1. Conditions for Admission
Candidates for admission to the first year of the four-semester M.E / M.Tech Degree programme in Engineering shall be required to have passed B.E / B.Tech degree of Annamalai University or any other authority accepted by the syndicate of this University as equivalent thereto. They shall satisfy the conditions regarding qualifying marks and physical fitness as may be prescribed by the Syndicate of the Annamalai University from time to time. The admission for M.E Part Time programme is restricted to those working or residing within a radius of 90 km from Annamalainagar. The application should be sent through their employers.

2. Branches of Study in M.E / M.Tech
The Branch and Eligibility criteria of programmes are given in Annexure I

3. Courses of study
The courses of study along with the respective syllabi and the scheme of Examinations for each of the M.E / M. Tech programmes offered by the different Departments of study in the Faculty of Engineering and Technology are given separately.

4. Choice Based Credit System (CBCS)
The curriculum includes three components namely Program Core, Program Electives and Open Electives, Mandatory Learning Courses and Audit Courses in addition to Thesis. Each semester curriculum shall normally have a blend of theory and practical courses.

5. Assignment of Credits for Courses
Each course is normally assigned one credit per hour of lecture / tutorial per week and 0.5 credit for one hour of laboratory or project or industrial training or seminar per week. The total credits for the programme will be 68.

6. Duration of the programme
A student of M.E / M.Tech programme is normally expected to complete in four semesters for full-time / six semesters for part-time but in any case not more than four years for full-time / six years for part-time from the date of admission.

7. Registration for courses
A newly admitted student will automatically be registered for all the courses prescribed for the first semester, without any option. Every other student shall submit a completed registration form indicating the list of courses intended to be credited during the next semester. This registration will be done a week before the last working day of the current semester. Late registration with the approval of the Dean on the recommendation of the Head of the Department along with a late fee will be done up to the last working day. Registration for the Thesis Phase - I and Phase-II shall be done at the appropriate semesters.

8. Electives

8.1 Program Electives
The student has to select two electives in first semester, another two electives in the second semester and one more in the third semester from the list of Program Electives.

8.2 Open Electives
The student has to select two electives in third semester from the list of Open Electives offered by the Department and / or other departments in the Faculty of Engineering and Technology.

8.3 MOOC (SWAYAM) Courses
Further, the student can be permitted to earn credits by studying the Massive Open Online Courses offered through the SWAYAM Portal of UGC with the approval of the Head of the Department concerned. These courses will be considered as equivalent to open elective courses. Thus the credit earned through MOOC courses can be transferred and considered for awarding Degree to the student concerned.

8.4 Value added courses (Inter Faculty Electives)
Of the two open elective courses, a student must study one value added course that is offered by other Faculties in our University either in second or third semester of the M.E programme.

9. Industrial Project
A student may be allowed to take up the one program elective and two open elective courses of third semester (Full Time program) in the first and second semester, to enable him/her to carry out Project Phase-I and Phase-II in an industry during the entire second year of study. The condition is that the student must register those courses in the first semester itself. Such students should meet the teachers offering those elective courses themselves for clarifications. No specific slots will be allotted in the time table for such courses.

10. Assessment
10.1 Theory Courses
The break-up of continuous assessment and examination marks for theory courses is as follows:

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Marks</th>
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<tbody>
<tr>
<td>First assessment (Mid-Semester Test-I)</td>
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</tr>
<tr>
<td>Second assessment (Mid-Semester Test-II)</td>
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</tr>
<tr>
<td>Third Assessment</td>
<td>5</td>
</tr>
<tr>
<td>End Semester Examination</td>
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</table>

10.2 Practical Courses
The break-up of continuous assessment and examination marks for Practical courses is as follows:

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Marks</th>
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<tr>
<td>First assessment (Test-I)</td>
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<tr>
<td>Second assessment (Test-II)</td>
<td>15</td>
</tr>
<tr>
<td>Maintenance of record book</td>
<td>10</td>
</tr>
<tr>
<td>End Semester Examination</td>
<td>60</td>
</tr>
</tbody>
</table>

10.3 Thesis work
The thesis Phase I will be assessed for 40 marks by a committee consisting of the Head of the Department, the guide and a minimum of two members nominated by the Head of the Department. The Head of the Department will be the chairman. The number of reviews must be a minimum of three per semester. 60 marks are allotted for the thesis work and viva voce examination at the end of the third semester. The same procedure will be adopted for thesis Phase II in the fourth semester.

10.4 Seminar / Industrial Training
The continuous assessment marks for the seminar / industrial training will be 40 and to be assessed by a seminar committee consisting of the Seminar Coordinator and a minimum of two members nominated by the Head of the Department. The continuous assessment marks will be awarded at the end of the seminar session. 60 marks are allotted for the seminar / industrial training and viva voce examination conducted based on the seminar / industrial training report at the end of the semester.

11. Student Counselors (Mentors)
To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a member of the faculty who shall function as student counselor (mentor) for those students throughout their period of study. Such student
counselors shall advise the students in selecting open elective courses from, give preliminary approval for the courses to be taken by the students during each semester, and obtain the final approval of the Head of the Department monitor their progress in SWAYAM courses / open elective courses.

12. Class Committee
For each of the semesters of M.E / M.Tech programmes, separate class committees will be constituted by the respective Head of the Departments. The composition of the class committees from first to fourth semesters for Full time and first to sixth semesters for Part-time will be as follows:

- Teachers of the individual courses.
- A Thesis coordinator (for Thesis Phase I and II) shall be appointed by the Head of the Department from among the Thesis supervisors.
- A thesis review committee chairman shall be appointed by the Head of the Department.
- One Professor or Associate Professor, preferably not teaching the concerned class, appointed as Chairman by the Head of the Department.
- The Head of the Department may opt to be a member or the Chairman.
- All counselors of the class and the Head of the Department (if not already a member) or any staff member nominated by the Head of the Department may opt to be special invitees.

The class committee shall meet three times during the semester. The first meeting will be held within two weeks from the date of class commencement in which the type of assessment like test, assignment etc. for the third assessment and the dates of completion of the assessments will be decided.

The second meeting will be held within a week after the completion of the first assessment to review the performance and for follow-up action.

The third meeting will be held after all the assessments but before the University semester examinations are completed for all the courses, and at least one week before the commencement of the examinations. During this meeting the assessment on a maximum of 25 marks for theory courses / 40 marks for practical courses, for Industrial Training and for Thesis work (Phase-I and Phase-II) will be finalized for every student and tabulated and submitted to the Head of the Department for approval and transmission to the Controller of Examinations.

13. Temporary Break Of Study
A student can take a one-time temporary break of study covering the current semester and / or the next semester with the approval of the Dean on the recommendation of the Head of the Department, not later than seven days after the completion of the mid-semester test. However, the student must complete the entire programme within the maximum period of **four years for Full time / six years for Part time.**

14. Substitute Assessments
A student who has missed, for genuine reasons accepted by the Head of the Department, one or more of the assessments of a course other than the end of semester examination may take a substitute assessment for any one of the missed assessments. The substitute assessment must be completed before the date of the third meeting of the respective class committees.

A student who wishes to have a substitute assessment for a missed assessment must apply to the Head of the Department within a week from the date of the missed assessment.
15. **Attendance Requirements**

The students with 75% attendance and above are permitted to appear for the University examinations. However, the Vice Chancellor may give a rebate / concession not exceeding 10% in attendance for exceptional cases only on Medical Grounds.

A student who withdraws from or does not meet the minimum attendance requirement in a semester must re-register and repeat the same semester in the subsequent academic years.

16. **Passing and declaration of Examination Results**

All assessments of all the courses on an absolute marks basis will be considered and passed by the respective results passing boards in accordance with the rules of the University. Thereafter, the controller of examinations shall convert the marks for each course to the corresponding letter grade as follows, compute the grade point average (GPA) and cumulative grade point average (CGPA) and prepare the mark sheets.

