and DNA motif searches.
6. Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees.
7. Gene Prediction for Prokaryotes and Eukaryotes genome.
8. Bio-molecules structure visualization and analysis using free and commercial software's.
9. Predict secondary structures of Globular and Membrane proteins.
10. Predict tertiary structures and validation - using online and commercial software's.
11. Ligand design using Marvin sketch and identification of biological activity using PASS Server.
12. Molecular Docking using Autodock and LeadIT.
13. Demo: Molecular Simulation using GROMACS.
14. Demo: Molecular Simulation using Discovery Studio 3.5.

**TEXT BOOKS:**

| | | | |
|---|---|---|---|
| 1 | David W Mount | Bioinformatics: Sequence and Genome Analysis, 2nd edition | Cold Spring Harbor Laboratory Press, (2001). |
| 2 | Jin Xiong | Essentials Bioinformatics | Cambridge university press, (2006). |
| 3 | Andreas D. Baxevanis, B. F. Francis Ouellette | Bioinformatics A Practical Guide to the Analysis of Genes and Proteins | Wiley-Inter science (2001). |

**REFERENCE BOOKS:**

| | | | |
|---|---|---|---|
| 1 | Smith DW | Bio-computing Informatics and the Genome Projects | Academic Press, (1993). |
| 2 | Durbin, Eddy, Krogh, and Mitchison | Biological Sequence Analysis | Allied Publishers, (1998). |

# VI Semester Syllabus
# 2017-18

## IMMUNOTECHNOLOGY

| | | | |
|---|---|---|---|
| Contact Hrs./ Week | : 4 | Credits : | 4 |
| Total Lecture Hrs. | :52 | CIE Marks : | 50 |
| Sub. Code | :6BT04 | SEE Marks : | 50 |

**Prerequisites:** Biochemistry and Microbiology

**Course objectives:**

- To study the types of immune responses presented by the human body
- To understand the importance of B-cell and T-cell differentiation
- To find out the role of macrophages as the killing agents
- To learn about the hypersensitivity reactions
- To know about the causes of autoimmune diseases, clinical manifestations and their treatment
- To understand the immunological techniques like ELISA, Immunofluorescence.

**Course outcomes:**

A student who has met the objectives of the course will be able to:

- Explain the defensive mechanism present in the human body (L2)
- Describe how body is going to be protected by various infections caused by bacteria, viruses etc. (L2)
- Implement PCR reactions for production of genetically engineered cells (L3)
- Develop monoclonal antibodies (L6)
- Perform Blood typing (L3)

### UNIT-I

**The Immune System:** Introduction, anatomy of immune system, cells and organs of the immune system - Primary and secondary Lymphoid organs, antigens, Different Characteristics of Antigens, Mitogens, Hapten, Immunogen, Adjuvants.

**Classification of Immune Responses:** Types of immune responses – Racial, special and individual, Classification of immune system – innate - Skin and mucosal surface, Physiological Barriers, Phagocytic Barriers, Inflammation and adaptive immunity.

**10 Hrs.**

### UNIT-II

**Humoral Mediated Immunity:** B-lymphocytes and their activation - T-cell dependent activation and T-cell independent activation; structure and function of immunoglobulins, immunoglobulin classes and subclasses,

idiotypes and anti-idiotypic antibodies, genetic control of antibody production

**Cell-Mediated Immunity:** Thymus derived lymphocytes (T cells) - their ontogeny and types- $T_H$ cells, $T_S$ cells, Tc cells and $T_D$ cells, mechanisms of T cell activation ,MHC Complex – Structure, classification and its biological role, antigen presenting cells (APC) – professional and non professional, macrophages, dendritic cells, langerhans cells, mechanism of phagocytosis, Antigen processing and presentation – classI and class II MHC.

**12 Hrs.**

**UNIT-III**

**Immune Regulation and Tolerance:** Complement activation - classical , properdin and lectin pathway and their biological functions – complement fixation test, cytokines and their role in immune response, immunotolerance and its types - Low zone, High zone, Classical and Infectious tolerance, Theories of Tolerance Induction – central and peripheral, Hypersensitivity its types - immediate and delayed type; Coombs' and Cell classification, and treatment.

**Immunological Disorder:** Autoimmune disorders and types - Systemic autoimmune diseases and Localized autoimmune diseases, pathogenic mechanisms, treatment, experimental models of auto immune disease, primary and secondary immunodeficiency disorders – primary and secondary, mechanism of AIDS, rheumatoid arthritis and allergies.

