## I Semester

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
<th>Teaching hours/week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for Total Marks</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lecture</td>
<td>Practical / Field Work / Assignment/ Tutorials</td>
<td>I.A.</td>
<td>Exam</td>
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<tr>
<td>14BBC11</td>
<td>Numerical Methods &amp; Biostatistics</td>
<td>4</td>
<td>2</td>
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<tr>
<td>14BBC12</td>
<td>Concepts in Biotechnology</td>
<td>4</td>
<td>2</td>
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<td>50</td>
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<tr>
<td>14BBC13</td>
<td>Molecular Biology &amp; Genetic Engineering</td>
<td>4</td>
<td>2</td>
<td>3</td>
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<tr>
<td>14BBC14</td>
<td>Principles of Biochemical Engineering</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>50</td>
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<tr>
<td>14BBC15</td>
<td>Elective-I X</td>
<td>4</td>
<td>2</td>
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<tr>
<td>14BBC16</td>
<td>Genetic Engineering &amp; Biochemical Engineering Lab</td>
<td>--</td>
<td>3</td>
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<tr>
<td>14BBC17</td>
<td>Seminar</td>
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### Elective – I

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>14BBC151</td>
<td>Analytical Techniques</td>
</tr>
<tr>
<td>14BBC152</td>
<td>Computational Biology</td>
</tr>
<tr>
<td>14BBC153</td>
<td>Bioprocess Control &amp; Instrumentation</td>
</tr>
<tr>
<td>Subject Code</td>
<td>Name of the Subject</td>
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<tr>
<td>-------------</td>
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</tr>
<tr>
<td>14BBC21</td>
<td>Fermentation Technology</td>
</tr>
<tr>
<td>14BBC22</td>
<td>Bioreactor Plant Design</td>
</tr>
<tr>
<td>14BBC23</td>
<td>Plant &amp; Animal Biotechnology</td>
</tr>
<tr>
<td>14BBC24</td>
<td>Bioseparation &amp; Product Recovery</td>
</tr>
<tr>
<td>14BBC25</td>
<td>Elective-II</td>
</tr>
<tr>
<td>14BBC26</td>
<td>Fermentation Technology &amp; Bioseparation Lab</td>
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<tr>
<td>14BBC27</td>
<td>Seminar</td>
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<tr>
<td>**</td>
<td>Project Phase-I(6 week Duration)</td>
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**Between the III Semester and IV Semester after availing a vacation of 2 weeks.**

Elective – II

<table>
<thead>
<tr>
<th>Subject Code</th>
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<tr>
<td>14BBC251</td>
<td>Cell Culture Techniques</td>
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<tr>
<td>14BBC252</td>
<td>Effluent Treatment &amp; Management</td>
</tr>
<tr>
<td>14BBC253</td>
<td>Bioprocess Optimization, Modeling &amp; Simulations</td>
</tr>
</tbody>
</table>
**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM**
**SCHEME OF TEACHING AND EXAMINATION FOR**
**M.TECH. BIOTECHNOLOGY & BIOCHEMICAL ENGINEERING (BBC)**

### III Semester: INTERNSHIP

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject</th>
<th>No. of Hrs./Week</th>
<th>Duration of the Exam in Hours</th>
<th>Marks for Total Marks</th>
<th>Total CREDITS</th>
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<tbody>
<tr>
<td></td>
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<td>Lecture</td>
<td>Practical / Field Work</td>
<td>I.A.</td>
<td>Exam</td>
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<tr>
<td>14BBC31</td>
<td>Seminar / Presentation on Internship (After 8 weeks from the date of commencement)</td>
<td>-</td>
<td>-</td>
<td>25</td>
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<tr>
<td>14BBC32</td>
<td>Report on Internship</td>
<td>-</td>
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<td>75</td>
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<tr>
<td>14BBC33</td>
<td>Evaluation and Viva-voce</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>–</td>
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<td>125</td>
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</table>

* The student shall make a midterm presentation of the activities undertaken during the first 8 weeks of internship to a panel comprising **Internship Guide**, a senior faculty from the department and Head of the Department.
# The College shall facilitate and monitor the student internship program.
The internship report of each student shall be submitted to the University.
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>No. of Hrs./Week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for Total Marks</th>
<th>CREDITS</th>
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<tbody>
<tr>
<td>14BBC41</td>
<td>Research Methodology, Biosafety and IPR</td>
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<tr>
<td>14BBC4X</td>
<td>Elective-III</td>
<td>4</td>
<td>3</td>
<td>150</td>
<td>4</td>
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<tr>
<td>14BBC43</td>
<td>Evaluation of Project Phase-I</td>
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<tr>
<td>14BBC44</td>
<td>Evaluation of Project Phase-II</td>
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<tr>
<td>14BBC45</td>
<td>Evaluation of Project Work and Viva-voce</td>
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<td>100+100</td>
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<tr>
<td>Total</td>
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**ELECTIVE III**

<table>
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<tr>
<th>Subject Code</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>14BBC421</td>
<td>Food Process Technology</td>
</tr>
<tr>
<td>14BBC422</td>
<td>Biopharmaceutical Technology</td>
</tr>
<tr>
<td>14BBC423</td>
<td>Project Management, Entrepreneurship and Biobusiness</td>
</tr>
</tbody>
</table>
Note:

1) Project Phase – I: 6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall carryout literature survey / visit to Industries to finalize the topic of dissertation.

2) Project Phase – II: 16 weeks duration during III Semester. Evaluation shall be taken during the Second week of the IV Semester. Total Marks shall be 25.


Marks of Evaluation of Project:

- The I.A. Marks of Project Phase – I & II shall be sent to the University along with Project Work report at the end of the Semester.

4) During the final viva, students have to submit all the reports.

5) The Project Valuation and Viva-Voce will be conducted by a committee consisting of the following:

   a) Head of the Department (Chairman)
   b) Guide
   c) Two Examiners appointed by the university. (Out of two external examiners at least one should be present).
NUMERICAL METHODS & BIOSTATISTICS

Subject Code : 14BBC11    IA Marks : 50
No. of Lecture Hrs./ Week : 04    Exam Hrs : 03
Total No. of Lecture Hrs. : 50    Exam Marks : 100

Course Objectives:
- Theoretical knowledge and applications of Numerical Methods and Statistical Procedures
- To develop skills towards the design & analysis of statistical experiments
- Use appropriate numerical and statistical methods to analyze and interpret data
- Demonstrate effective use of these tools in problem solving and analysis

Course Outcomes:
At the end of the course the graduates should be able to:
- Demonstrate strong basics in statistics and numerical analysis, which serve as a foundation to tackle live problems in various spheres of bioscience and bioengineering

MODULE I:
Introduction to statistics and study design: Introduction to statistics, data, variables, types of data, tabular, graphical and pictorial representation of data. Significance of statistics to biological problems, experimental studies; randomized controlled studies, historically controlled studies, cross over, factorial design, cluster design, randomized; complete, block, stratified design, biases, analysis and interpretation.

10 HOURS

MODULE II:
Descriptive statistics and Observational study design: Types of variables, measure of spread, logarithmic transformations, multivariate data. Basics of study design, cohort studies, case-control studies, outcomes, odd ratio and relative risks.
Principles of statistical inference: Parameter estimation, hypothesis testing. Statistical inference on categorical variables; categorical data, binomial distribution, normal distribution, sample size estimation.