<table>
<thead>
<tr>
<th>Marks</th>
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<tr>
<td>90 to 100</td>
<td>‘S’</td>
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<tr>
<td>80 to 89</td>
<td>‘A’</td>
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<tr>
<td>70 to 79</td>
<td>‘B’</td>
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<tr>
<td>60 to 69</td>
<td>‘C’</td>
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<tr>
<td>55 to 59</td>
<td>‘D’</td>
</tr>
<tr>
<td>50 to 54</td>
<td>‘E’</td>
</tr>
<tr>
<td>Less than 50</td>
<td>‘RA’</td>
</tr>
<tr>
<td>Withdrawn from Examination</td>
<td>‘W’</td>
</tr>
</tbody>
</table>

A student who obtains less than 30 / 24 marks out of 75 / 60 in the theory / practical examinations respectively or is absent for the examination will be awarded grade RA.

A student who earns a grade of S, A, B, C, D or E for a course is declared to have successfully completed that course and earned the credits for that course. Such a course cannot be repeated by the student.

A student who obtains letter grade RA / W in the mark sheet must reappear for the examination of the courses.

The following grade points are associated with each letter grade for calculating the grade point average and cumulative grade point average.

- S - 10
- A - 9
- B - 8
- C - 7
- D - 6
- E - 5
- RA - 0

Courses with grade RA / W are not considered for calculation of grade point average or cumulative grade point average.

A student can apply for re-totaling of one or more of his examination answer papers within a week from the date of issue of mark sheet to the student on payment of the prescribed fee per paper. The application must be made to the Controller of Examinations with the recommendation of the Head of the Department.

After the results are declared, mark sheets will be issued to the students. The mark sheet will contain the list of courses registered during the semester, the grades scored and the grade point average for the semester.

GPA is the sum of the products of the number of credits of a course with the grade point scored in that course, taken over all the courses for the semester, divided by the sum of the number of credits for all courses taken in that semester.

CGPA is similarly calculated considering all the courses taken from the time of admission.

17. **Awarding Degree**

After successful completion of the programme, the degree will be awarded with the following classifications based on CGPA.

For First Class with Distinction the student must earn a minimum of 68 credits within four semesters for full-time / six semesters for Part time from the time of admission, pass all the courses in the first attempt and obtain a CGPA of 8.25 or above.
For First Class, the student must earn a minimum of 68 credits within two years and six months for full-time / three years and six months for Part time from the time of admission and obtain a CGPA of 6.75 or above. For Second class, the student must earn a minimum of 68 credits within four years for full-time / six years for Part time from the time of admission.

18. **Ranking of Candidates**

The candidates who are eligible to get the M.E /M.Tech degree in First Class with Distinction will be ranked on the basis of CGPA for all the courses of study from I to IV semester for M.E / M.Tech full-time / I to VI semester for M.E / M.Tech part-time.

The candidates passing with First Class and without failing in any subject from the time of admission will be ranked next to those with distinction on the basis of CGPA for all the courses of study from I to IV semester for full-time / I to VI semester for M.E / M.Tech part-time.

19. **Transitory Regulations**

If a candidate studying under the old regulations M.E. / M.Tech could not attend any of the courses in his/her courses, shall be permitted to attend equal number of courses, under the new regulation and will be examined on those subjects. The choice of courses will be decided by the concerned Head of the department. However he/she will be permitted to submit the thesis as per the old regulations. The results of such candidates will be passed as per old regulations.

The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the courses of study and the syllabi from time to time.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Department</th>
<th>Programme (Full Time &amp; Part time)</th>
<th>Eligible B.E./B.Tech Programme</th>
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<tbody>
<tr>
<td>1</td>
<td>Chemical Engineering</td>
<td>i. Chemical Engineering</td>
<td>B.E. / B.Tech – Chemical Engg, Petroleum Engg, Petrochemical Technology</td>
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<tr>
<td></td>
<td></td>
<td>iii. Industrial Bio Technology</td>
<td>B.E. / B.Tech – Chemical Engg, Food Technology, Biotechnology, Leather Technology</td>
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<td></td>
<td>iv. Industrial Safety Engineering</td>
<td>B.E. / B.Tech – Any Branch of Engineering</td>
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<td>ii. Environmental Engineering &amp; Management</td>
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<tr>
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<td>ii. Construction Engg. and Management</td>
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<tr>
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<td>iii. Geotechnical Engineering</td>
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<tr>
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<td></td>
<td>iv. Disaster Management &amp;Engg.</td>
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<tr>
<td></td>
<td></td>
<td>ii. Smart Energy Systems</td>
<td>B.E. / B.Tech – Electrical and Electronics Engg, Control and Instrumentation Engg, Electronics and communication Engg, Electronics and communication Engg,</td>
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<td>iii. Power System</td>
<td>B.E. / B.Tech – Electrical and Electronics Engg, Control and Instrumentation Engg, Electronics and communication Engg,</td>
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<td>Electronics &amp; Instrumentation Engineering</td>
<td>i. Process Control &amp; Instrumentation</td>
<td>B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electornics Engg, Control and</td>
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<td>8</td>
<td>Information Technology</td>
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<td>B.E. / B.Tech - Computer Science and Engineering, Information Technology, Electronics and Communication Engg, Software Engineering</td>
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<tr>
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</tr>
</tbody>
</table>
DEPARTMENT OF CHEMICAL ENGINEERING

M.Tech INDUSTRIAL BIOTECHNOLOGY

VISION

Our vision is to be a leading Chemical Engineering Department in the Nation, to create and develop technocrats, entrepreneurs and business leaders

MISSION

The department fosters chemical engineering as a profession that interfaces engineering and all aspects of basic sciences to disseminate knowledge in order to prepare the students to be successful leaders and practitioners and to meet the present and future needs of the society by highest degree of standards and ethics.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

I. To provide students with solid fundamentals and strong foundation in statistical, scientific and engineering subjects required to create and innovate in the field of biotechnology.

II. To train students with good scientific and technical knowledge so as to comprehend, analyze, design, and create novel products and solutions for developing novel therapeutics and enzymes.

III. To prepare students to excel and succeed in Biotechnology research or industry through the latest state-of-art post graduate education.

IV. This course enables the student to develop good communication and leadership skills, respect for authority, loyalty, necessity of bioethics, social responsibility, awareness of the environment and the life-long learning needed for a successful scientific and professional career.

PROGRAM OUTCOMES (POs):

On successful completion of the Masters in Biotechnology graduates will be able to

1. Acquire in depth knowledge of Biological science and Bioengineering for gaining ability to develop and evaluate new ideas
2. Demonstrate Scientific and technological skills to design and perform research through modern techniques for the development of high throughput process and products.

3. Analyze Biotechnological problems and formulate intellectual and innovative vistas for research and development.

4. Provide potential solutions for solving technological problems in various domains of Biotechnology considering the societal, public health, cultural environmental factors.

5. Examine the outcomes of Biotechnological issues critically and gain knowledge for composing suitable corrective measures.

6. Create and apply modern engineering tools for the prediction and modeling of complex bioengineering activities.

7. Posses self management and team work skills towards collaborative, multidisciplinary scientific endeavors in order to achieve common goals.