**10 Hrs.**

**UNIT-IV**

**Transplantation Immunology:** Immunological basis of graft and its types - autograft, allograft, isograft and xenograft, types – hyperacute, acute and chronic, and mechanism of graft rejection, role of HLA in graft rejection; cellular and molecular mechanism – direct and indirect presentation, tissue typing, immunosuppression - definition and immunosuppressive drugs – glucocorticoids, cytostatics, antibodies and drugs on immunophilins. **Tumor of the Immune System:** tumor specific antigens and its types – TSA and TAA, tumor potent immune response – NK cells and Macrophages.

**10 Hrs.**

**UNIT-V**

**Molecular Immunology:** Basic concepts of vaccine design and development Vaccines and their types, production of recombinant-DNA vaccines. Catalytic antibodies, application of PCR technology to produce antibodies, immunotherapy with genetically engineered antibodies. Production of monoclonal and polyclonal antibodies and their applications. Stem cells isolation, culturing and applications to immunology.

**Immunological Techniques:** Antigen antibody interaction – Precipitation reactions, Agglutination reactions, Blood typing, A, B, ABO & Rh, principles and applications of ELISA, Radioimmunoassay (RIA), immuno-electrophoresis, Immunofluorescence, chemiluminescence assays.

**10 Hrs.**

**TEXT BOOKS:**

| | | |
|---|---|---|
| 1 | Tizard | Immunology an Introduction, Thomson 2004. |
| 2 | J Kubey | Immunology,2003, WH Freeman. |
| 3 | Ashim K Chakravarthy | Immunology & Immunotechnology, Oxford University Press |

**REFERENCE BOOKS:**

| | | |
|---|---|---|
| 1 | Roitt I | Essential Immunology, Blackwell Scientific Publications, Oxford, 1991. |
| 2 | Benjamini E | Molecular Immunology, 2002. |
| 3 | Benjamini E. and Leskowitz S | Immunology A short course, Wiley Liss, NY, 1991. |
| 4 | Peter Parham | The Immune System, Garland Science, 2005 |
| 5 | Peter Wood | Understanding Immunology, Pearson Education, II edition, 2006 |

## BIOREACTORS ANALYSIS AND DESIGN

| | | | |
|---|---|---|---|
| Contact Hrs./ Week | : 4 | Credits : | 4 |
| Total Lecture Hrs. | :52 | CIE Marks : | 50 |
| Sub. Code | : 6BT05 | SEE Marks : | 50 |

**Prerequisites:** Engineering Mathematics, Transport Processes, Chemical Reaction Engg.

**Course objectives:**

- To introduce the concept of Bioreactor- its functions and operations
- To provide the various types of Bioreactors for different configurations, and its applications in all the field of Biotechnology
- To sterilize bioreactors and mechanism involved in different types of sterilization
- To develop the model for bioreactors from basic fundamental heat, mass and microbial equations
- To study the transport process and mechanical aspects of Bioreactors

**Course Outcomes:**

Upon completion of this course the student will be able to:

- Explain the definition of Bioreactors, types and its function and operation. (L3,L1)
- Evaluate the sterilization time and death kinetics of different types of sterilization techniques adopted (L5).
- Formulate and develop the model equations for various types of bioreactors like STR, PFTR, Combination of bioreactors, etc (L4,L5).
- Estimate the power requirement of bioreactors by considering other transport process parameters (L3).
- To design the bioreactor with necessary mechanical aspects (L6)

### UNIT I

**Introduction :**

Overview of Biological Reactions-Submerged liquid fermentation-Solid-state fermentation, Elements in Bioreactor design, Rate expression in Biological systems-Enzymatic reactions-cellular reactions, Basic concept of Energy Transfer-Metabolic energy-Factors affecting performance in bioreactors-Effect of agitation-effect of shear-Effect of modes of heat transfer, Basic concept of Mass Balance.