10 HOURS

MODULE III:
Comparison of means: Test statistics; t-test, F distribution, independent and dependent sample comparison, Wilcoxon Signed Rank Test, Wilcoxon-Mann-Whitney Test, ANOVA.
Correlation and simple linear regression: Introduction, Karl Pearson correlation coefficient, Spearman Rank correlation coefficient, simple linear regression, regression model fit, inferences from the regression model, ANOVA tables for regression.
Multiple linear regression and linear models: Introduction, Multiple linear regression model, ANOVA table for multiple linear regression model, assessing model fit, polynomials and interactions. One-way and Two-way ANOVA tables, T-tests; F-tests. Algorithm and implementation using numerical methods with case studies.

10 HOURS

MODULE IV:
Design and analysis of experiments: Random block design, multiple sources of variation, correlated data and random effects regression, model fitting. Completely randomized design, stratified design. Biological study designs. Optimization strategies with case studies.

10 HOURS

MODULE V:
Statistics in microarray, genome mapping and bioinformatics: Types of microarray, objectives of the study, experimental designs for micro array studies, microarray analysis, interpretation, validation and microarray informatics. Genome mapping, discrete sequence matching, programs for mapping sequences with case studies.

10 HOURS

TEXT BOOKS:

REFERENCE BOOKS:
CONCEPTS IN BIOTECHNOLOGY

Subject Code : 14BBC12  IA Marks : 50
No. of Lecture Hrs./ Week : 04  Exam Hrs : 03
Total No. of Lecture Hrs. : 50  Exam Marks : 100

Course objectives:
- Appreciate the Basic concepts and apply the knowledge to Biotechnological problems
- Use these skills towards the design & analysis of life science experiments
- Demonstrate effective use of these tools and techniques in solving problems relevant for society

Course Outcomes:
At the end of the course the graduates should be able to:
- Demonstrate strong basics in principles of biotechnology which serve as a foundation to tackle live problems in various spheres of bioengineering

MODULE I:
Introduction to Biology; Macromolecules; Carbon chemistry; Proteins: Structure, folding, catalysis; Nucleic acids: DNA & RNA; storage and transfer of genetic information; Lipids: membranes, structure & function; Carbohydrate chemistry, energy storage, building blocks.

10 HOURS

MODULE II:
Cell Structure: Eukaryotic and Prokaryotic cells, plant and animal cells, structure of nucleus, mitochondria, ribosomes, Golgi bodies, lysosomes, endoplasmic reticulum, chloroplast, vacuoles; Cell cycle and cell division: Different phases of cell cycle, cell division: Mitosis and meiosis.
Mendelian law of inheritance: Monohybrid and dihybrid inheritance, law of segregation and independent assortment; Gene Interaction; Multiple alleles, supplementary and complementary genes, epistasis. Identification of genetic material: classical experiments; chromosome structure and organization, chemical composition of chromatin, structural organization of nucleosomes, heterochromatin, polytene and lamp-brush chromosomes, human chromosomes, chromosomal disorders.

10 HOURS

MODULE III:
Scope and History of microbiology, Introduction to the structure and functions of microorganism: Bacteria, Viruses, Fungi and Protozoan’s. Microscopy and microbial techniques: Study of microscopes; sterilization techniques: Heat, steam, Radiation, Filtration and chemical methods; Pure culture techniques: Serial Dilution, Streak, Spread, Pour Plate.
Imune System, Innate and adaptive immunity, antigens and antibodies; types of immune response, hypersensitivity. Humoral immunity: B-lymphocytes, Immunoglobulin classes, Major Histocompatibility Complex (MHC). Cell mediated immunity. Thymus derived lymphocytes (T-cells), Antigen presenting cells (APC); Immunity to infection, Cytokines.

10 HOURS

MODULE IV:
Scope of agricultural biotechnology, Role of Microbes in agriculture, Biopesticides, Bio fertilizers (Nitrogen fixing microbes), GM crops. Plant metabolic engineering and industrial products: Molecular farming for the production of industrial enzymes, biodegradable plastics,
antibodies, edible vaccines. Metabolic engineering of plants for the production of fatty acids, industrial oils, flavonoids etc. Basic aspects of Food & Nutrition.  

**MODULE V:**
Industrially important Microorganisms, Preservation techniques, Different media for fermentation, basic structure of fermenter and different types. Types of fermentation processes (surface, submerged, and solid state) and their products (ethanol, citric acid, lactic acid, enzymes, antibiotics)

**10 HOURS**

**TEXT BOOKS**
3. Prescott and Dunn, Industrial Microbiology, Macmillian, 1982

**REFERENCE BOOKS**
MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Subject Code : 14BBC13  
IA Marks : 50

No. of Lecture Hrs./ Week : 04  
Exam Hrs : 03

Total No. of Lecture Hrs. : 50  
Exam Marks : 100

Course objectives:

• To impart theoretical knowledge of the Molecular Biology and Genetic Engineering.
• To develop technical skills including the ability to design & conduct experiments
• To use appropriate analytical methods to critically review the experimental observations and results

Course Outcomes:

At the end of the course the graduates should be able to:

• Demonstrate strong basics in principles of Molecular Biology and Genetic Engineering which serve as a foundation to tackle live problems in various spheres of life science industry and research labs.

MODULE I:
DNA Replication: Comparative account on initiation, elongation and termination in prokaryotes and eukaryotes DNA Repair: Mismatch correction, Mechanisms in thymine-dimer repair: Photoreactivation, Nucleotide excision repair, SOS repair DNA Recombination: Homologous and non-homologous recombination; Holliday Model; Site specific recombination: General mechanism, Examples: SSR in Bacteria-bacteriophage, FLP/FRT and Cre/Lox recombination. Transcription: Prokaryotic & Eukaryotic Mechanisms; Significance of Promoters, Enhancers, Silencers, Transcription factors, Activators and repressors; Post transcriptional modifications; Transcription inhibitors.

10 HOURS

MODULE II:
Genetic Code and its properties; Wobble hypothesis. Translation: Role of Ribosomes & tRNA; Mechanism of translation: Activation of amino acids, initiation complex formation, elongation of polypeptide, termination and release of polypeptide; Post-translational modifications; Transport of proteins and molecular chaperones. Transcriptional regulation in Prokaryotes: General mechanism of positive and negative control; Operon concept: lac, trp, and gal operons; Transcriptional control in Eukaryotes: Chromatin remodeling: Acetylation and deacetylation of histone proteins; Regulatory proteins: DNA binding transactivators, coactivators; Homeotic gene and their role in gene regulation.

10 HOURS

MODULE III:

10 HOURS

MODULE IV:
Gene transfer techniques into plants: Microprojectile bombardment; Agrobacterium transformation, Ti plasmid: structure and functions, Ti plasmid based vectors, mechanism of T-
DNA transfer; Chloroplast transformation; Transgenic science in plant improvement: resistance to biotic and abiotic stresses, biopharming – plants as bioreactors.  

**MODULE V:**
Introduction of DNA into mammalian cells; Animal vectors and Transfection techniques; Transgenic science for improvement of animals and livestock, animal as bioreactors for recombinant proteins. Gene transfer techniques into microbial cells: transformation, electroporation, lipofection, calcium phosphate mediated; Genetic manipulation of microbes for the production of insulin, growth hormones.  

**TEXT BOOKS:**

**REFERENCE BOOKS:**
### Course Objectives:

- To appreciate the concepts underlying in various Chemical engineering streams like Unit operations, Fluid Mechanics, Thermodynamics, Heat transfer etc which are fundamental to Biochemical Processes.
- To comprehend the essentials of design of Bioreactors / fermenters that would prepare them to leverage their knowledge of biological molecules / products, for scale up operations and productions.