8. Develop entrepreneurial and managerial skills for the implementation of multidisciplinary projects.

9. Demonstrate adherence to accepted standards of professional bioethics and social responsibilities.

10. Posses the attitude necessary for lifelong and acquire communication skills relevant to professional positions.

11. Acquire knowledge in advanced fermentation techniques catering to fulfill the need of the society.

12. Develop skills in genetic engineering, enzyme engineering and bioprocess engineering to meet out the needs of biotechnology industries.
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<thead>
<tr>
<th>Educational Objectives</th>
<th>Program Outcomes</th>
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<td>III</td>
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<td>IV</td>
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# FACULTY OF ENGINEERING AND TECHNOLOGY
## DEPARTMENT OF CHEMICAL ENGINEERING

Program: M.Tech

## CURRICULUM – 2019

### SEMESTER I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
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<td>Project work &amp; Viva-voice</td>
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# DEPARTMENT OF CHEMICAL ENGINEERING

Program: M.Tech (PART TIME)  
Specialization: Industrial Biotechnology

## CURRICULUM – 2019

### SEMESTER I

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LIST OF PROGRAM ELECTIVES

1. Immunotechnology
2. Metabolic Process and Engineering
3. Computer Aided Learning of Structure and Functions of proteins
4. Advanced Genetic Engineering
5. Animal Biotechnology
6. Phytochemistry
7. Advanced Genomics and Proteomics
8. Bioreactor Design and Analysis
9. Nanobiotechnology
10. Biofuels and BioRefinery Engineering
11. Bioprocess Modelling and Simulation
12. Cancer Biology
13. Analytical Techniques in Biotechnology
14. Biothermodynamics
15. Plant Biotechnology

Audit Course-I & II

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.

List of Open Electives

1. Biotechnology in Food Processing
2. Computational Fluid Dynamics
3. Environmental Biotechnology
4. Technology Management
COURSE OBJECTIVES
Enable the students
• To learn enzyme reactions and its characteristics along with the production and purification process
• To give the student a basic knowledge concerning biotransformation reactions with the usage of enzymes
• To understand the production process of Primary and Secondary metabolites

FUNDAMENTALS OFFERMENTATION

INDUSTRIAL FERMENTATION PROCESSES
Aerobic and anaerobic fermentations – Batch culture, continuous culture, fed batch culture – Comparison of batch and continuous culture – Submerged and solid state fermentation for the production of enzymes – Immobilization of enzymes and techniques for enzyme immobilization – Biocatalysis in organic media using enzymes – Biotransformation with crude enzymes and whole cells.

PRODUCTION OF ENZYMES AND METABOLITES
Production of Proteases, Cellulas, Lipase, Amylase, Glucose isomerase, Pectinase, Peroxidase Production of primary metabolites– organic acids (Citric acid, Lactic acid), amino acids (Glutamic acid, Lysine),alcohols (ethanol, butanol). Production of secondary metabolites – aminoacids (Glutamic acid, Lysine), antibiotics (Penicillin, streptomycin), Vitamins (Vitamin B12, Riboflavin)

ENZYME KINETICS
Overview of enzyme and its action – Time course of enzymatic reactions – Effects of substrateconcentration on velocity – Rapid equilibrium model of enzyme kinetics – Steady state model of enzyme kinetics – Significance of $k_{cat}$ and $K_m$ – Experimental Measurement of $k_{cat}$ and $K_m$ – Linear transformations of enzyme kinetic data – Bi Bi reaction mechanisms – Modes of reversibleinhibition- Allosteric regulation of enzymes.

APPLICATIONS OF ENZYMES
Enzymes in organic synthesis – Enzymes as biosensors – Enzymes for food, pharmaceutical, tannery, textile, paper and pulp industries – Enzyme for environmental applications- Enzymes for analytical and diagnostic applications – Enzymes for molecular biology research.
REFERENCES:

COURSE OUTCOMES
At the end of this course, students will be able to
1. Acquire knowledge on enzyme and enzyme reactions that will be the key step in to proceed towards various concepts in biotechnology.
2. Understand the theoretical and practical aspects of kinetics will provide the importance and utility of enzyme kinetics towards research.
3. Know the process of immobilization in food, pharmaceutical and chemical industries and will provide simple and easy method of implementation.
4. Get ideas on Processing, Production and Purification of enzymes and metabolites at an industrial scale will be helpful to work technologically.
5. Acquire knowledge on applications of enzymes in food, pharma industries and effluent treatments.

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COURSE OBJECTIVES
Enable the students
• To improve the programming skills of the student in the field of Biological research.
• To know the recent evolution in biological databank usage
• To apply the knowledge of computer tools in biotechnology

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LINUX OS AND PERL

BIOLOGICAL SEQUENCES AND DATABANKS
Introduction to Biological sequences and methods of sequencing, Biological databases: Primary, Secondary and Composite databanks - Scoring matrices: PAM, BLOSUM - Data lifecycle

SEQUENCE ANALYSIS

DATA ANALYSIS AND VISUALIZATION

STRUTURAL ANALYSIS
Protein structure visualization and prediction: Pymol, Rasmol, ab initio folding, Threading, Homology modelling - RNA structure prediction, Mfold - Molecular dynamics: Rosetta - protein-ligand docking – QSAR-Protein-protein interaction

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Develop bioinformatics tools with programming skills.
2. Apply computational based solutions for biological perspectives.
3. Acquire knowledge on sequencing techniques
4. Gain knowledge in computer based tools in Bioinformatics
5. Develop skills on structural analysis of proteins and data analysis of gene
### COURSE OBJECTIVES

Enable the students

- To improve the basic knowledge and concepts in the field of research.
- To understand the importance patent right
- To know the importance of intellectual property rights

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Effective literature studies approaches, analysis Plagiarism, Research ethics,

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee


Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

### REFERENCES:

2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

COURSE OUTCOMES
At the end of this course, students will be able to
1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

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COURSE OBJECTIVES
Enable the students
- To learn and understand the principles behind the qualitative and quantitative estimation of bio molecules and laboratory analysis of the same in the body fluids
- To have a practical hands on experience on Absorption Spectroscopic methods and to validate spectrometric and microscopic techniques
- To acquire experience in the purification by performing chromatography
EXPERIMENTS
1. Estimation of amino acids by Ninhydrin method
2. Estimation of total sugars by Phenol sulphuric acid method
3. Estimations of carbohydrates – reducing vs non-reducing, polymeric vs oligomeric, hexose vs pentose.
4. Estimation of protein concentration using Lowry’s and Bradford method
5. DNA determination by UV-visible spectrophotometer – hyperchromic effect.
6. Separation of amino acids and lipids by TLC.
7. Enzyme kinetics: Determination of Km, Vmax and Kcat, Kcat/ Km.
8. Restriction enzyme – Enrichment and unit calculation.
10. Gel filtration – Size based separation of proteins.
12. Extraction and characterization of photochemical using UV-visible spectrophotometer.
13. Separation of compounds using Column chromatography.

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Quantify Bio molecules using spectroscopy methods
2. Purify enzymes and metabolites using Chromatography techniques
3. Solve problems related Enzyme involved reactions and kinetics
4. Design processes for the recovery and subsequent purification of target biological products.
5. Learn about the analytical techniques in estimation of bio molecules

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IMMUNOTECHNOLOGY LABORATORY ADVANCED AND GENETIC ENGINEERING

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COURSE OBJECTIVES
Enable the students

- To give practical exposure in the clinical diagnosis.
- To give laboratory training in different immunotechnological techniques.
- Provide hands-on experience in performing basic recombinant DNA techniques.
- To understand the principle behind each techniques and applications of each methodology in applied biological research.