**Understanding of Bioreactors :** What is a Bioreactor?, why should we Study Bioreactors, Development of Bioreactors, Purpose and importance of

Bioreactors-Necessary function of bioreactors-requirements of bioreactor-Major component and its purposes-additional information on important components, Other Bioreactor Configurations, Bioreactor development for solid-State fermentation(SSF)-Necessary features of a typical bioreactor used in SSF, Classification of bioreactors-Classification of bioreactors in SLF-Classification of bioreactors in SSF, Bioreactors for Animal Cell Cultivation-Classification of bioreactors used for animal cell culture, Bioreactors for Plant Cell Culture-Reactors for suspension culture, Bioreactors for Immobilized System, Bioreactors used in Different areas of Environmental Control and Management, Bioreactors Used for Combined Reactions and Separation

**10Hrs**

**UNIT II**

**Sterilization** Bioreactors, sterilization methods, Thermal death kinetics, Design criterion, Batch sterilization, Continuous sterilization, Air sterilization, Numerical conceptual.

**Bioreactor Operation:** Introduction, Common Operations of Bioreactors-Setting up bioreactor for submerged liquid fermenataion(SLF)-Inoculum development for bioreactor operation, Selection/Identification of Other Common Factors Necessary for Smooth Operation of Bioreactors,

**10Hrs**

**UNIT III**

**Biochemical Aspect of Bioreactor Design :**

Introduction, General growth reation-rates Law-Temperature dependence of rate law for growth-Stoichiometry - Application of yield factors-The mass balance-General Energy balance in Biorecators. **Bioreactors for submerged liquid fermentation of microbial cells-**batch Bioreactors. Introduction-Calculation of total batch time-Calculation of batch reaction time from ideal systems-Calculation of $T_r$ for simultaneous synthesis of cells and products-Non-ideality in batch reactor- Quantitative evaluation of Batch processes.

Continuous Flow Bioreactors, Introduction-Purpose of continuous flow reactors-difference between turbidostat and chemostat operations-Ideal CFSTBR-chemostat-Mean residence time-Comparison of batch bioreactor and single stage CFSTBR-washout condition

**12Hrs**

**UNIT IV**

Plug Flow Tubular Reactor (PFTR)-Comparison of ideal mixed flow(batch and CFSTBR) and plug flow tubular reactors, Recycle Bioreactors-Objectives-Recycling in biological reactions-analysis of recycle reactors. Combination of Bioreactors, Combination of Bioreactors-Combination of continuous flow bioreactors-classification of multistage bioreactors-

Semi-continuous Bioreactors, Semi-continuous Bioreactors- A few definitions- Analysis of semi-batch reactor-Fed-batch bioreactors.

**Transport Process in Bioreactors:**

Introduction-Mass transfer-Mass transfer phenomena in bioreactors, Heat Transfer, Other Parameters Influencing Transfer Operations-Power input-Mixing time**.**

**12Hrs**

**UNIT V**

**Case Studies:**

Introduction design of Packed Bed Bioreactor-Design of packed bed reactor for a bio-film growth on support system, Type of analysis-What are the parameters measure?, Design bioreactor, Design of Bioreactors for Solid State Fermentation(SSF)

**Mechanical Aspects of Bioreactor design:** Introduction, Requirements for Construction of Bioreactor, guidelines for Bioreactor Design-Preferred materials for bioreactor design and fabrication-Welding techniques, Bioreactor Vessels-Geometry of reactor vessel-Components in bioreactor vessel-Size of vessel-the design procedure of vessel wall of bioreactor, Design of flange-Design of shaft-Design of pin key/sunk key, Agitator Assembly-Drive configuration-Types of stirrer assembly-Types of agitators. Design of enzyme reactor.

**10Hrs**

**TEXT BOOKS:**


| | | |
|---|---|---|
| 1 | Tapobrata Panda | Bioreactors Analysis and Design, Tata McGraw Hill Education Private Limited, New Delhi, |
| 2 | James M. Lee | Biochemical Engineering |
| 3 | S. Y. Lee, J. Nielsen, G. Stephanopoulos | Fundamental Bioengineering , Volume 1, Wiley-VCH, Verlag GMBH & Co, KGaA |

## RESEARCH METHODOLOGY, BIOSAFETY AND BIOETHICS

| | | | |
|---|---|---|---|
| Contact Hrs./ Week | : 3 | Credits : | 3 |
| Total Lecture Hrs. | : 39 | CIE Marks : | 50 |
| Sub. Code | : 6BT08 | SEE Marks : | 50 |

**Prerequisites**: Basics of Microbiology, Genetic engg etc

**Course objectives**: The course will help to:

1. Introduce the concept of research methodology, research design and methods.
2. Provide a knowledge on developing a research plan
3. Provide insights into ethical issues and genetically modified organism
4. Provide a knowledge on bioethics, biosafety and risk assessment.
5. Discuss the concepts of intellectual property rights and patenting.