### Course Outcomes:

At the end of the course the graduates should be able to:

- Demonstrate strong basics in principles of bioengineering which serve as a foundation to tackle live problems in various spheres of biochemical engineering.
- Search for information from relevant data hand books, for the design and execution of experiments using bioreactors / fermenters.

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### MODULE I:

Historical development of bioprocess technology, an overview of traditional and modern applications of biotechnological processes, Roles and responsibilities of a Chemical engineer in bioprocess industry, Steps in bioprocess development. Biology of the cell, classification, construction and cell nutrients. Industrial enzymes - Nomenclature and Classification of enzymes, structure and functions of enzymes with relevant case studies.

10 HOURS

### MODULE II:

Mixing-Power requirement (Calculation of power no), Ungassed and gassed fluids, factors affecting the broth viscosity, Mixing equipments (Banbury mixers, Muller Mixers), Size Reduction (laws of size reduction, Mechanical efficiency and crushing efficiency Concept of Sphericity, Volume surface Mean Diameter, Arithmetic Mean Diameter, Mass mean diameter, Volume Mean Diameter and Proof for sphericity is unity for regular object) Crushing equipments (Jaw crusher, Garyatery crusher, Shredders, Ball mill) Filtration (constant pressure and constant rate filtration explanations with only the equations.

10 HOURS

### MODULE III:

Industrially important filtration equipments (Rotary filters, Plate and frame filters and Leaf filters) Settling and its type (free and Hindred settling: equation for newtons, Intermediate Stokes regimes and Criteria for selection of the equation) Problems, Size Enlargement operations. Flow pattern in agitated vessel, Role of shear in fermentation broth, bubble shear, rheological behavior of fermentation broth, 3-D Continuity equation, Pressure drop in flow through packed bed and Fluidized bed (Kozeny,Carman, Blake Plummer Equations), Flow of compressible fluids, Time to empty the liquid from a tank (Rectangle Tank and Hemispherical Tank), problems, Problems on calculation of resultant velocity and resultant acceleration of fluid on space ordinates (x,y,z). Numerical Problems.

10 HOURS

### MODULE IV:
Basics of Thermodynamics, Procedure for Energy balance and Energy balance for cell culture, Concept of Internal energy, Enthalpy-calculations procedure (Enthalpy and internal energy changes calculations using first law of Thermodynamics), calculations of Entropy changes (Entropy changes for constant Temperature, Constant volume, constant pressure and work lost due to entropy) Differential equations of Entropy, Problems on entropy and Its calculations, Gibbs Free energy and other free energies of systems, Effect of temperature and Pressure on the Gibbs free energy and Helmoltz free energy. Discussion of Case studies.

MODULE V:
Introduction to Heat transfer over view of Industrial Heat Exchangers (Construction and working principle of DPHE, STHE, Helical coil heat exchangers along with the heat transfer equations) and Concept of LMTD, Boiling Condensation, Nucleate and film boiling (Regimes of pool boiling) Regenerators and Recupretors. Transient growth kinetics, measurement of microbial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen Batch, fed batch and continuous cultures. Discussion of Case studies.

TEXT BOOKS:

REFERENCE BOOKS:
2. Engineering Thermodynamics by K.V. Narayan 3rd edition 2010
ELECTIVES – I
ANALYTICAL TECHNIQUES

Subject Code  : 14BBC151  IA Marks : 50
No. of Lecture Hrs./ Week  : 04  Exam Hrs : 03
Total No. of Lecture Hrs.  : 50  Exam Marks : 100

Course objectives:
- To learn theoretical principles and applications of the various analytical techniques used in life science industry and research labs.

Course Outcomes:
At the end of the course the graduates should be able to:
- Demonstrate strong basics in appreciating the principles and applications of various analytical techniques applied in the domain of life sciences and bioengineering

MODULE I:
Brief review of electromagnetic spectrum and absorption of radiations. Theory of spectroscopy, absorption by organic molecules, choice of solvent and solvent effects, modern instrumentation – design and working principle. Applications of UV-Visible spectroscopy (qualitative and quantitative analysis). Principles of vibrational spectroscopy, frequency and factors influencing vibrational frequency, instrumentation and sampling techniques, interpretation of spectra, applications in biology. FT-IR-theory and applications, Attenuated Total Reflectance (ATR). Raman Spectroscopy, theory, instrumentation, and applications to biology. Discussions with Case studies. 10 HOURS

MODULE II:
Fundamental Principles of NMR, Instrumentation, solvents, chemical shift, and factors affecting chemical shift, spin-spin coupling, coupling constant, and factors influencing the value of coupling constant, spin-spin decoupling, proton exchange reactions, FT-NMR, 2D -NMR, NMDR, NOE, NOESY, COSY and applications in Pharmacy, interpretation of spectra, C13 NMR-Introduction, Natural abundance, C13 NMR Spectra and its structural applications. Discussions with Case studies. 10 HOURS

MODULE III:
Basic principles and instrumentation, ion formation and types, fragmentation processes and fragmentation pattern, Chemical ionization mass spectroscopy (CIMS), Field Ionization Mass Spectrometry (FIMS), Fast Atom Bombardment MS (FAB MS), Matrix Assisted laser desorption / ionization MS (MALDI-MS), GC-MS. LC-MS. MS-MS. Discussions with Case studies. 10 HOURS

MODULE IV:
Introduction, generation of X-rays, X-ray diffraction, Bragg’s law, X-ray powder diffraction, interpretation of diffraction patterns and applications. Single crystal diffractions of biomolecules. Fibre diffraction. Neutron diffraction. XAFS. ORD Principle, Plain curves, curves with cotton effect, octant rule and its applications with example, circular dichroism and its relation to ORD. Discussions with Case studies. 10 HOURS

MODULE V:
Classification of chromatographic methods based on mechanism of separation: paper chromatography, thin layer chromatography, ion exchange chromatography, column chromatography and affinity chromatography – techniques and applications. Gas Chromatography: Theory and principle, column operation, instrumentation, derivatisation methods and applications. HPLC, LC-MS and applications in HPTLC. Discussions with Case studies.

**10 HOURS**

**TEXT BOOKS**
3. George T. Tsao, Philip M. Boyer Chromatography, Springer-Verlag, 1993

**REFERENCE BOOKS**
COMPUTATIONAL BIOLOGY

Subject Code : 14BBC152  IA Marks : 50
No. of Lecture Hrs./ Week : 04  Exam Hrs : 03
Total No. of Lecture Hrs. : 50  Exam Marks : 100

Course objectives:
- To learn theoretical principles and applications of the various aspects of computational biology.

Course Outcomes:
At the end of the course the graduates should be able to:
- Demonstrate good appreciation in applying the concepts of computational biology to tackle live problems in various spheres of life sciences research.

MODULE I:
Sequence databases Formats, querying and retrieval, Nucleic acid & Protein sequence databases, Genome Databases, NCBI, EBI, TIGR, SANGER ; Various file formats for bio-molecular sequences: Similarity matrices; Pair-wise alignment; BLAST; Statistical significance of alignment; Sequence assembly; multiple sequence alignment; Tools and techniques. Phylogenetics: distance based and character based approaches. Discussions with Case studies.

