1. **Program Objectives (POs)**

The primary objective of the Bachelor of Industrial Biotechnology program is to prepare professionals with the skills required to work in the Biotechnology industry with particular emphasis on the engineering aspects of manufacturing and design.

They are trained to

1. Achieve successful professional and technical career.
2. Have a strong foundation in Basic Sciences, Mathematics, Medical Sciences, Bioinformatics and process engineering.
3. Have knowledge on the theory and practices in the field of Biotechnology, especially in the areas of Downstream processing, Medical biotechnology and Bioinformatics and allied areas.
4. Engross in life-long learning to keep themselves abreast of new developments.
5. Practice and inspire high ethical values and technical standards.

The Overall objective of the Program is to promote education and research in biotechnology and provide academic and professional excellence for immediate productivity in industrial, governmental, or clinical settings for an ultimate benefit of society and environment.

As a result of this program, the student will be able to:

1. Recall factual information on broad knowledge based proficiency in core themes, principles and components of Basic Sciences.
2. Create and develop strategies that reflect the interdisciplinary nature of science, regulation and enterprise in the biotechnology industry.
3. Define and solve problems using scientific methods in biotechnology and allied subjects.
4. Consider implications of biotechnology in societal, environmental and educational frameworks.
5. Access current information and literature in science and Prepare and present scientific data.
6. Demonstrate knowledge of biological processes from the molecular and cellular perspectives.
7. Approach and solve biological problems critically with scientific literacy in individual and group settings.
8. Able to understand, analyze and apply the process engineering concepts an incredibly wide diversity of applications including pharmaceutical development, crop and livestock improvement, diagnostic and therapeutic medicine, industrial processing, and bioremediation of contaminated environments.
## Programme Outcomes

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>II</td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Semester</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Year</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Communicative English</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engineering Mathematics I</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engineering Physics</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engineering Chemistry</td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Problem Solving and Python Programming</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engineering Graphics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Problem Solving and Python Programming Laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics and Chemistry Laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>2nd Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technical English</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Engineering Mathematics II</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics of Materials</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic Civil and Mechanical Engineering</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Microbiology</td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Biochemistry</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engineering Practices Laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Biochemistry Laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transforms and Partial Differential Equations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Applied Thermodynamics for Biotechnologists</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic Industrial Biotechnology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bioorganic Chemistry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cell Biology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stoichiometry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Microbiology Laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cell Biology Laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interpersonal Skills / Listening and Speaking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>SEM 4</td>
<td>Probability and Statistics</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fluid Mechanics and Heat Transfer Operations</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Molecular Biology</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enzyme technology and Bio-Transformations</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bioprocess Principles</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Environmental Science and Engineering</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical Engineering Laboratory for Biotechnologists</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Molecular Biology Laboratory</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advanced Reading and Writing</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEM 5</td>
<td>Mass Transfer Operations</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bioprocess Engineering</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Analytical Methods and Instrumentation</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protein Engineering</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professional Communication</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bioprocess Laboratory I</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Analytical Methods and Instrumentation Laboratory</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bioinformatics</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEM 6</td>
<td>Genetic Engineering</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Applied Chemical Reaction Engineering</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bioprocess Laboratory II</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Genetic Engineering Laboratory</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Quality Management</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEM 7</td>
<td>Downstream Processing</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Immunology</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Downstream Processing Laboratory</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Immunology Laboratory</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEM 8</td>
<td>Project Work</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## ANNA UNIVERSITY, CHENNAI
### AFFILIATED INSTITUTIONS
#### REGULATIONS 2017
##### B. TECH. BIOTECHNOLOGY
#### CHOICE BASED CREDIT SYSTEM
##### I TO VIII SEMESTERS (FULL TIME) CURRICULA AND SYLLABI