**Course outcomes**: Upon completion of this course, the students will be able to:

1. Apply the research methods, design the research projects and choose the method(L3)
2. To evaluate the research plan(L5)
3. Understand the ethical issues involved in research (L2)
4. Remember biosafety requirements and risk assessment (L1)
5. Understand the intellectual rights in biotechnology research and industry(L2)

### UNIT – I

**Introduction to research:** Science & Research. Basic & Applied Research, Steps in Research Meaning, Objectives and Characteristics of research - Research methods Vs Methodology - Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research - Developing a research plan.

**7 Hrs.**

### UNIT II

**Research design and methods** – Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models -

Developing a research plan - Exploration, Description, Diagnosis, and Experimentation - Determining experimental and sample designs.

**8 Hrs**

**UNIT-III**

**Ethical Issues:** Ethical issues in genetically modified organisms (foods and crops); bioethics in biodiversity and resource management. Animal cloning and human cloning and their ethical aspects. Testing of drugs on human volunteers, organ transplantation and ethical issues; Xenotransplantion and its ethical and social issues. Drafting of application to IBSC and procedure. BT cotton, golden rice, genetic manipulation and ethical considerations. Genetic studies in ethnic races.

**8 Hrs.**

**UNIT-IV**

**Introduction to Bioethics:** Needs and definition of Bioethics, Ethical issues in biotechnology. Application of bioethics, the expanding scope of ethics from biomedical practice to biotechnology. Social and ethical issues in Biotechnology.

**Biosafety and Risk Assessment:** Introduction; Historical Background; Introduction to Biosafety, Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety levels; specific microorganisms; Recommended biosafety levels for Infectious agents and Infected Animals; Biosafety guidelines - Government of India. Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements (Cartagena Protocol).

**9 Hrs.**

**UNIT – V**

**Introduction to Intellectual Property and patenting:** Concept of property intellectual property (IP). Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP. IP as a factor in R&D; IPs of relevance to biotechnology with case studies.

**7 Hrs.**

**Text books:**


| | | |
|---|---|---|
| 1 | Traynor PL | 2000 Biosafety Management, Virginia polytechnic Institute Publication. |
| 2 | Sateesh M.K | (2008) Bioethics & Biosafety, IK Publishers. |
| 3 | T. M Murray and M.J. Mehlman | Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons 2000 |

**Reference Books:**


| | | |
|---|---|---|
| 1 | Sasson A. | 1993) Biotechnologies in developing countries present and future, UNESCO Publishers. |
| 2 | Rao MB | 2003), WTO and International Trade, Vikas Publishing House Pvt. Ltd.<br><br>Erbisch F H and Maredia K M (2003), Intellectual Property Rights in Agricultural Biotechnology, Orient Longman Ltd |

## MARINE BIOTECHNOLOGY

| | | | |
|---|---|---|---|
| Contact Hrs./ Week | : 3 | Credits : | 3 |
| Total Lecture Hrs. | : 39 | CIE Marks : | 50 |
| Sub. Code | : 6BTE011 | SEE Marks : | 50 |

**Prerequisites:** 10+2 biology ( Zoology section) ; Environmental science

**Course objectives:**

- To understand the biology of arthropoda
- To study the effects of pollution on marine life
- To learn the methods of studying the marine microorganism collection
- To study the physical, chemical & biological aspects of marine life
- To study about screening, isolation, purification of bioactive compounds from marine flora & fauna

**Course outcomes:**

A student who has met the objectives of the course will be able to:

- Explain the general biology, morphology & anatomy of arthropoda (L2)
- Explain about the renewable & non renewable resources of ocean (L2), Describes the methods for microorganism collection, isolation, culture & identification (L2).
- Elucidate the major pollutants of marine life (L2), Describes the ethical & moral issues concerning food health & environmental safety (L2).
- Carry out screening, isolation, purification of bioactive compounds from marine flora & fauna (L3).

### UNIT-I

**Aqua Culture**

Classification and Characteristics of Arthropoda. Crustacean characteristic key to Myanmar's Economically Important species of Prawns and Shrimps, General biology, embryology, morphology, anatomy and organ systems of – (a) Shrimp and Prawn, (b) Finfish, (c) Marine and freshwater fish. Preparation, culture and utilization of live food organisms, phytoplankton zooplankton cultures, Biology of brine shrimp Artemia, quality evaluation of Cyst, hatching and utilization, culture and cyst production.