10 HOURS

MODULE II:
Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs and profiles, various types of pattern representations viz. consensus, regular expression (Prosite-type) and sequence profiles; trees Motif representation: consensus, regular expressions; PSSMs; Markov models; Regulatory sequence identification using Meme; Gene finding: composition based finding, sequence motif-based finding. Profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches. Discussions with Case studies.

10 HOURS

MODULE III:
PDB, NDB, Chemical Structure database. Pubchem, Gene Expression database: GEO, SAGE, InterPro, Prosite, Pfam, ProDom, Gene Ontology Structure classification database: CATH, SCOP, FSSP, Protein-Protein interaction databases. Representation of molecular structures (DNA, mRNA, protein), secondary structures, domains and motifs; Protein structure classification, evolution; structural quality assessment; structure comparison and alignment; Visualization software (Pymol, Rasmol etc.); 3-D structure comparison and concepts, CE, VAST and DALI, concept of coordinate transformation, RMSD, Z-score for structural comparison. Discussions with Case studies.

10 HOURS

MODULE IV:
Structure prediction: Chou Fasman, GOR methods; analysis of results and measuring the accuracy of predictions. Prediction of membrane helices, solvent accessibility; RNA structure prediction; Mfold; Fundamentals of the methods for 3D structure prediction (sequence similarity/identity of target proteins of known structure, fundamental principles of protein folding etc.) Homology/comparative modelling, fold recognition, threading approaches, and ab initio structure prediction methods. Force fields, backbone conformer generation by Monte Carlo
approaches, side-chain packing; Energy minimization; Structure analysis and validation: Pdbsum, Whatcheck, Procheck, Verify3D and ProsaII; Rosetta; Discussions with Case studies.  

10 HOURS

MODULE V:
Computational biology in drug design: Target identification, validation and Identification and Analysis of Binding sites; virtual screening, lead optimization. Ligand based drug design: QSARs and QSPRs, In silico prediction ADMET properties for Drug Molecules. Pharmacophore identification. Protein-ligand docking; Rigid and Semi Flexible Molecular Docking. Studying Protein-Protein interactions via computational biology tools. 

Computational Biology applications for proteomics, Comparative genomics, Transcriptomics, Microarray technology, expression profiles data analysis; SAGE; MS Data analysis, Probabilistic Models of Evolution, Protein arrays; Metabolomics, Gene Mapping, SNP analysis, Systems Biology. Discussions with case studies.  

10 HOURS

TEXT BOOKS

REFERENCE BOOKS
6. Thomas E. Creighton Proteins: structures and molecular properties, New York Freeman, 1992 
8. Tsai, C Stan, Biomacromolecules: Introduction to Structure, function and Informatics, Wiley & Sons, 2007
BIOPROCESS CONTROL AND INSTRUMENTATION

Subject Code : 14BBC153  IA Marks : 50
No. of Lecture Hrs./ Week : 04  Exam Hrs : 03
Total No. of Lecture Hrs. : 50  Exam Marks : 100

Course objectives:
- To learn theoretical principles and applications of the bioprocess principles, control systems and instrumentation aspects involved in the equipments and processes at life science industry and research labs.

Course Outcomes:
At the end of the course the graduates should be able to:
- Demonstrate strong basics in principles of process control, instrumentation and automation, which serves as a foundation to tackle live problems in various spheres of biochemical engineering

MODULE I:
Aims and objectives of control system, closed loop control and open loop control systems- Examples, Elements of control system, process variables, process parameters, Representation of control systems in terms of block diagrams and its explanation, Laplace transforms. Z transforms. 10 HOURS

MODULE II:
Fundamentals of Static and dynamic characteristics. Indicators and recorders. Pressure measurement- Bourdon, diaphragm and bellow type gages. Vacuum measurements. Temperature measurement- Bimetal and resistance thermometers, thermocouples and pyrometers, Flow measurement, Level measurement devices, pH and DO analyzers, on-line and off-line analysis of biomass estimation. 10 HOURS

MODULE III:
Introduction to controller, Mode of action of controllers and the Transfer function, Response of the controller to Step, Pulse, Linear changes to error signals, qualities of good controller, proportional Band. Transmitters, Measurements systems. Measurement of process variables, Actuators, Positioners, Control valves, Valve body, valve Plug, Variable Displacement pumps, and constant output pumps, PLC. Sequential control, Logic and security systems. 10 HOURS

MODULE IV:
Block diagram Deduction, Analysis of typical control system-Closed loop analysis -Servo and Regulatory problems for First and second order systems, Closed and loop transfer functions, P-controller for set point change, off-set,P-controller for load change, Pi controller with set point change. Stability. Process identification, Root locus, Routh Array, Bode and Nyquist diagrams. Stability margins. Robustness, Steady state errors. Frequency domain response. 10 HOURS

MODULE V:

**TEXT BOOKS**

**REFERENCE BOOKS**
GENETIC ENGINEERING & BIOCHEMICAL ENGINEERING LAB

Subject Code : 14BBC16       IA Marks : 25
No. of Lab Hrs./ Week : 03            Total No. of Lecture Hrs. : 36
Exam Hrs : 03                          Exam Marks : 50

COURSE OBJECTIVES

• To gain practical knowledge of the Genetic Engineering and Biochemical engineering
• Use appropriate analytical methods to critically review the experimental observations and results

Course Outcomes:
At the end of the course the graduates should be able to:
• Demonstrate strong basics in the lab skills of Molecular Biology and Genetic Engineering which serve as a foundation to tackle live problems in various spheres of life science industry and research labs
• Demonstrate strong bench skills in basics of bioengineering which serve as a foundation to tackle live problems in various spheres of biochemical engineering
• Search for information from relevant data hand books, for the design and execution of experiments.

1. Preparation of buffers and molecular biology reagents.
2. Methods in genomic DNA/plasmid Isolation, Purification; Quantification of nucleic acids by agarose electrophoresis and spectrophotometric methods. Trouble shooting
3. Transformation of Bacterial Cells: Preparation of competent cells, transformation, screening of transformants,
4. PCR-Preparation of reagents, amplification and visualization.
5. Southern hybridization and Trouble shooting.
6. Isolation of Enzymes (from suitable sources)
7. Preparation of cell free lysate and filtration
8. Ammonium sulfate precipitation and dialysis
9. Ion exchange chromatography and generation of purification table
10. Enzyme Kinetic Parameters: Km, Vmax and Kcat
11. Assessing enzyme/protein purity
12. Isoelectric focusing of purified protein

TEXT/REFERENCE BOOKS

SEMESTER II

FERMENTATION TECHNOLOGY

Subject Code  :  14BBC21      IA Marks  :  50
No. of Lecture Hrs./ Week :  04      Exam Hrs :  03
Total No. of Lecture Hrs. :  50      Exam Marks :  100

Course objectives:

- Appreciate the theoretical principles and applications of the Fermentation processes and technologies that are useful for life science projects.

Course Outcomes:

At the end of the course the graduates should be able to:

- Demonstrate strong appreciation in applying the concepts and skills towards fermentation processes, which serves as a foundation to tackle live problems in various spheres of bioengineering.

MODULE I:
History of development of Fermentation Industry, The range of fermentation process, Microbial biomass, enzymes, metabolites, recombinant products, Transformation process, the component parts of Fermentor. Types of industrial bioprocesses; submerged, surface, solid state fermentations: aerobic, anaerobic and light based processes. The differences between laboratory, pilot, and manufacturing scale bioreactor experiments, Green biologics of fermentation technology, types of Reactor and reactor design, process economics. Discussions with case studies.