IMMUNOTECHNOLOGY
1. Collection of serum, storage and purification of total IgG (salt precipitation).
2. Evaluation of Antibody titre by direct ELISA
3. Evaluation of Antigen by Sandwich ELISA
4. Characterization of antigens by native and SDS-PAGE
5. Characterization of antigens by Western blot analysis – Wet and semidry transfer
6. Conjugation of Immunoglobulin’s (Streptavidin, colloidal gold)
7. Methods for prototype development of Immunodiagnostics (ICT card)
8. Blood smear identification of leucocytes by Giemsa stain
9. Separation of mononuclear cells by Ficoll-Hypaque
10. Separation of spleenocytes and proliferation against mitogens

GENETIC ENGINEERING
1. Isolation of DNA
2. Electroporation to Yeast
3. Isolation of RNA
4. cDNA synthesis
5. Primer designing
6. Real-time PCR
7. Plasmid isolation and confirming recombinant by PCR and RE digestion.
8. Western blot with ECL detection
9. Site directed mutagenesis
10. Southern blot (Non-radioactive)

Required Equipments:

Microscopes, restainer (mouse, rat, rabbit), purification columns, microplate reader, UV spectrometer, PAGE apparatus, Western blot apparatus (dry/semi-dry/wet), centrifuge, Haemocytometer, required strains & consumables

Microscopes, PCR, purification columns, microplate reader, UV spectrometer, PAGE apparatus, Western blot apparatus (dry/semi-dry/wet), Southern blot apparatus, centrifuge, Haemocytometer, required stains, chemicals, enzymes & consumables

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Know on immunological / clinical tests.
2. Understand the main principles, methods for preparation and cloning of DNA in various organisms.
3. Express clearly about the gene amplification and methods for analysis of DNA, such as hybridization, restriction analysis and gene expressions.
4. Know clearly about the gene amplification and methods for analysis of DNA, such as hybridization, restriction analysis and gene expressions.
5. Use genetic and biotechnological techniques to manipulate genetic materials and develops new and improved living organisms.

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COURSE OBJECTIVES
Enable the students
- To impart knowledge on design and operation of fermentation processes with all its prerequisites.
- To endow the students with the basics of microbial kinetics, metabolic stoichiometry and energetics.
- To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

METABOLIC STOICHIOMETRY AND ENERGETICS
Outline of Stoichiometry and energetics – Growth yields, Growth yields based on total energy and ATP generation – Conservation of mass principles - Carbon and oxygen balances, ATP generation during growth – Relationship between substrate consumption, growth, respiration and noncellular products – Growth energetics of aerobic and anaerobic process – Case studies on
mass and energy balance for Embden–Meyerhoff–Parnas pathway, continuous ethanol fermentation, penicillin production.

**MICROBIAL GROWTH, KINETICS, MAINTENANCE AND PRODUCT**

**STRUCTURED MODELS**
Structured models for growth and product formation – Compartmental and metabolic models – Mechanistic models - Product formation kinetics – Gaden’s and Deindoerfer’s classifications – Chemically and genetically structured models – Kinetics models of heterogenous bioprocesses – Biofilm kinetics, Unstructured models of pellet growth – Considerations for the production of r-DNA products.

**MASS TRANSFER IN BIOLOGICAL SYSTEMS**
Interphase Gas-Liquid mass transfer – General oxygen balances for Gas-Liquid transfer – Models for oxygen transfer in large scale bioreactors – Case studies for large scale bioreactors – Model for oxygen gradients in a bubble column bioreactor, air lift bioreactor – Model for a multiple impeller fermenter – Gas-liquid mass transfer of components other than oxygen.

**DIFFUSION AND BIOLOGICAL REACTION IN IMMOBILIZED BIOCATALYST**

**REFERENCES**

**COURSE OUTCOMES**
At the end of this course, students will be able to
1. Apply engineering principles to systems containing biological catalysts to meet the needs of the society.
2. Interpret the kinetics of living cells and to develop a strategy to solve the issues emerging during fermentation processes.
3. Gain knowledge on modeling of biological systems
4. Apply the knowledge of mass transfer in biological systems
5. Acquire knowledge about effective factor of immobilized biological systems

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COURSE OBJECTIVES
Enable the students
- To understand the methods to obtain pure proteins, enzymes and in general about product development R & D
- To have depth knowledge and hands on experience on Downstream processes to commercial therapeutically important proteins.
- To gain knowledge on membrane separation of bio molecules

DOWNSTREAM PROCESSING IN BIOTECHNOLOGY
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 – Separation characteristics of proteins and enzymes – size, stability, properties – Flocculation and conditioning of broth – Process design criteria for various classes of bio products (high volume, low value products and low volume, high value products) – Upstream production methods affect downstream purification strategies.

PHYSICO-CHEMICAL BASIS OF BIO-SEPARATION PROCESSES

MEMBRANE SEPARATIONS AND ENRICHMENT OPERATIONS
Theory, Design consideration and configuration of membrane separation processes – Reverse osmosis, microfiltration, ultra filtration, dialysis and pervaporation – Structure and characteristics of membranes – Membrane modules – Enrichment Operations – Extraction equipment for extraction – Aqueous two-phase extraction process – Evaporators – Types of
evaporators – Adsorption isotherms and techniques – Protein precipitation – Methods of precipitation.

**MECHANISM AND MODES OF CHROMATOGRAPHIC SEPARATION**
Chromatography – Classification of chromatographic techniques – General description of column chromatography – Chromatographic terms and parameters – Practice of chromatography – Partition, normal-phase, displacement, reversed-phase, size exclusion, ion exchange, hydrophobic, affinity chromatography – Scale-up of chromatography – Process considerations in Preparative liquid chromatography and HPLC.

**FINISHING OPERATIONS AND FORMULATIONS**

**REFERENCES**

**COURSE OUTCOMES**
At the end of this course, students will be able to
1. Acquire knowledge about bio products and purifications strategies.
2. Apply advanced downstream processing methods for product recovery.
3. Know about the components of downstream equipment and shall be used in the effective design of separation system for successful operations.
5. Gain knowledge about finishing operation and formulation of bioproducts

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COURSE OBJECTIVES
Enable the students
- To learn about mass transfer in bio reactors and sterilization kinetics.
- To provide hands on training in Downstream processing through simple experimentations in the laboratory.
- To understand the nature of the end product, its concentration, stability and degree of purification required for targeted biological products.
- To gain knowledge about analogy when solving problems typical for the bio industry or for research.

1. Enzyme immobilization studies – Gel entrapment, adsorption and cross linking immobilisation.
2. Batch cultivation – *E.coli* – growth rate, substrate utilization kinetics, product analysis after induction, metabolite analysis by HPLC.
3. Fed batch cultivation - *E.coli* - growth rate, substrate utilization kinetics, product analysis after induction, metabolite analysis by HPLC.
5. Optimization techniques – PlackettBurman, Response surface methodology.
6. Bioreactor studies: Sterilization kinetics, k\textsubscript{La} determination, residence time distribution.
7. Cell separation methods-Centrifugation and microfiltration
9. Aqueous two phase extraction of biologicals.
10. Protein precipitation by salting –out method (ammonium sulphate).
11. Protein purification method- Column chromatography.

Required Equipments:
Centrifuge, Column for purification, Ultrasonicator, Homogeniser, Microfiltration capsule, Hot air oven, Incubator, Laminar air flow chamber, HPLC, required chemicals & stains.

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Gain ability to investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems.
2. Know about fermentation strategies in biochemical product production.
3. Acquire knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.
4. Learn the basic principles and techniques of chromatography to purify the biological products and formulate the products for different end uses.
5. Understand about the purification and polishing methods of biological products

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**COURSE OBJECTIVES**

- To train the students in the field work related to biotechnology and to have a practical knowledge in carrying out work.
- To train and develop skills in solving problems during execution of certain works related to biotechnology

The students individually undergo a training program in reputed concerns in the field of biotechnology during the summer vacation (at the end of second semester for full-time/ IV semester for part time) for a minimum stipulated period of four weeks. At the end of the training, the student has to submit a detailed report on the training they had, within ten days from the commencement of third semester for full time/fifth semester for part time. The student will be evaluated by a team of staff members nominated by head of the department through a vivavoce examination

**COURSE OUTCOME**

1. The student can face the challenges and practice with confidence
2. The student will be benefitted by the training with managing the situation arises during the execution of work related to biochemical process industries.