**10 Hrs.**

### UNIT-II

**Techniques**

Chromosome manipulation in aquaculture - hybridization, ploidy induction, gynogenesis, androgenesis and sex reversal in commercially important fishes. Application of microbial biotechnology in culture ponds, bioaugmentation, bioremediation, nutrient cycling, and biofertilization. Probiotics –Immunostimulants. Tools for disease diagnosis in cultivable organisms- Enzyme immuno assays - Dot immunobinding assay - Western blotting - Latex agglutination test - Monoclonal antibodies - DNA based diagnosis

**10 Hrs.**

**UNIT-III**

**Marine Environment**

Biological Oceanography: The division of the marine environment – benthing, pelagic, batuyal, littoral. Ocean waters as biological environment. Distribution and population of plants and animals. Marine ecology and fisheries potential. Effects of pollution on marine life. Geological and geophysical Oceanography: Geophysical and geological processes. Ocean basin rocks and sediments. Beach and beach processes, littoral sediment transports. Coastal erosion-causes and protection. Resources of the ocean-renewable and non-renewable. **Marine Microbiology**. Methods of studying the marine micro-organisms collection, enumeration, isolation, culture & identification based on morphological, physiological and biochemical characteristics. Preservation of marine microbes, culture collection centres (ATCC, IMTECH, etc.). Microbial nutrition and nitrogen fixation. Seafood microbiology - fish & human pathogens. Indicator of Pollution - faecal coliforms - Prevention & control.

**12 Hrs.**

**UNIT-IV**

**Marine Biotechnology**

Physical, Chemical and Biological aspects of marine life. Air – Sea interaction – Green house gases (CO2 and Methane). Marine pollution-major pollutants (heavymetal, pesticide, oil, thermal, radioactive, plastics, litter and microbial). Biological indicators and accumulators: Protein as biomarkers, Biosensors and biochips. Biodegradation and Bioremediation. Separation, purification and bioremoval of pollutants. Biofouling - Biofilm formation Antifouling and Anti

boring treatments. Corrosion Process and control of marine structures. Biosafety – special characteristics of marine environment that bear on biosafety. Ethical and moral issues – food health, and environmental safety concerns.

**12 Hrs.**

**UNIT-V**

**Marine Pharmacology**

Terms and definitions. Medicinal compounds from marine flora and fauna - marine toxins – antiviral, antimicrobial. Extraction of crude drugs, screening, isolation, purification and structural characterization of bioactive compounds. Formulation of drugs and Drug designing: Pharmacological evaluation – routes of drug administration – absorption, distribution, metabolism and excretion of drug, clinical trials.

**08 Hrs.**

**TEXT/REFERENCE BOOKS:**


| | | |
|---|---|---|
| 1 | Ranga & Shammi | Fish Biotechnology |
| 2 | Kenneth | Environmental impacts of Aquaculture, CRC. pp. 214. |
| 3 | David J.Attaway et al. | Marine Biotechnology |
| 4 | Morries H. Baslow | Marine Pharmacology, The Williams & Wilkins Co., Baltimore. |
| 5 | Kenneth, C. Highnam and Leonard Hill | The comparative endocrinology of the invertebrates, Edward Arnold Ltd. |

## DAIRY BIOTECHNOLOGY

| | | | |
|---|---|---|---|
| Contact Hrs./ Week | : 3 | Credits : | 3 |
| Total Lecture Hrs. | : 39 | CIE Marks : | 50 |
| Sub. Code | : 6BTE012 | SEE Marks : | 50 |

**Prerequisite:** Basic microbiology

**Course objectives:**

- To study the microbial changes in refrigerated raw milk
- To learn about production of dairy based products using genetically engineered bacteria & animals
- To understand the importance of antimicrobial substances naturally present in milk
- To study the sanitary features of the dairy equipment
- To understand the concept of clean room & its importance in manufacturing of biopharmaceuticals
- To learn the quality systems like ISO 9001:2000 series

**Course outcomes:**

A student who has met the objectives of the course will be able to:

- Explain manufacturing & processing of dairy products (L2)
- Enlighten on the enzymes used in dairy industry (L2)
- Explain whey processing & utilization of products generated from whey (L2)
- Explain the working & maintenance of cleaning equipments involved in dairy industry (L2)
- Apply the methods involved in cleaning or sterilizing the manufacturing facility (L3)
- Apply the concepts of ISO & can participate in groups working for different ISO accreditation (L3)

### UNIT-I

**Introduction**

Overview of dairy industry, Characteristics of dairy Industry. Manufacturing & processing of dairy products, effect of processing on constituents and methods of evaluation of dairy products.