10 HOURS

MODULE II:
Primary and secondary screening of industrially important microbes, Screening methods, General Techniques in improvement of industrial strains, Isolation of auxotrophic mutants, resistant mutants, revertant mutants, Selection by induced mutants producing improved yields of secondary metabolites. Preservation and storage at reduced temperature; Agar slopes, liquid nitrogen, dehydrated form, dried culture and lyophilisation. Quality control of preservation of stock cultures.

10 HOURS

MODULE III:

10 HOURS

MODULE IV:

10 HOURS

10 HOURS

TEXT BOOKS:

REFERENCES BOOKS:
BIOREACTOR PLANT DESIGN

Subject Code : 14BBC22  IA Marks : 50
No. of Lecture Hrs./ Week : 04  Exam Hrs : 03
Total No. of Lecture Hrs. : 50  Exam Marks : 100

Course objectives:
• Appreciate the theoretical aspects, instrumentation and components of bioreactors, and their applications to the design concepts via CAED.

Course Outcomes:
At the end of the course the graduates should be able to:
• Demonstrate strong appreciation in applying the concepts and skills towards design of bioreactors and fermenters via CAED

MODULE I:
Bioprocess definition, objectives, Material and energy balance involved, Energy based calculation involved in bioprocess technology (Upstream and Downstream process Both steady state and Unsteady state), Process Flow diagrams development, validation (introduction, structure and resources for validation) and Validation of biopharmaceutical facilities, validation of systems and processes including SIP and CIP, cGMP guidelines.
Seed culture and inoculum development, culture cell banks, Operational models of reactors (Batch, continuous, Fed Batch, repetitive batch, recycle and continuous cultivation), Novel bioreactors (Stirred tank, Air lift & Loop reactors, fluidized bed reactor, Packed bed and Hollow fiber membrane bioreactors, immobilized Bioreactor), Bioreactors for waste treatment processes; SSF bioreactors, Selection of bioprocess equipment (upstream and downstream), heat transfer and mass transfer equipments.

10 HOURS

MODULE II:
Basic design and construction of fermenters and its auxiliaries, Material of construction, Vessels for Bioprocess (Vessel geometry and vessel design), bearing assemblies, Motor drives, Aseptic seals, Flow measuring and control devices, Agitator and Sparger Design, piping, valves, Pressure relief system, Conveyor and elevator, sensors and instrumentation, control system and stability of control system.

10 HOURS

MODULE III:
Reactor configuration, Facility design aspects and Utility supply aspects, Equipment cleaning aspects, Design considerations for maintaining sterility of process streams and process equipment, Materials of construction for bioprocess plants.
Medium requirements and formulation for fermentation processes (examples of simple and complex media), design and usage of commercial media for industrial fermentations, Batch and continuous heat sterilization of liquid media, Filter sterilization of liquids, Air sterilization-Techniques involved, sterility test and integrity test, Inoculation process, sampling process, cell harvesting, Cooling of fermenter system, water system for bioprocess industry (production of triple distilled water), Primary packing and secondary packing, waste disposable technology, environmental aspects.

10 HOURS

MODULE IV:
Mass transfer in heterogeneous biochemical reaction systems; Oxygen transfer in submerged fermentation processes, Oxygen uptake rates and determination of oxygen transfer coefficients
(k_{\text{L}}), role of aeration and agitation in oxygen transfer. Heat transfer processes in biological systems. Numerical using Reynold’s, Prandtl’s, Chilton & Colburn analogies.

Scale up and scale down issues. Effect of scale up on oxygenation, mixing, sterilization, pH, temperature, nutrient availability and supply; Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients. Scale up of downstream processes: Adsorption; (LUB method); Extractors (geometry based rules); Filtration (cross flow filtration, TFF) Chromatography (constant resolution etc.); Centrifugation (equivalent times etc.). Scale-down related aspects. 10 HOURS

MODULE V:
Concepts of CAED, Detailed process and mechanical design of the following equipments via CAED – Agitated and jacketed vessels, fermenter vessels, shell and tube heat exchanger and double pipe heat exchanger. Types of joints (welded), pipe and pipe fittings. 10 HOURS

TEXT BOOKS

REFERENCE BOOKS
PLANT AND ANIMAL BIOTECHNOLOGY

Subject Code : 14BBC23 IA Marks : 50
No. of Lecture Hrs./ Week : 04 Exam Hrs : 03
Total No. of Lecture Hrs. : 50 Exam Marks : 100

Course objectives:
- Biotechnology of Plant and Animal systems for diverse applications

Course Outcomes:
At the end of the course the graduates should be able to:
- Appreciate the concepts towards exploiting these systems for diverse Biotechnological applications

MODULE I:
Introduction to plant tissue culture. Tissue culture media (composition and preparation) Sterilization methods; Culture media and growth regulators; Various types of culture and single cell isolation techniques; callus, suspension, Totipotency: Organogenesis, somatic embryogenesis. Embryo culture. Androgenesis and gynogenesis. Endosperm culture. Protoplast culture, selection of cybrids and asymmetric hybrids. Cryopreservation. 10 HOURS

MODULE II:
Introduction to Plant Genetic Engineering: Gene isolation – General strategies for cloning genes from plants. Types of plant vectors; Ti and Ri-plasmids: structure and functions, Ti plasmid based vectors, advantages. Gene transfer techniques in plants; Vector mediated (Agrobacterium and Virus mediated gene transfer), Direct gene transfer (Physical and Chemical methods). Screening and selection of transformants – Marker genes (Reporter genes and selectable markers). Molecular markers and Marker-Assisted selection- Non-PCR based approaches (RFLP) and PCR based techniques- RAPD, AFLP, SSRs, STS. 10 HOURS

MODULE III:
Transgenics for long shelf life of fruits , Stress Resistance, Herbicide resistance - phosphinothricin, glyphosate, atrazine; Insect resistance, Transgenics for increased nutritional quality (Golden Rice), male sterile lines- barstar and barnase systems, Molecular farming for the production of lipids & fatty acids, biodegradable plastics (polyhydroxybutyrate), industrial enzymes antibodies, edible vaccines. 10 HOURS

MODULE IV:
Biology of cultured cells. Animal Cell culture media- Physiochemical properties, Balanced salt solutions, complete media, Serum containing and Serum- free media. Primary culture- Types, Primary explants and method of tissue disaggregation, Chick embryo cell culture, Mouse embryo cell culture, Human biopsy materials. Subculture and Propagation of cell cultures. Quantitation and Cytotoxicity assays - hemocytometer, Electronic counting, Dye exclusion and inclusion tests, clonogenic assay, Metabolic assays, MTT based assay. Cell lines – Properties of finite and continuous cell lines, characterization, authentication, routine maintenance and preservation of cell lines. Contamination - Detection and Prevention of contaminants. Scale-up of animal cell cultures- Scale-up in suspension and monolayer. Immortalization of cell lines. 10 HOURS

MODULE V:
Invitro fertilisation and embryo culture., Embryo preservation, Artificial insemination, preparation of foster mother, embryo transfer, Cloning - concept of nuclear transfer, nuclear reprogramming and creation of Dolly; Stem cells - embryonic and adult stem cells, plasticity and concept of regenerative medicine; Gene therapy (ex vivo and in vivo), Transgenic animals: Methods of transgenesis and applications (biopharming, disease models, functional knockouts), Application of animal cell culture - Vaccine production, monoclonal antibody production, specialized cell types, Concepts of tissue engineering, outlines of human genome project, human disease genes, Molecular techniques for rapid diagnosis of genetic diseases., applications.