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### Syllabus Contents:
The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The dissertation should have the following:
- Relevance to social needs of society
- Relevance to value addition to existing facilities in the institute
- Relevance to industry need
- Problems of national importance
- Research and development in various domain

The student should complete the following:
- Literature survey
- Problem Definition
- Motivation for study and Objectives
- Preliminary design / feasibility / modular approaches
- Implementation and Verification
- Report and presentation

The dissertation stage II is based on a report prepared by the students on dissertation allotted to them. It may be based on:
- Experimental verification / Proof of concept.
- Design, fabrication, testing of Communication System.
- The viva-voce examination will be based on the above report and work.
Guidelines for Dissertation Phase – I and II

- As per the AICTE directives, the dissertation is a year long activity, to be carried out and evaluated in two phases i.e. Phase – I: July to December and Phase – II: January to June.
- The dissertation may be carried out preferably in-house i.e. department’s laboratories and centers OR in industry allotted through department’s T & P coordinator.
- After multiple interactions with guide and based on comprehensive literature survey, the student shall identify the domain and define dissertation objectives. The referred literature should preferably include Springer/Science Direct. In case of Industry sponsored projects, the relevant application notes, papers, product catalogues should be referred and reported.

- Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and phase-wise work distribution, and submit the proposal within a month from the date of registration.
- Phase – I deliverables: A document report comprising of summary of literature survey, detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, A record of continuous progress.
- Phase – I evaluation: A committee comprising of guides of respective specialization shall assess the progress/performance of the student based on report, presentation and Q&A. In case of unsatisfactory performance, committee may recommend repeating the phase-I work.

- During phase – II, student is expected to exert on design, development and testing of the proposed work as per the schedule. Accomplished results/contributions/innovations should be published in terms of research papers in reputed journals and reviewed focused conferences OR IP/Patents.
- Phase – II deliverables: A dissertation report as per the specified format, developed system in the form of hardware and/or software, A record of continuous progress.
- Phase – II evaluation: Guide along with appointed external examiner shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend for extension or repeating the work.

COURSE OUTCOME
At the end of the course students will be

1. Able to develop better knowledge about bioprocess engineering, fermentation techniques and genetic engineering from literatures.
2. Benefited by the implementation of computational tools to solve the problems arising in bioprocesses.
3. Acquiring knowledge to represent bioprocesses with suitable kinetic models.
4. Gaining knowledge to transform technology to commercial products by scaling up
5. Developing technical reporting and project preparation for entrepreneurship
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**COURSE OBJECTIVES**

Enable the students
- To understand the structure, functions and integration of immune system.
- To explain the antigen-antibody interactions that offers defence mechanism
- To know various techniques of therapeutically significant monoclonal and engineered antibodies production

**IMMUNE SYSTEM AND ITS RESPONSE**


**ANTIGEN AND ANTIBODY**

Production of antibodies – Polyclonal, monoclonal – Hybridoma technology – Antibody – Isolation and identification – Validation and their use – Agglutination and precipitation tests – Coomb’s test – ELISA types – ELISpot– Plaque forming cell assay, Epitope mapping, Antigen detection assay,
SDS-PAGE- immunoblotting and immunoprecipitation – Immunofluorescence and immunohistochemistry – Measurement of Ag-Ab interaction.

**CELLULAR IMMUNOLOGICAL TECHNIQUES**

PBMC separation from the blood – Ficoll-hypaque method – Identification of lymphocytes based on CD markers – FACS – Lymphoproliferation assay – Cr5I release assay – Macrophage cultures detection assays – Rosette assay – Cytokine bioassays: IL2, IFNγ, TNFα – Mixed lymphocyte reaction – HLA typing.

**VACCINE TECHNOLOGY**

Principles in vaccine development – Adjuvant, Immunization (Active and Passive immunization) – Vaccine validation – Protein based vaccines – DNA vaccines – Plant based vaccines – Edible

IMMUNOTHERAPEUTICS

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Aware the immune system structure and functions, immunity to various pathogens
2. Know about concepts evolved in antibody and antigens
3. Acquire knowledge about vaccine development processes
4. Produce the therapeutic and diagnostic molecules
5. Aware of tumour, allergy and hypersensivity reactions

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COURSE OBJECTIVES
Enable the students
• To understand metabolic networks in single cells and at the individual organ level
• To understand the use of organisms to produce valuable substances on an industrial scale
• To minimize the cost of production in an effective manner

CELLULAR METABOLISM

REGULATION, MANIPULATION AND SYNTHESIS OF METABOLIC PATHWAY

ANALYSIS AND METHODS FOR THE METABOLIC FLUX
Metabolic flux map – Fluxes through the catabolic pathways in microbes – Metabolic flux analysis for determined, over-determined and under-determined systems – Sensitivity analysis – Direct flux determination from fractional label enrichment – Applications involving complete enumeration of metabolite isotopomers – Carbon metabolite balances.

APPLICATION OF METABOLIC FLUX ANALYSIS

ANALYSIS OF METABOLIC CONTROL AND INDUSTRIAL CASE STUDIES
Fundamental of Metabolic Control Analysis (MCA), MFA, and MPA and their application, relating system variables to enzyme kinetics, Multi-substrate enzyme kinetics, Metabolic engineering examples for bio-fuel, bio-plastic and green chemical synthesis and industrial case studies.

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Gain knowledge about various transport processes in biological systems.
2. Understand regulations related to enzymatic and microbial systems.
3. Familiar with metabolic flux analysis.
4. Acquire the concept of biochemistry regulations and culture media designing.
5. Know the various metabolic control analysis techniques and kinetic studies.

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**COURSE OBJECTIVES**

Enable the students

- To identify the importance of protein bio molecules.
- To realize the structure-function relationships in proteins.
- To utilize the computational methods in protein structures and functions.

**AMINO ACIDS AND 3D STRUCTURE**

Amino acids – Acid-base properties – Stereo chemical representations – Chemical and Physical properties – Primary structure – Secondary structure and motifs – Tertiary structures and domains – Quaternary structures – Classifications – CATH, SCOP – Protein Data Base analysis.

**FIBROUS AND MEMBRANE PROTEINS**


**FUNCTION AND CONTROL OF FUNCTION**


**BIOSYNTHESIS AND DEGRADATION**

Factors determine the rate of degradation – Proteases – Lysosomes – Ubiquitin mediated pathway.

**DETERMINATION AND PREDICTION OF 3D STRUCTURE**

**REFERENCES**

**COURSE OUTCOMES**
At the end of this course, students will be able to
1. Gain knowledge about amino acids and its metabolism.
2. Analyze the various interactions in protein makeup.
3. Familiar with different levels of protein structure.
4. Acquire the concept of biosynthesis and degradation of proteins.
5. Know the role of functional proteins in various field of study.

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**COURSE OBJECTIVES**
Enable the students
- To understand the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.
- To know the heterologous expression of cloned genes in different hosts, production of recombinant proteins and PCR techniques.
• To understand the comparative of genomics and proteomics.

CLONING WITH SPECIALIST-PURPOSE VECTORS
M13 based vectors, production of RNA probes and interfering RNA - controllable promoters for maximal expression of cloned gene – \( \lambda P_l, \) trc, T7 and pBAD - factors affecting the expression of cloned genes - purification tags for purification of cloned gene product – vectors for solubilization of expressed proteins - gateway system of transferring DNA fragments to vectors

cDNA LIBRARY CONSTRUCTION

MUTAGENESIS AND ALTERED PROTEIN SYNTHESIS
Random mutagenesis - Error-prone PCR, Rolling circle error-prone PCR, use of mutator strains, temporary mutator strains, Insertion mutagenesis, ethyl methanesulfonate, DNA Shuffling, signature tagged mutagenesis and transposon mutagenesis. Incorporation of unnatural amino acids into proteins – Phage and cell-surface display for selection of mutant peptides

GENOME ENGINEERING
DNA damage – sources and types - DNA double stranded break repair mechanisms - Engineered nucleases in genome engineering - meganucleases, ZFNs, TALEN and CRISPR-Cas system – Mechanisms and applications – Benefits of genome engineering – targeted gene mutation, creating chromosome rearrangement, studying gene function with stem cells, transgenic animals, endogenous gene labelling and targeted transgene addition – genome engineering -prospects and limitations.