### SEMESTER I

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>HS8151</td>
<td>Communicative English</td>
<td>HS</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>MA8151</td>
<td>Engineering Mathematics – I</td>
<td>BS</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>PH8151</td>
<td>Engineering Physics</td>
<td>BS</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>CY8151</td>
<td>Engineering Chemistry</td>
<td>BS</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>GE8151</td>
<td>Problem Solving and Python Programming</td>
<td>ES</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>GE8152</td>
<td>Engineering Graphics</td>
<td>ES</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>GE8161</td>
<td>Problem Solving and Python Programming Laboratory</td>
<td>ES</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>BS8161</td>
<td>Physics and Chemistry Laboratory</td>
<td>BS</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>31</td>
<td>19</td>
<td>0</td>
<td>25</td>
</tr>
</tbody>
</table>

### SEMESTER II

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>HS8251</td>
<td>Technical English</td>
<td>HS</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>MA8251</td>
<td>Engineering Mathematics – II</td>
<td>BS</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>PH8254</td>
<td>Physics of Materials</td>
<td>BS</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>BE8252</td>
<td>Basic Civil and Mechanical Engineering</td>
<td>ES</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>BT8291</td>
<td>Microbiology</td>
<td>BS</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>BT8251</td>
<td>Biochemistry</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>GE8261</td>
<td>Engineering Practices Laboratory</td>
<td>ES</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>BT8261</td>
<td>Biochemistry Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>29</td>
<td>21</td>
<td>0</td>
<td>25</td>
</tr>
</tbody>
</table>
## SEMESTER III

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>MA8353</td>
<td>Transforms and Partial Differential Equations</td>
<td>BS</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>BT8301</td>
<td>Stoichiometry</td>
<td>PC</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>BT8302</td>
<td>Applied Thermodynamics for Biotechnologists</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>BT8303</td>
<td>Basic Industrial Biotechnology</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>BT8304</td>
<td>Bioorganic Chemistry</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>BT8305</td>
<td>Cell Biology</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>BT8361</td>
<td>Microbiology Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>BT8311</td>
<td>Cell Biology Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>HS8381</td>
<td>Interpersonal Skills/Listening and Speaking</td>
<td>EEC</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>31</td>
<td>19</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

## SEMESTER IV

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>MA8391</td>
<td>Probability and Statistics</td>
<td>BS</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>BT8401</td>
<td>Fluid Mechanics and Heat Transfer Operations</td>
<td>ES</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>BT8402</td>
<td>Molecular Biology</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>BT8403</td>
<td>Enzyme Technology and Bio-transformations</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>BT8404</td>
<td>Bioprocess Principles</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>GE8291</td>
<td>Environmental Science and Engineering</td>
<td>HS</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>BT8411</td>
<td>Chemical Engineering Laboratory for Biotechnologists</td>
<td>ES</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>BT8412</td>
<td>Molecular Biology Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>HS8461</td>
<td>Advanced Reading and Writing</td>
<td>EEC</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>20</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

5
### SEMESTER V

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>BT8501</td>
<td>Mass Transfer Operations</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>BT8591</td>
<td>Bioprocess Engineering</td>
<td>ES</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>BT8502</td>
<td>Analytical Methods and</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Instrumentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>BT8503</td>
<td>Protein Engineering</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>Professional Elective I</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Open Elective I*</td>
<td>OE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>BT8511</td>
<td>Bioprocess Laboratory I</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>BT8512</td>
<td>Analytical Methods and</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Instrumentation Laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>HS8581</td>
<td>Professional Communication</td>
<td>EEC</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>28</td>
<td>18</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

* - Course from the curriculum of the other UG Programmes

### SEMESTER VI

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>BT8651</td>
<td>Bioinformatics</td>
<td>PC</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>BT8601</td>
<td>Genetic Engineering</td>
<td>PC</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>BT8691</td>
<td>Applied Chemical Reaction</td>
<td>ES</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Professional Elective II</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Professional Elective III</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Professional Elective IV</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>BT8611</td>
<td>Bioprocess Laboratory II</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>BT8612</td>
<td>Genetic Engineering Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>29</td>
<td>19</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>
### SEMESTER VII