10 HOURS

TEXT BOOKS

REFERENCE BOOKS
6. HS Chawla, Biotechnology in Crop Improvement, Intl Book Distributing Company. 1998
14BB24 BIOSEPARATIONS AND PRODUCT RECOVERY

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**Course objectives:**
- To understand the theoretical aspects and components of Bioseparation techniques for due exploitation of these for diverse Biotechnological applications

**Course Outcomes:**
At the end of the course the graduates should be able to:
- Demonstrate strong appreciation in applying the concepts and skills towards exploiting these techniques for diverse Biotechnological applications

**MODULE I:**
Role and importance of downstream processing in biotechnological processes. Problems and requirements of bio product purification. Economics of downstream processing in biotechnology; cost cutting strategies, characteristics of biological mixtures, process design criteria for various classes of by-products (high volume, low valve products and low volume, high valve products).

**MODULE II:**
Primary separation and recovery process, cell disruption methods for intracellular products, removal of insoluble (particulate debris), centrifugation and filtration methods. Membrane based separations (dialysis, micro and ultra-filtration, reverse osmosis), theory design and configuration of membrane separation equipment application. Enrichment operations; precipitation methods (with salts, organic solvents and polymer extractive separations aqueous two phase extraction).

**MODULE III:**
Theory of Electrophoresis; Classification; Applications : Moving boundary electrophoresis, Zone Electrophoresis, Gel Electrophoresis, Continuous Gel Electrophoresis, Disc gel Electrophoresis, Agarose Gel Electrophoresis, Cellulose Acetate, Starch Gel and page (Polyacrylamide gel electrophoresis) and SDS - Polyacrylamide, High voltage electrophoresis, Isoelectric focusing, Immunelectrophoresis. Capillary electrophoresis. PFGE.

**MODULE IV:**
Adsorption and absorption, Kinds of adsorption interactions. Adsorption characteristics, molecular orientation, adsorption isotherms: quantitative Relationships; adsorption from solutions, and the importance of Adsorption phenomena. Principle and classification of chromatography, important terms of chromatography, Partition chromatography - Single dimensional (Both Ascending and Descending) and two dimensional chromatography; Paper chromatography, Thin layer chromatography, Adsorption Chromatography.

**MODULE V:**
Ion Exchange Chromatography, Gel Filtration Chromatography, Affinity Chromatography. Principle of HPLC, theory and calculations, Instrumentation both analytical and preparative, Types of Columns, Detectors; Sampling Methods; Applications of HPLC, LCMS, GCMS. FPLC, HPTLC. Drying techniques, Crystallization, lyophilisation, Pervaporation, super liquid extraction, foam based separations, in situ product removal, Single step purification,
TEXT BOOKS
2. Asenjo, Juan A. Asenjo Separation Processes in Biotechnology. CRC Press. 1990

REFERENCE BOOKS
7. David Freifelder Physical Biochemistry W H Freeman, 1982
**ELECTIVES – II**

**CELL CULTURE TECHNIQUES**

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Course objectives:

- To focus on theoretical aspects and components of Cell Culture Techniques for due exploitation of these for diverse Biotechnological applications.

Course Outcomes:

At the end of the course the graduates should be able to:

- Demonstrate the concepts of Cell Culture Techniques and its diverse applications to Biotechnological applications.

**MODULE I:**

Introduction to Plant Cell and Tissue Culture: Definition and technologies; Design of typical plant tissue culture laboratory and its management. Sterilization methods and principles; Plant tissue culture (PTC): Media composition, phytohormones and their selective usage, Concept of Cellular Totipotency. Callus & suspension cultures. Plant propagation: Regeneration through meristem and callus cultures; Somatic embryogenesis: production, preservation and use of somatic embryos as propagules; Artificial Seeds and Automation of Somatic Embryo Production. Embryo culture; Haploid plant production; Protoplast culture; Somatic hybridization; Induction & utilization of somatic variants; Cryopreservation: Storage of germplasm. **10 HOURS**

**MODULE II:**

Plant tissue culture and biosynthesis of secondary products: Principles and the technology, pharmaceutical, pigments, other natural products and beverage production; Kinetics, scale up and Characterization: optimization of physiochemical parameters. Plant secondary metabolites manipulation of different pathways (Metabolic engineering), genetic stability of production. Large scale production of secondary metabolites: Different types of reactors and their design; Biotransformation: Principle and applications; Commercialization of tissue culture technology: Concept of commercialization. **10 HOURS**

**MODULE III:**

Animal Cell culture techniques, Laboratory design & Equipments; sterilization of different materials used in animal cell culture; Aseptic concepts; Maintenance of sterility; Cell culture vessels. Media and reagents: Types of cell culture media; Ingredients of media; Physiochemical properties of the culture media; Balance salt solutions; Natural and artificial media, Serum and its importance, Serum free media, chemically defined media, Protein free media; Preparation and sterilization of cell culture media, serum and other reagents. **10 HOURS**

**MODULE IV:**

Primary culture techniques and cell lines; selection, isolation and preparation of tissue (mouse and chick embryo isolation); isolation of cells by tissue disaggregation; enzymatic & mechanical methods. Viability tests and Quantitation. Criteria for Sub culture. Secondary culture. Characterization and maintenance of cell lines. Continuous cell lines, Organotypic culture, preservation of cell lines. Common cell culture contaminants. Biology of cultured cells. Stem
cells; Types, identification, culture and applications. Scale up studies. Concepts of tissue engineering and case studies.

**MODULE V:**

**TEXT BOOKS**

**REFERENCE BOOKS**
EFFLUENT TREATMENT AND MANAGEMENT

Subject Code : 14BBC252  IA Marks : 50
No. of Lecture Hrs./ Week : 04  Exam Hrs : 03
Total No. of Lecture Hrs. : 50  Exam Marks : 100

Course objectives:
- To understand the significance of sustainable development and protection of ecosystem
- To comprehend the importance of various waste treatment technologies to protect earth
- To apply the principles of biotechnology to clean up pollution in environment
- Enabling to understand the importance of environmental management techniques in assessing the impacts due to pollution.

Course Outcomes:
At the end of the course :
- Student should demonstrate the ability to use biotechnology for sustainable development.
- Students should be learning the designing the pollution control equipments to treat pollutants.
- Students entrusted with ability to use principles of biotechnology to protect ecosystem.

MODULE I:
Concerns pertaining to Ecological damage, Environmental Pollution Types - Water, Soil, Air, Noise and Thermal pollutions, their sources and ecological effects of pollutants on living and non-living systems. Soil erosion, its control techniques and sediment control. Acid rain: sources and solutions. Significance of GHGs and carbon footprint; Biodegradation, of xenobiotic compounds, organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants and microbial treatment of oil pollution. Extraction of metals from ores; Recovery of metals from solutions; Microbes in petroleum extraction; Microbial desulfurization of coal. Environmental implications of Acid mine drainage and its remediation; Role of Biotechnology in providing solutions to environmental problems.  
10 HOURS

MODULE II:
BOD, COD and TOC – Estimation and correlation; Definition of Waste; Physical, Chemical and Biological characteristics of Industrial waste. Nitrification and Denitrification and their kinetics; Wastewater treatment systems.Waste Management in different industries (food processing, leather tanning, pharmaceutical, textile) Solid waste management: landfills, composting, earthworm treatment, recycling and processing of organic residues, Sources and dispersion of atmospheric pollutants and dispersion models. Control methods for air pollutants, noxious pollutants and odour control; Design of air pollution control equipments; Photochemical reactions.  
10 HOURS

MODULE III:
Types (Suspended and Attached growth processes), Aerobic and Anaerobic treatment of wastes; Other biological treatment process, Anaerobic digestion – Stoichiometry & Kinetic relationships, design consideration, Process modeling and control, Biological nutrient removal, Biological treatments with Case studies; Bioremediation types and biorestoration of
contaminated lands. Handling of hazardous wastes from bioprocess industries and related case studies.  