GENETIC MANIPULATION OF CELLS AND ANIMALS
Overview - principle of gene transfer - methods of gene transfer to animal cell culture - selectable markers for animal cells - Isolation and manipulation of mammalian embryonic stem cells - Using gene transfer to study gene expression and function - creating disease models using gene transfer and gene targeting technology - potential of animal for modelling human disease

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Understand the basics of genes and its functionalities.
2. Know the clone methods of commercially important genes.
3. Produce the commercially important recombinant proteins.
4. Mutagenesis of gene and genome sequencing techniques.
5. Apply the skills of microarrays, Analysis of Gene expression and proteomics, techniques in genetic manipulation.

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COURSE OBJECTIVES
Enable the students
- To provide the fundamentals of animal cell culture, diseases and therapy
- To know the concepts of basic genetic engineering
- To gain knowledge about the micromanipulation and transgenic animals

CELL CULTURE
Culturing of cells– Primary and secondary cell lines – Genetics of cultured cells – Scaling up in suspension – Monolayer culture – Bio-reactors used for animal cell culture – Roller bottle culture– Bioreactor process control – Stirred animal cell culture – Air-lift fermentor, Chemostat/Turbidostat– Cell lines and their applications.

GENE CLONING VECTORS AND IMMUNOLOGY

STEM CELL AND CLONING

GENE THERAPY

METHODS OF TRANSGENESIS AND APPLICATIONS
Rumen manipulation – Probiotics embryo transfer technology – Invitro fertilization, transgenesis – Methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods – Biopharming – Transgenic animal technology, application to production and therapeutics (mice, sheep, cattle) – Artificial insemination and embryo transfer – Transgenic growth hormone genes.

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Understand the animal cell culture, animal diseases and its diagnosis.
2. Gain the knowledge for therapy of animal infections.
3. Know the concepts of micromanipulation technology and transgenic animal technology.
4. Acquire knowledge about the gene manipulation.
5. Use the knowledge gained in this section to apply in the field of clinical research.

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COURSE OBJECTIVES
Enable the students
• To give the details of plant derived value added compounds and its functions
• To know about the pharma drugs using plant sources
• To provide knowledge on biotech based production of agro medicines

HERBAL DRUGS
Phytochemicals and their classification– Phytochemical screening – Physiochemical tests — Macroscopic and microscopic techniques – Traditional plant and Herbal remedies — Herbal drugs WHO guidelines – Standardization of Herbal Drugs Derivatives with Special Reference to Brazilian Regulations

PHYTOCOMPOUNDS
Plant extract used to Bacterial, Fungal and Parasitic infection – Biological and Toxicology Properties of plant extract – Anti-MRSA and Anti-VRE activities of Phytoalexins and Phytoncides – Anti microbial and targeted screening of Plant extract – Plant derived compound against drug resistant microorganisms – Antioxidant and antitumor Plant metabolites (fruits and vegetables) – Bioactive compounds as food

PHYTOMEDICINE AND PHYTOPHARMACEUTICALS
Medicinal Plants for Development of Phytomedicine and Use in Primary Health Care – Immunostimulants and adaptogen from Plants – Polyphenols for Atherosclerosis and Ischemic Heart disease – Cancer Chemopreventive agents – Lipidoxidation nitrogen Radicals – Phytochemicals in oilseeds – Flavonoids in Cardiovascular disease – Bioengineering and Breeding approaches in improving phychochemical content of plants.

SEPARATION TECHNIQUES AND STRUCTURE ELUCIDATION

SECONDARY METABOLITES PRODUCTION

REFERENCES

**COURSE OUTCOMES**
At the end of this course, students will be able to
1. Understand the fundamentals of phytochemicals and its functions.
2. Use the knowledge for the development of therapeutic products.
3. Learn the separation techniques of herbal agromedicines and its analysis.
4. Gain the knowledge about the plant tissue culture based secondary metabolites.
5. Use of the gained knowledge for improvement in quality of products.

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**COURSE OBJECTIVES**
Enable the students
- To understand the gene cloning methods, tools and techniques involved in genome analysis and genomics.
- To explain the heterologous expression of cloned genes in different hosts, production of recombinant proteins and PCR techniques.
- To identify the importance of protein bio molecules and the structure-function relationships in proteins.
- To explain comparative genomics and proteomics.

**GENE AND GENOME ANALYSIS**
Gene prediction in prokaryotes and eukaryotes - Genome-wide association (GWA) analysis - Massively parallel Signature sequencing (MPSS), Whole genome Shotgun sequencing, Next Generation Sequencing (NGS) - Cytogenetic and physical mapping - GDB, NCBI, OMIM, NGI/MGD - Structural annotation - Functional annotation - Limitation of genomics

**GENOME INFORMATICS**
Functional genomics: Developmental biology and Differential gene expression, Microarray analysis- Epigenomics: Histone modification assays-ChIP-Chip and ChIP-Seq, DNA
Methylation assays - DNA hybridization technique - Metagenomics: de novo transcriptome assembly

GENOMIC DIVERSITY
Study systems: Cyanobacteria, Plasmodium, Yeast, Virus, Arabidopsis thaliana, Homo sapiens, Worm, Zebra fish - Comparative databases: COG, KEGG, MBGD, PEDANT, Organism Specific databases

PROTEOME INFORMATICS
2D Electrophoresis - Spot visualization and picking - Database for 2D gel - Tryptic digestion of protein - Peptide fingerprinting - Data analysis: Mass spectrometry; ion source (MALDI, spray sources); analyzer (ToF, quadrupole, quadrupole ion trap) and detectors - Ramachandran plot - Post-translational modifications of proteins, protein folding - Limitation of proteomics

APPLICATIONS OF GENOMICS AND PROTEOMICS
Genomic medicine - Synthetic biology and bioengineering - Conservation genomics - Interaction proteomics - Protein networks - Expression proteomics – Biomarkers - Proteogenomics

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Aware of how to clone commercially important genes and recombinant proteins.
2. Aware of gene and genome sequencing techniques.
3. Apply the skills of aware of microarrays, Analysis of Gene expression and proteomics, techniques in gene mapping.
4. Analyze the various interactions in protein makeup and different levels of protein structure.
5. Practice the latest application of protein science in their research.
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**COURSE OBJECTIVES**
Enable the students

- To gain knowledge about design and scale-up of bioreactors.
- To develop bioengineering skills for the production of biochemical product using integrated biochemical process
- To acquire knowledge of instrumentation and control of bioreactors

**BASIC BIOREACTOR CONCEPTS**
Bioreactor Operation – Batch operation, semi-continuous and fed-batch operation, Continuous Operation – Chemostat, turbidostat – Microbiological reactors, enzyme reactors – Tank-type, Column-type biological reactors – Case studies – Continuous Fermentation with Biomass Recycle, Tanks-in-series, Tubular plug flow bioreactors.

**AERATION AND AGITATION IN BIOPROCESS SYSTEMS**
Mass transfer in agitated tanks – Effect of agitation on dissolved oxygen - Correlations with kl.a in Newtonian and non Newtonian liquid – Power number, Power requirement for mixing in aerated and non aerated tanks for Newtonian and non Newtonian liquids – Agitation rate studies - Mixing time in agitated reactor, residence time distribution – Shear damage, bubble damage, Methods of minimizing cell damage – Laminar and Turbulent flow in stirred tank bioreactors.

**SELECTION AND DESIGN OF BIOPROCESS EQUIPMENT**
Materials of construction for bioprocess plants – Design considerations for maintaining sterility of process streams processing equipments, selection, specification – Design of heat and mass transfer equipment used in bioprocess industries – Requirements, design and operation of bioreactor for microbial, plant cell and animal cell.