**Dairy Microbiology**

Microbial quality of milk produced under organized versus unorganized milk sector in India and comparison with developed countries; Impact of various stages like milking, chilling, storage and transportation on microbial quality of milk with special reference to psychrotrophic organisms; Direct and indirect rapid technique for assessment of microbial quality of milk. Milk as a vehicle of pathogens; Food infection, intoxication

and toxic infection caused by milk borne pathogens like E. coli, Salmonella typhi,etc . Microbiological changes in bulk refrigerated raw milk; Mastitis milk: organisms causing mastitis, detection of somatic cell count (SCC). Role of microorganisms in spoilage of milk; souring, curdling, bitty cream, proteolysis, lipolysis; abnormal flavors and discoloration.

**10 Hrs.**

**UNIT-II**

**Dairy Biotechnology**

Genetic engineering of bacteria and animals intended for dairy-based products: DNA cloning. protoplast fusion & cell culture methods for trait improvement with instances cited. Enzymes in dairy industry & production by whole cell immobilization. Biotechnology of dairy effluent treatment. Ethical issues relating to genetic modification of dairy microbes & milk-yielding animals

**10 Hrs.**

**UNIT-III**

**By products Technology**

Status, availability and utilization of dairy by-products in India and abroad, associated economic and pollution problems. Physico chemical characteristics of whey, butter milk and ghee residue, by-products from skim milk such as Casein; Whey processing & utilization of products generated from whey. Significance of antimicrobial substances naturally present in milk (responsible for its nutraceutical properties): immunoglobulin, lactoferin, lysozymes, LP systems.

**10 Hrs.**

**UNIT-IV**

**Dairy Engineering**

Sanitization: Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, standard glass piping, plastic tubing, fittings and gaskets, installation, care and maintenance of pipes & fittings. Description, working and maintenance of can washers, bottle washers. Factors affecting washing operations, power requirements of can the bottle washers, CIP cleaning and designing of system.

Homogenization: Classification, single stage and two stage homogenizer pumps, power requirements, care and maintenance of homogenizers, aseptic homogenizers. Pasteurization: Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers.

Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Aseptic packaging and equipment.

Filling Operation: Principles and working of different types of bottle filters and capping machine, pouch filling machine (Pre-pack and aseptic filling bulk handling system.

**12 Hrs.**

**UNIT-V**

**Quality and Safety Monitoring in Dairy Industry**

Current awareness on quality and safety of dairy foods; consumer awareness and their demands for safe foods; role of codex alimentarious commission (CAC) in harmonization of international standards; quality (ISO 9001:2000) and food safety (HACCP) system and their application during milk production and processing. National and international food regulatory standards; BIS, PFA, ICMSF, IDF etc., their role in the formulation of standards for controlling the quality and safety of dairy foods. Good Hygiene Practices (GHP): Rapid assessment of dairy food for microbial and non-microbial contaminants; Enumeration Principles of detection of predominant spoilage organisms and pathogens, pesticides. Quality of water and environmental hygiene in dairy plant; chlorination of dairy water supply, treatment and disposal of waste water and effluents, Quality of air & personnel hygiene.

**10 Hrs.**

**TEXT BOOKS:**

| | | |
|---|---|---|
| 1 | Hui, Y.H | Dairy Science & Technology Handbook (Vols 1-3). Ed, Wiley Publishers. |
| 2 | Robinson R.K | Dairy Microbiology Handbook (3rd Ed), Wiley Publishers. |

**REFERENCE BOOKS:**

| | | |
|---|---|---|
| 1 | N.C Gautam | Comprehensive Biotechnology (Vol 6)- Ed, Shree Pblns. |
| 2 | Powar & Daginawala | General Microbiology ( Vol 2), Himalaya Publishers |
| 3 | Myer Kutz | Handbook of Farm, Dairy & Food Machinery, Andrew Publishers. |