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>GE8077</td>
<td>Total Quality Management</td>
<td>HS</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>BT8751</td>
<td>Downstream Processing</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>BT8791</td>
<td>Immunology</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Professional Elective V</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Professional Elective VI</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Open Elective II *</td>
<td>OE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>BT8711</td>
<td>Downstream Processing Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>BT8712</td>
<td>Immunology Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>26</td>
<td>18</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

* - Course from the curriculum of the other UG Programmes

### SEMESTER VIII

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>BT8811</td>
<td>Project Work</td>
<td>EEC</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>20</td>
</tr>
</tbody>
</table>

TOTAL CREDITS: 179

### PROFESSIONAL ELECTIVES (PEs)

#### PROFESSIONAL ELECTIVE I, SEMESTER V

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BT8001</td>
<td>Biophysics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>BT8002</td>
<td>Symbolic Mathematics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>BT8003</td>
<td>Principles of Food Processing</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>BT8004</td>
<td>Advanced Biochemistry</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>GE8071</td>
<td>Disaster Management</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

#### PROFESSIONAL ELECTIVE II, SEMESTER VI

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BT8005</td>
<td>Animal Biotechnology</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>BT8006</td>
<td>Systems Biology</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>BT8071</td>
<td>Biological Spectroscopy</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>CH8791</td>
<td>Transport Phenomena</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>PY8023</td>
<td>Chemistry of Medicines</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>GE8075</td>
<td>Intellectual Property Rights</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
### PROFESSIONAL ELECTIVE III, SEMESTER VI

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>BT8007</td>
<td>Cancer Biology</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>BT8008</td>
<td>Molecular Pathogenesis of Infectious Diseases</td>
<td>PE</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>BT8009</td>
<td>Biopharmaceutical Technology</td>
<td>PE</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>BT8010</td>
<td>Bioentrepreneurship</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>GE8076</td>
<td>Professional Ethics in Engineering</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>BT8011</td>
<td>Marine Biotechnology</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

### PROFESSIONAL ELECTIVE IV, SEMESTER VI

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>BT8012</td>
<td>Bioethics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>BT8013</td>
<td>Metabolic Engineering</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>BT8014</td>
<td>Lifestyle Diseases</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>BT8015</td>
<td>Structural Biology</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>BT8016</td>
<td>Genomics and Proteomics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>BT8017</td>
<td>Biofuel</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>GE8073</td>
<td>Fundamentals of Nanoscience</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

### PROFESSIONAL ELECTIVE V, SEMESTER VII

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>BT8018</td>
<td>Plant Biotechnology</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>BT8019</td>
<td>Process Equipments and Plant Design</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>BT8020</td>
<td>Bioconjugate Technology and Applications</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>BT8021</td>
<td>Genetics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>PY8071</td>
<td>Clinical Trials</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>GE8074</td>
<td>Human Rights</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>GE8072</td>
<td>Foundation Skills in Integrated Product Development</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