**SCALEUP AND SCALEDOWN ISSUES**
Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply – Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer co-efficients – Scale up of downstream processes – Adsorption (LUB method), Chromatography (constant resolution etc.), Filtration (constant resistance etc.), Centrifugation (equivalent times etc.), Extractors (geometry based rules) – Scale-down related aspects.
**BIOREACTOR INSTRUMENTATION AND CONTROL**


**REFERENCES**


**COURSE OUTCOMES**

At the end of this course, students will be able to
1. Select appropriate bioreactor configurations and operation modes based upon the nature of bio products and cell lines and other process criteria.
2. Understanding the modeling and simulation of various bioprocesses
3. Identify problems and seek practical solutions for implementation of large scale production of bioproducts.
4. To identify the ways and means to reduce costs and enhance the quality of products.
5. To acquire knowledge about instrumentation facilities in bioreactors to control bioprocesses.

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**COURSE OBJECTIVES**

Enable the students
- To learn about basis of nanomaterials
- To know the concepts of preparation methods and types of nanomaterilas

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• To gain knowledge about applications of nanomaterials in genetic engineering

NANOSCALE PROCESSES AND NANOMATERIALS

STRUCTURAL AND FUNCTIONAL PRINCIPLES OF NANOBIO TECHNOLOGY

PROTEIN-BASED NANOTECHNOLOGY

DNA-BASED NANOTECHNOLOGY

NANOMEDICINE AND NANOSENSING

REFERENCES
5. Shoseyov, O. and Levy I., “Nanobiotechnology: Bioinspired Devices and Materials of the
COURSE OUTCOMES
At the end of this course, students will be able to
1. Familiarize about the science of nanomaterials
2. Demonstrate the preparation and characterization of nanomaterials
3. Understand the production of nanomaterials using biological molecules
4. Knowledge of nanomaterials in genetic engineering
5. Applications of nanomaterials in drug development.

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CHBTPEXX BIOFUELS AND BIOREFINERY ENGINEERING

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COURSE OBJECTIVES
Enable the students
• To impart knowledge on Bioconversion of renewable lignocellulosic biomass to bio fuel and value added products
• To demonstrate a drive towards products benign to natural environment and increasing the importance of renewable materials
• To emphasise the development of Biomass an inexpensive feedstock considered sustainable and renewable to replace a wide diversity of fossil based products

INTRODUCTION

ETHANOL
Ethanol as transportation fuel and additive; bioethanol production from carbohydrates; engineering strains for ethanol production from variety of carbon sources to improved productivity.

BIODIESEL
Chemistry and Production Processes; Vegetable oils and chemically processed biofuels; Biodiesel composition and production processes; Biodiesel economics; Energetics of biodiesel production and effects on greenhouse gas emissions Issues of ecotoxicity and sustainability with expanding biodiesel production.
OTHER BIOFUELS
Biodiesel from microalgae and microbes; biohydrogen production; biorefinery concepts

PLATFORM CHEMICALS
Case studies on production of C3 to C6 chemicals such as Hydroxy propionic acid, 1,3propanediol, propionic acid, succinic acid, glucaric acid, cis-cismuconic acid.

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Understand the fundamentals of biofuels.
2. Utilization of biomass as feedstock for sustainable and renewable energy generation.
3. Replace fossil fuel based products with Biodiesel derived from vegetable oils.
4. Know the concepts of production of third generation biofuels
5. Develop of biorefineries for economical production of biofuels

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COURSE OBJECTIVES
Enable the students
• To understand the overall industrial bioprocess so as to help them to manipulate the process.
• To impart knowledge on design and operation of fermentation processes with all its prerequisites.
• Provide the students with the basics of bioreactor engineering.
• To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.
CONCEPTS AND PRINCIPLES
Introduction to modelling – Systematic approach to model building – Material and energy balance– Classification of models – General form of dynamic models dimensionless models – General form of linear systems of equations nonlinear function – Conservation principles thermodynamic principles of process systems

MODELS
Structured kinetic models – Compartmental models (two and three) – Product formation Unstructured models – Genetically structured models – Stochastic model for thermal sterilization of the medium – Modelling for activated sludge process – Model for anaerobic digestion – Models for lactic fermentation and antibiotic production

MODELLING OF BIOREACTORS
Modelling of non-ideal behaviour in Bioreactors – Tanks-in-series and Dispersion models – Modelling of PFR and other first order processes – Analysis of packed bed and membrane bioreactors Recombinant Cell Culture Processes – Plasmid stability in recombinant Cell Culture limits to over-expression

MONITORING OF BIOPROCESSES
On-line data analysis for measurement of important physio-chemical and biochemical parameters– State and parameter estimation techniques for biochemical processes – Biochemical reactors-model equations – Steady-state function – Dynamic behaviour – Linearization – Phase plane analysis – Multiple steady state – Bifurcation behaviour

SOLUTION STRATEGIES

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Understand the Knowledge about the fundamental models of bioprocesses.
2. Select appropriate bioreactor configurations and operation modes based upon the nature of bio products.
3. Apply modelling and simulation of bioprocesses to enhance the quality of products and systems.
4. Identify problems and seek practical solutions for large scale implementation of Biotechnology.
5. Acquire knowledge of various tools for modeling and simulation of bioprocesses.

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COURSE OBJECTIVES
Enable the students
- To understand the Basic of biology of cancer
- To know the impact of antibodies against cancer in the human body leading to more effective treatments
- To understand the immunology based detection methods and imaging techniques
- To realize the cell based and cytokine based immunotherapy against cancer

PRINCIPLES OF CANCER BIOLOGY

PRINCIPLES OF CARCINOGENESIS

MOLECULAR BIOLOGY OF CANCER

CANCER METASTASIS
CANCER THERAPY
Therapy forms – Surgery, chemotherapy, radiation therapy - Detection of cancers – Prediction of aggressiveness of cancer – Advances in cancer detection – Tumor markers; New approaches of cancer therapy – mAbs, vaccines, gene therapy, stem cell therapy.

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Know about carcinogenic materials leading to cancer.
2. Value the role of immune system against cancer.
3. Understand the cancer microenvironment and its influence on immune cells.
4. Gain knowledge of key factors controlling cancer therapy.
5. Acquire Knowledge about the applications of biology for cancer treatment.

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COURSE OBJECTIVES
Enable the students
• To acquire knowledge on the different chromatographic methods for separation of biological products.
• To have a fundamental knowledge about the instrumentation of spectroscopic analysis
• To understand the methods to obtain pure proteins, enzymes and in general about product development R & D

PROTEIN CRYSTALLOGRAPHY
Biological macromolecules – Principle of protein crystallization – Method – Testing –

**PROTEIN AND PEPTIDE PURIFICATION**
Chromatographic methods for protein and peptide purification – Multidimensional chromatography – High throughput screening of soluble recombinant proteins – Immunoprecipitation – Affinity chromatography for antibody purification – Role of reverse phase HPLC in proteomic research.

**ELECTROPHORETIC TECHNIQUES**

**MICROSCOPY**

**SPECTROSCOPY**

**REFERENCES**

**COURSE OUTCOMES**
At the end of this course, students will be able to
1. Gain knowledge about fundamentals of biological molecules.
2. Acquire knowledge about the advanced microscopic techniques.
3. Understand the fundamentals of various spectroscopic methods.
4. Apply the skills of microscopy and spectroscopy techniques for biological products purification and separation.
5. Apply principles of various unit operations used in downstream processing.
COURSE OBJECTIVES
Enable the students
• To study about the fundamentals of thermodynamic systems.
• To learn about basic concepts of classical and statistical thermodynamics.
• To demonstrate the capability to analyze the energy conversion performance in a variety of modern applications in biological systems.