## ENZYME TECHNOLGY

| | | | |
|---|---|---|---|
| Contact Hrs / week | : 04 | Credits | : 4 |
| Total Lecture Hrs | : 52 | CIE Marks | : 50 |
| Subject Code | : 6BTE014 | SEE Marks | : 50 |

**Prerequisites:** Biochemistry

**Course objectives:**

- To study the classification of enzymes and factors affecting enzyme action such as apoenzyme, prosthetic group, cofactors.
- To study about the kinetics of single and multiple substrate reactions along with enzyme activity, regulation.
- To study different mechanisms of enzyme actions.
- To study about the production methods of enzymes and its purification techniques.
- To learn the applications in the industries and their great importance in scientific research, clinical Diagnosis and in industry.
- To learn about enzyme immobilization methods, their repeated use and kinetics

**Course outcomes:**

A student who has met the objectives of the course will be able to:

- Carry out independent research in enzymology and related field (L3)
- Describe how enzyme act on substrate and form products, the reaction velocity (L2)
- Explain the mechanism of enzyme reaction (L2)
- Perform characterization of unknown enzyme including molecular weight determination (L3)
- Application of various enzymes in food, feed and industry including pharmaceuticals application against various diseases (L3)

### UNIT - I

**Introduction to Enzymes**

**History of enzymology:** Nomenclature and classification of enzymes; holoenzyme, apo-enzyme, cofactor, coenzyme, prosthetic group; enzyme activity unit and turn over number and other catalytic bio-molecules. Isozymes and Allosteric Enzymes, Biological Roles of enzymes, Activation Energy of enzymes, chemical nature of enzymes and active sites of enzyme

and identification of functional groups at active sites, Numerical Conceptual.

**10 Hrs**

**UNIT - II**

**Kinetics of Enzyme Catalyzed Reactions**

Introduction to bioenergetics, methods used for investigating the kinetics of enzyme catalyzed reactions; principles that explain catalytic power and substrate specificity of enzymes; Michaelis-Menten equation, Vmax and Km; enzyme inhibition, types of enzyme inhibitions, and determination of Ki; kinetics of single substrate and multi-substrate reactions. Regulatory enzymes; allosteric enzymes and their mode of action, Conceptual Numericals.

**12 Hrs**

**UNIT - III**

**Mechanism of Enzyme Action**

Enzyme action; effect of enzyme on the rate and equilibrium of a reaction; enzyme substrate complex, factors responsible for catalytic efficiency of enzyme; proximity and orientation effect, covalent catalysis, strain and distortion theory; mechanism of action of enzymes without cofactors (lysozyme and glyceraldehydes 3-phosphate dehydrogenases), mechanism of action of enzymes with cofactors / coenzymes, Conceptual Numericals;

**10 Hrs**

**UNIT - IV**

**Enzyme Technology**

Strategies used for enzyme production, isolation and purification; estimation of enzyme activity; characterization of an enzyme, criteria of enzyme purity, determination of the molecular weight (Mr) and the number of sub-units of an enzyme; isoelectric focusing (pI); effect of inhibitors; Industrial applications of enzymes in cheese making, brewing and production of organic acids; enzyme immobilization and its importance; protein engineering; enzyme therapy, enzyme inhibitors and drug design, Conceptual Numericals.

**10 Hrs**

**UNIT - IV**

**Industrial Application of enzymes**

Immobilization of enzymes: concepts, different methods of immobilization, characterization of immobilized enzymes and application of immobilized enzymes. Impact of genetic engineering on enzyme production; types of extremeophiles enzymes and their application. Industrial use of carbohydrases, proteases and lipases, uses of enzymes in detergent,

leather, beverage, petroleum, heavy metal, food and pharmaceutical industry, Conceptual Numericals.

**10 Hrs**

**TEXT BOOKS:**

| | | |
|---|---|---|
| 1 | Segal, L.H | Enzyme Kinetics, Wiley Interscience, USA (1975). |
| 2 | Walsh, C | Enzymatic reaction mechanism, Freeman and Company, USA (1979). |
| 3 | Gerhartz, W | Enzyme in Industry, production and application VCH (1990). |
| 4 | Shultz, A.R. | Enzyme Kinetics, Cambridge Press (1994). |
| 5 | Alan Fresht | Enzyme structure and mechanism, 2nd edition, Freeman and Company (1995). |

**REFERENCE BOOKS:**

| | | |
|---|---|---|
| 1 | Trevor, P. | Understanding Enzymes, 4th edition, Prentice Hall/Ellis, Harwood, England (1995) |
| 2 | Dixon, M and Webb E.C | Enzymes, 3rd edition, Academic Press, New York (1997). |
| 3 | Nicholas C. Price and Lewis Stevens | Fundamentals of Enzymology. 3rd edition (2001) |
| 4 | Palmer | Enzymes, Horwood Publishing Series (2001). |
| 5 | Helmut Uhling | Enzyme Technology, John Wiley (1998). |

1.