**MODULE IV:**  
Characterization of water contaminants and their measurement, Spectroscopic techniques, AAS, NAA, GCMS, HPLC, Electro analytical techniques, Environmental sensing techniques. Discussions with Case studies.  

**MODULE V:**  

**TEXT BOOKS**  

**REFERENCE BOOKS**  
BIOPROCESS OPTIMIZATION, MODELING AND SIMULATION

Subject Code : 14BBC253  IA Marks : 50
No. of Lecture Hrs./ Week : 04  Exam Hrs : 03
Total No. of Lecture Hrs. : 50  Exam Marks : 100

Course objectives:
- To know the theoretical aspects and components of Bioprocess, optimization techniques, modeling and simulation methods for due exploitation of these for diverse Biotechnological applications

Course Outcomes:
At the end of the course:
- Students would demonstrate the ability to use the various skills related to Bioprocess, optimization techniques, modelling theories and simulation methods for due exploitation of these for diverse Biotechnological applications.

MODULE I:
Scope and hierarchy of optimization, examples of applications of optimization, the essential features, procedure of optimization problems, obstacles to optimization. Classification of models, fitting functions to empirical data, the method of least squares, factorial experimental designs, fitting a model to data subject to constraints, Continuity of functions, unimodal versus Multimodel functions. Convex and Concave functions, Convex region, Necessary and sufficient conditions for an extremum of an unconstrained function one-dimensional search quadratic approximation.

10 HOURS

MODULE II:
Numerical methods, function of one variable, scanning and bracketing procedures, Newton’s, Quasi-Newton’s and Secant methods of uni-dimensional search, region elimination methods, polynomial approximation methods, multivariable optimization: Direct methods, random search, grid search, uni-variate search, simplex method, conjugate search directions, Powell’s method, indirect methods- first order, gradient method, conjugate method, indirect method- second order: Newton’s method forcing the Hessain matrix to be positive definite, movement in the search direction, termination, summary of Newton’s method.

10 HOURS

MODULE III:
Optimization of Unit operations recovery of waste heat, STHE and DPHE (Pinch technology), optimal design of stages in distillation column. Optimal pipe diameter, optimal residence time for maximum yield in an ideal isothermal batch reactor, chemostat, optimization of thermal cracker using liner programming, Optimization of components in bioreactor- media, oxygen requirement, pH, temperature. L/D ratio, Flow rate optimization of fluids. Optimal speed of agitator, paddles.

10 HOURS

MODULE IV:
simulation. Random number generation and their techniques - tests for random numbers Random variable generation.

**MODULE V:**

**10 HOURS**

**TEXT BOOKS**

**REFERENCE BOOKS**
FERMENTATION TECHNOLOGY & BIOSEPARATION LAB

Subject Code : 14BBC26       IA Marks : 25
No. of Lecture Hrs./ Week : 03       Total No. of Lecture Hrs. : 36
Exam Hrs : 03                      Exam Marks : 50

Course Objectives:

• Appreciate the theoretical principles and Practical applications of the Fermentation processes and technologies that are useful for life science projects.
• Appreciate the practical aspects and components of Bio separation techniques for due exploitation of these for diverse Biotechnological applications

Course Outcomes:

At the end of the course the graduates should be able to:

• Demonstrate the ability to interpret the growth kinetics of Microbes, purification processes and the concepts behind the analytical instruments employed in the industry.
• Comprehend the essentials of design of Bioreactors / fermenters that would prepare them to leverage their knowledge of biological molecules / products, for scale up operations and productions.

1. Development of inoculum and biomass estimation (dry weight basis) in Shake flask studies
2. Preparation of the fermenter
3. Production and estimation of citric acid in both SSF and submerged fermentation
4. Production of ethanol/enzymes in fermenter- Study of product formation kinetics and substrate utilization
5. Production ethanol/enzyme by immobilized microbes
6. Purification of intracellular products through cell disruption techniques (homogenation/sonication)
7. Separation of biomass/product through tangential flow filtration (TFF)
8. Product enrichment operation through two phase aqueous extraction
9. Analysis of biomolecules through TLC/HPLC
10. Separation of Enzymes through gel and ion exchange chromatography
11. Molecular weight determination of protein by both native and SDS PAGE
12. Characterization protein by western blotting

TEXT/REFERENCE BOOKS

SEMESTER III

INTERNSHIP / PROJECT WORK ACTIVITIES
SEMESTER IV

RESEARCH METHODOLOGY, BIOSAFETY & IPR
Subject Code : 14BBC41 IA Marks : 50
No. of Lecture Hrs./ Week : 04 Exam Hrs : 03
Total No. of Lecture Hrs. : 50 Exam Marks : 100

COURSE OBJECTIVES

• To understand and apply the different methodologies of scientific research.
• To be capable of applying the principles of biosafety guidelines in the use of genetically modified organisms.
• To be able to define and distinguish between the various types of intellectual property protection in their respective context.

COURSE OUTCOMES

At the end of the course the graduates should be able to:
  o demonstrate the ability to use research methodology tools in a stepwise, logical fashion.
  o capable of examination and evaluation of biosafety requirements while designing experiments.
  o endowed with the ability to discriminate between different types of IPR safeguards and their mode of application.

MODULE I:
Concept of Research: types & classification, steps involved. Identification of the research question, hypotheses, and justification for the topic. Literature Collection: Review of literature, research/discriminative reading, consulting source material. Research Objectives and hypothesis. Research Design: detailed discussion of the conceptualization and operationalization of variables. Research method and materials. Research action. Data collection and analysis plan: data gathering – thorough description of methods of data gathering and sources.; Analytical techniques – detailed discussion of data gathering and analytical methods, including explanation of their suitability of these techniques compared with others and any possible problems arising from the methods selected; application and execution of analytical techniques and interpretations of findings. Format for manuscript writing, documentation, organization of reference material, bibliography, end note etc to be discussed with case studies. Research budget and resources. 10 HOURS

MODULE II:
Introduction to Intellectual Property; Types of IP: Patents, Trademarks, Copyright & Related Rights, Issues related to plagiarism in research, copyright laws, acknowledging the sources etc to be discussed with case studies. Basics of Patents and Concept of Prior Art; Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of “prior art”; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENTScope(WIPO), IPO, etc.) 10 HOURS

MODULE III:
Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies. Patent filing
procedures; National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies.

**10 HOURS**

**MODULE IV:**
Biosafety; Introduction & historical background; Primary Containment for Biohazards; Biosafety Levels for Microbes, Plants & Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs: RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication. Roles of Institutional Biosafety Committees.