CONCEPTS AND LAWS OF THERMODYNAMICS

ENERGY TRANSFORMATION AND BIOENERGETICS
Distribution of energy – Carbon, energy and life – Molecular level energy storage – Biothermodynamics of energy use by plant and animals – Methods for measuring the thermodynamic stability of membrane proteins – Protein folding – Modeling the native state ensemble of proteins using statistical thermodynamics – Energetic profiles of proteins derived from thermodynamics of the native state ensemble – Principle of components analysis of energetic profile space – Energetic profiles are conserved between homologous proteins.

GIBB’S FREE ENERGY AND ITS APPLICATIONS
STASTICAL THERMODYNAMICS AND BINDING EQUILIBRIA

REACTION KINETICS TO BIOLOGICAL SYSTEM
Free energy analysis of chemical reactions – Chemical coupling to drive reactions in biological systems – First order and second order reactions – Collision theory – Transition state theory – Free energy of activation – Arrhenius rate constant equation – Applications – Temperature and concentration effects on enzyme kinetics – Reaction mechanism of lysozyme – Kinetic identification of reaction intermediates – Sequential enzyme reactions in metabolism and analysis.

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Understand the fundamental thermodynamic properties of biological systems.
2. Acquire knowledge about the application of thermodynamics for energy conversion in biological systems.
3. Design, interpret and analyze the fundamental data for betterment of bioprocesses.
4. Understand the vapour liquid equilibrium for calculations of microbial growth and product formation.
5. Gain knowledge about various kinetic models using thermodynamic properties.

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COURSE OBJECTIVES
Enable the students
  • To gain knowledge of plant cells and its functions
  • To study the basics of genetic engineering methods in plant biology
  • To develop knowledge on transgenic plants

PLANT TISSUE CULTURE
Concept of cellular totipotency – Cytodifferentiation – Organogenic differentiation – Nutritional requirements – Seed culture, embryo culture, Protoplast culture, Micropropagation, Cell suspension – In vitro production of haploids – Somaclonal variation – Germplasm storage and cryopreservation.

CHLOROPLAST AND MITOCHONDRIA
Structure, function – Light and dark reaction and genetic material – Rubisco synthesis and assembly, coordination, regulation and transport of proteins – Mitochondria: Genome – Cytoplasmic male sterility and import of proteins – Comparison and differences between mitochondrial and chloroplast genome – Chloroplast transformation

PLANT METABOLISM AND METABOLIC ENGINEERING
Nitrogen fixation – Nitrogenase activity – Nod genes, nif genes, bacteroids – Plant nodulins
Production of secondary metabolites – Flavanoid synthesis and metabolic engineering.

GENE TRANSFER IN PLANTS

TRANSGENICS IN CROP IMPROVEMENT

REFERENCES
**COURSE OUTCOMES**
At the end of this course, students will be able to
1. Understand the fundamentals of plant cells, structure and functions
2. Learn the nitrogen fixation mechanism and significance of viral vectors
3. Gain knowledge about the plant tissue culture and transgenic plants
4. Acquire knowledge in development of high yielding plant varieties using genetic engineering
5. Gain knowledge for the development of therapeutic products

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**COURSE OBJECTIVES**
Enable the students
- To know about the constituents and additives present in the food.
- To gain knowledge about the microorganisms, food spoilage diseases.
- To know different techniques used for the preservation of foods.

**FOOD PROCESSING**
Heat Processing using steam or water (Blanching, Pasteurization) – Heat sterilization (Evaporation and distillation) – Heat processing using hot air (Dehydration, baking and roasting)
– Heat processing using hot oils – Processing by the removal of heat (chilling, Freezing) – High pressure processing of foods – Pulsed electric field processing of liquids and beverages – Non-thermal processing by radiofrequency electric fields.

**FOOD FERMENTATION**
FERMENTED FOODS


FOOD PRESERVATION TECHNIQUES

Spoilage of food - Microbiology of water, meat, milk, vegetables – Food poisoning – Cold preservation – Heat conservation – Ionizing radiation – High pressure – Electric field – Chemical food preservation – Combination of techniques for food preservation – Natural antioxidants – Antimicrobial enzymes – Edible coatings – Control of pH and water activity.

FOOD QUALITY AND CONTROL

Analysis of food – Major ingredients present in different product – Food additives, vitamins – Analysis of heavy metal, fungal toxins, pesticide and herbicide contamination in food – Microbial safety of food products – Chemical safety of food products – Good manufacturing practice

REFERENCES


COURSE OUTCOMES

At the end of this course, students will be able to

1. Understand the applications of heat transfer principles in food processing.
2. Gain knowledge of usage of microorganism in food processing.
3. Acquire knowledge of fermentation in food processing.
4. Understand the principles of different food preservations techniques.
5. Gain knowledge about quality control measures used in food processing industries.

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COURSE OBJECTIVES:
Enable the students

- To develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics.
- To perform calculations pertaining to processes and operations.
- To apply fluid mechanics principles to applied problems

GOVERNING EQUATIONS

NUMERICAL ANALYSIS

COMPRESSIBLE FLOW COMPUTATION

TURBULENT FLOW COMPUTATION

FINITE ELEMENT METHOD

REFERENCES

**COURSE OUTCOMES**
At the end of this course, students will be able to
1. Gain knowledge about fundamentals of fluid flow.
2. Understand the application of numerical methods to solve fluid dynamic problems.
3. Acquire knowledge related to properties of fluid statics and dynamics.
4. Apply knowledge to study the models related to turbulent flow of fluids
5. Understand the concepts of finite element analysis methods and its applications in biological systems.

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**COURSE OBJECTIVES**
Enable the students
• To understand the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments
• To replace conventional treatment methodologies by molecular biology and genetic engineering strategies
• To seek the way for the alternate sources of energy to avoid environmental issues

**BIODEGRADATION AND BIOREMEDIATION**
Aerobic and Anaerobic degradation of aliphatic and aromatic compounds – Biodegradation of herbicides and pesticides. Bioremediation technologies – Biostimulation, Bioaugmentation, Bioventing, biosparging and Phytoremediation – Bioleaching, bioprecipitation, bioaccumulation and biosorption of heavy metals.

**MICROBIAL METABOLISM IN WASTE WATER TREATMENT**
BIOLOGICAL TREATMENT OF WASTE WATER

BIOTECHNOLOGY FOR AIR POLLUTION AND WASTE MANAGEMENT
Air pollution control and treatment strategies – Biotechnology for treating air pollutants – Biofilters and Bioscrubbers – Biotechnology for the management of agricultural, plastic, dairy, paper and pulp, textile, leather, hospital and pharmaceutical industrial wastes.

BIOPRODUCTS FROM RENEWABLE SOURCES
Overview of renewable sources – Production of biocompost and vermicompost – Production of biofertilizers and biopesticides – Production of biomethane, bioethanol, biohydrogen, biodiesel – Production of bioplastics and biopolymers – Bioelectricity generation and value added products from renewable sources.

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Gain knowledge about the fundamentals of environmental Pollution and its problems.
2. Find the scientific solutions for the environmental protection.
3. Acquire knowledge about the applications of microbes in waste water treatment systems.
4. Design microbial based air pollution treatment facilities.
5. Understand the various methods for biological conversion of waste materials into useful products
COURSE OBJECTIVE:
Enable the students
  • To understand the basic concepts of technology management
  • To impart the knowledge of various aspects of Creativity, Innovation and New Product Development
  • To understand the transfer of new technology to commercialization.

TECHNOLOGY MANAGEMENT

TECHNOLOGICAL FORECASTING & ASSESSMENT

TECHNOLOGY STRATEGY

TECHNOLOGY TRANSFER MANAGEMENT
TECHNOLOGY TRANSFER AND ACQUISITION

REFERENCES

COURSE OUTCOMES
At the end of this course, students will be able to
1. Gain knowledge on various issues related to Patents
2. Understand the innovative techniques to Quality enhancement
3. Develop new products from innovative ideas.
4. Acquire knowledge about various types of companies.
5. To know the importance of planning and evaluation.

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Mapping with Program outcomes