**Mini Project**

| | | | |
|---|---|---|---|
| Lab Hours/ Week | : 2 | Credits : | 2.0 |
| Sub. Code | : 6BTP01 | CIE Marks : | 50 |
| | | SEE Marks : | 50 |

The project can be taken by group of 4 students and mini project can be carried out in the dept. Under a guide or outside the department in institute/ company with a guide from the dept. and co guide from the institute/ company. Mini project is evaluated over 2 semesters (V & VI) and at the end of each semester. With no credit in the V sem., mini project is evaluated for 100 marks ( 50% CIE & 50% SEE). Semester End Examination is conducted by the internal and external examiners

## CHEMICAL REACTION ENGINEERING LABORATORY

| | | | |
|---|---|---|---|
| Lab Hours/ Week | : 3 | Credits : | 1.5 |
| Sub. Code | : 6BTL03 | CIE Marks : | 50 |
| | | SEE Marks : | 50 |

**Course Objectives:**

- To know the concept of various reactors
- To study the mechanisms of reactions in different types of reactors
- To learn the design of reactors at different condtions of reactors
- To know the behavior of reactors at non ideal conditions
- To learn the operations of advanced reactors like sono, photo-reactors

**Course Outcomes:**

- To determine the rate constants of various types of reactors [L3]
- To calculate the time for complete reactions and design involved in it [L3,L5]
- To observe the behaviuor of reactors at ideal and non-ideal conditions [L2]
- To apply the concept of enzyme catalyzed reactions, photo- and sono-reactors [L3]

**The experiment should be based on the following topics.**

1. Batch Reactor
2. Isothermal plug flow reactor
3. Mixed flow reactor
4. Semi Batch Reactor
5. Heterogeneous catalytic reactor
6. Segregated flow reactor
7. Adiabatic reactor
8. Packed Bed Reactor
9. RTD Studies in Tubular reactor

10. Effect of temperature on Rate of reaction
11. Bio Chemical Reaction (Batch)
12. RTD studies in mixed reactor
13. Enzyme catalyzed reactions in batch reactor
14. Sono-chemical reactor.
15. Photochemical reactor

## BIOANALYTICS LABORATORY

| | | | |
|---|---|---|---|
| Lab Hours/ Week | : 3 | Credits : | 1.5 |
| Sub. Code | : 6BTL04 | CIE Marks : | 50 |
| | | SEE Marks : | 50 |

**Course Objectives:**

- To know the importance of antigen-antibody interaction in various techniques.
- To understand the basic concept of Blood Grouping.
- To study fermentor principles and operations.
- To learn the operations of HPLC and FTIR

**Course Outcomes:**

A student who has met the objectives of the course will be able to:

- **Understanding** of immunotechniques which are used as diagnostic tools.(L2)
- **Analyse** different compound by chromatography methods (L3)
- **Describe** the parts and operation of HPLC (L2)
- **Outline** the concepts of fermentation process (L1)

**The experiment should be based on the following topics.**

1. Blood grouping and Rh typing.
2. Ouchterlony Double Diffusion (ODD)
3. Radial Immunodiffusion (RID)
4. Countercurrent immunoelectrophoresis (CCIEP)
5. Rocket immunoelectrophoresis(RIEP)
6. Enzyme Linked Immunosorbent Assay (ELISA)-Dot blot method.
7. Western blot
8. Determination of phenolic compounds by analytical HPLC
9. Determination and separation of phenolic compounds by preparative HPLC

10. Differential method of analysis of kinetic data using UV
11. Integral method of analysis of kinetic data using UV
12. Dynamic Light Scattering application in size detect ion of molecules and molecular aggregates using Zetasizer
13. Attenuated Total Reflectance (ATR) FTIR Spectrophotometry using FTIR
14. Ethanol production from Fermentation process