**10 HOURS**

**MODULE V:**

**10 HOURS**

**TEXT BOOKS:**
1. C R Kothari Research Methodology, New Age International (P) Ltd. 2008
4. P. Hambleton, J. Melling, T. T. Salusbury Biosafety in industrial biotechnology - Springer

**REFERENCE BOOKS:**
ELECTIVES - III

FOOD PROCESS TECHNOLOGY

Subject Code : 14BBC421   IA Marks : 50
No. of Lecture Hrs./ Week : 04   Exam Hrs : 03
Total No. of Lecture Hrs. : 50   Exam Marks : 100

COURSE OBJECTIVES

• To understand theoretical principles and Practical applications of the Food processes and technologies that are useful for increase shelf life of food.
• Practical aspects and components of food processing techniques for due exploitation of these for diverse techniques in food processing and preservation

COURSE OUTCOMES

At the end of the course the graduates should be able to:
• Demonstrate strong appreciation in applying the concepts and skills towards exploiting these techniques for food processing and preservation
• Students capable of examination and evaluation of food quality.
• Students demonstrate the ability to use these techniques for sustainable development

MODULE I:
Food preservation methods (Including fresh food storage, Low temperature and High temperature Methods, Preservation by drying, additives, asepsis), Modified atmosphere storage, Fermentation and Irradiation for preservation, Preparation (assembly) Methods including Emulsification, Homogenisation and Extrusion, food safety & sanitation laws and Regulations, Good Manufacturing Practices. Heat and mass Transfer in Food processing, Food Rheology, principle and theory (Freezing of Foods and freeze concentration, Food dehydraion and Extraction process), Kinetics of Chemical Reaction in foods. Steady-state and Unsteady-state heating and cooling of foods. Heat exchangers used in the food process industry. Heat transfer in agitated vessels. Effects of heat on foods. Heat sources (steam, microwave, RF). 10 HOURS

MODULE II:
Thermal inactivation kinetics, Thermal death time relationships, Process sterilizing value, Heat transfer in canned foods, thermal Process calculations (general methods, Ball formula method), Commercial sterilization systems (batch, continuous retort systems), Aseptic processing, Thermodynamics of food freezing. Phase diagrams, Properties of frozen foods, Freezing-time calculations, Freezing systems, Transport phenomena in freeze concentration. Economics of freeze concentration. 10 HOURS

MODULE III:
Thermodynamics of food evaporation, Thermal sensitivity of foods, Physical and chemical properties of foods related to evaporation, Types of evaporators, Evaporator calculations (single and multiple effect evaporators), Vapor recompression, Transport phenomena in evaporation. Instrumentation, control, automation. Economics of evaporation.
Equilibrium moisture content and water activity, Water sorption isotherms of foods, Drying rates, Transport phenomena in food dehydration, Quality changes in food during drying, Types of dryers, Dryer design and calculations, types of drying (Microwave, Infrared radiation, Electric and magnetic field, Sun drying). 10 HOURS
MODULE IV:
Filtration (Constant and falling rate filtration, Continuous filtration, Effects of compaction and of fouling, Filtration agents, Equipment.), Sedimentation in air and in liquids, Centrifugation (equations, effects of concentration, equipment), Membrane types and selection, Mechanisms of transport, Equipment, Classification of pressure-driven membrane processes (microfiltration, ultrafiltration, and reverse osmosis). 10 HOURS

MODULE V:
Rheology of extruder, Single and multiple screw extruders, Newtonian and non-Newtonian models for extruders, Dies, Power consumption. Residence-time distributions, Heat transfer in extruders, Cleaning and sanitation (Types of soil, Cleanliness criteria, Cleaning procedures and techniques), CIP systems, Cleaning agents, Cleaning kinetics and mechanisms. 10 HOURS

TEXT BOOKS

REFERENCE BOOKS
COURSE OBJECTIVES

- Concepts underlying in various biopharmaceuticals from different sources
- GMP practice, and the concepts behind the analytical instruments employed in the pharmaceutical industry.

COURSE OUTCOMES

At the end of the course the graduates should be able to:

- Apply the concepts and skills towards isolation purification and identification of different biopharmaceuticals
- Students should be capable of examination and evaluation of quality of drugs and pharmacovigilence process.
- Students can easily differentiate between pharmaceuticals and biopharmaceuticals and their applications

MODULE I:
Pharmaceutical & Biopharmaceutical biotechnology, current status & future prospects. Pharmaceuticals of animal origin, plant origin, and of microbial origin. Drug discovery, rational drug design. Delivery of biopharmaceuticals, Pre-clinical trials & clinical trials in brief; The role of regulatory authorities. Ethical safeguards & role of regulatory authorities, Brief account of phases 0,1,2,3 & pharmacovigilance, clinical trial designs (random & crossover), basics of data collection & management, interpretation of data. 10 HOURS

MODULE II:

MODULE III:
Biology & synthesis of cytokines, cytokine receptors and interferons in vivo & in vitro through use of recombinant DNA technology: Types of interferons & signal transduction pathways, production and medical uses/applications of IFN-α, IFN-β, Medical a IFN-γ, Additional isolated interferons. Biological significance & in vitro rDNA-based methods of synthesis for Interleukins e.g IL-1 & 2, Tumour necrosis factors (TNFs); Growth factors: Insulin-like growth factors (IGFs), Epidermal growth factor (EGF), Platelet-derived growth factor (PDGF), Fibroblast growth factors (FGFs), Transforming growth factors (TGFs), Neurotrophic factors, neurotrophins, Ciliary neurotrophic factor and glial cell line-derived neurotrophic factor. 10 HOURS

MODULE IV:
Biological significance & in vitro rDNA-based methods of synthesis for: therapeutic protein hormones – insulin; vaccines- HBV and tetanus immunoglobulin; hybridoma technologies for MAbs, transplantation and anti-tumour antibodies; peptide & DNA-based vaccines, Enzymes:
Asparaginase, DNase, Glucocerebrosidase, a-Galactosidase and urate oxidase, Superoxide dismutase, Lactase.

MODULE V:
Basic concepts and novel advances, Brain-specific drug targeting strategies, Pulmonary drug delivery, Cell specific drug delivery. Case studies for each to be discussed.

10 HOURS

TEXT BOOKS

REFERENCE BOOKS
COURSE OBJECTIVES

- Concepts underlying the various aspects related to project execution, monitoring, financial matters, entrepreneurial skills, proof-of-concepts to product realization, product life cycles, marketing, IPs, regulatory affairs, etc.

COURSE OUTCOMES

At the end of the course the graduates should be able to:
- Demonstrate strong appreciation in applying the concepts and skills towards handling of projects, timelines, strategic planning, IP generations, entrepreneurship, regulatory affairs, financial matters etc.

MODULE I:


10 HOURS

MODULE II:


10 HOURS

MODULE III


10 HOURS

MODULE IV:

Industrial R&D and product development. Product development and project management in Agri, Pharma, Health and other biotech industries. Overview of issues and techniques involved in conducting & outcome of research. The multidisciplinary nature of outcomes research: research design and methods, data collection measurement instruments and clinical endpoints, quality of life issues, behavior change, and cost-effectiveness. Analysis Transition from R&D to business units. Product development, market learning and transition from R&D. Management of
radical innovation technologies vs. stage gate approach in product development. Case studies.  

**MODULE V:**
Rights and responsibilities of business under the Indian Constitutional system. Basic standards, rules, principles and issues relating to the law of corporations; core issues affect the corporate governance of business; relationship between management, boards and shareholders. Business laws applied to Biotech industries. 

**TEXT/REFERENCE BOOKS**
4. Graham Dutfield, IPR, Trade and Biodiversity, Earthscan publications, 2000