### PROFESSIONAL ELECTIVE VI, SEMESTER VII

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>BT8022</td>
<td>Neurobiology and Cognitive Sciences</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>BT8023</td>
<td>Tissue Engineering</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>BT8091</td>
<td>Instrumentation and Process Control</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>BT8024</td>
<td>Biosafety and Hazard Management</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>BT8025</td>
<td>Immunotechnology</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>S. No.</td>
<td>COURSE CODE</td>
<td>COURSE TITLE</td>
<td>CATEGORY</td>
<td>CONTACT PERIODS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>--------------</td>
<td>----------</td>
<td>-----------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>HS8151</td>
<td>Communicative English</td>
<td>HS</td>
<td>4 L, 4 T, 0 P, 0 C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>HS8251</td>
<td>Technical English</td>
<td>HS</td>
<td>4 L, 4 T, 0 P, 0 C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>GE8291</td>
<td>Environmental Science and Engineering</td>
<td>HS</td>
<td>3 L, 3 T, 0 P, 0 C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>GE8077</td>
<td>Total Quality Management</td>
<td>HS</td>
<td>3 L, 3 T, 0 P, 0 C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ENGINEERING SCIENCES (ES)**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GE8151</td>
<td>Problem Solving and Python Programming</td>
<td>ES</td>
<td>3 L, 3 T, 0 P, 0 C</td>
</tr>
<tr>
<td>2.</td>
<td>GE8152</td>
<td>Engineering Graphics</td>
<td>ES</td>
<td>6 L, 2 T, 0 P, 4 C</td>
</tr>
<tr>
<td>3.</td>
<td>GE8161</td>
<td>Problem Solving and Python Programming Laboratory</td>
<td>ES</td>
<td>4 L, 0 T, 0 P, 4 C</td>
</tr>
<tr>
<td>4.</td>
<td>GE8252</td>
<td>Basic Civil and Mechanical Engineering</td>
<td>ES</td>
<td>4 L, 4 T, 0 P, 0 C</td>
</tr>
<tr>
<td>5.</td>
<td>GE8261</td>
<td>Engineering Practices Laboratory</td>
<td>ES</td>
<td>4 L, 0 T, 4 P, 0 C</td>
</tr>
<tr>
<td>6.</td>
<td>BT8401</td>
<td>Fluid Mechanics and Heat Transfer Operations</td>
<td>ES</td>
<td>4 L, 4 T, 0 P, 0 C</td>
</tr>
<tr>
<td>7.</td>
<td>BT8411</td>
<td>Chemical Engineering Laboratory for Biotechnologists</td>
<td>ES</td>
<td>4 L, 0 T, 4 P, 0 C</td>
</tr>
<tr>
<td>8.</td>
<td>BT8591</td>
<td>Bioprocess Engineering</td>
<td>ES</td>
<td>3 L, 3 T, 0 P, 0 C</td>
</tr>
<tr>
<td>9.</td>
<td>BT8691</td>
<td>Applied Chemical Reaction Engineering</td>
<td>ES</td>
<td>3 L, 3 T, 0 P, 0 C</td>
</tr>
</tbody>
</table>

**BASIC SCIENCES (BS)**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MA8151</td>
<td>Engineering Mathematics I</td>
<td>BS</td>
<td>4 L, 4 T, 0 P, 0 C</td>
</tr>
<tr>
<td>2.</td>
<td>PH8151</td>
<td>Engineering Physics</td>
<td>BS</td>
<td>3 L, 3 T, 0 P, 0 C</td>
</tr>
<tr>
<td>3.</td>
<td>CY8151</td>
<td>Engineering Chemistry</td>
<td>BS</td>
<td>3 L, 3 T, 0 P, 0 C</td>
</tr>
<tr>
<td>4.</td>
<td>BS8161</td>
<td>Physics and Chemistry Laboratory</td>
<td>BS</td>
<td>4 L, 0 T, 4 P, 0 C</td>
</tr>
<tr>
<td>5.</td>
<td>MA8251</td>
<td>Engineering Mathematics II</td>
<td>BS</td>
<td>4 L, 4 T, 0 P, 0 C</td>
</tr>
<tr>
<td>6.</td>
<td>PH8254</td>
<td>Physics of Materials</td>
<td>BS</td>
<td>3 L, 3 T, 0 P, 0 C</td>
</tr>
<tr>
<td>7.</td>
<td>BT8291</td>
<td>Microbiology</td>
<td>BS</td>
<td>3 L, 3 T, 0 P, 0 C</td>
</tr>
<tr>
<td>8.</td>
<td>MA8353</td>
<td>Transforms and Partial Differential Equations</td>
<td>BS</td>
<td>4 L, 4 T, 0 P, 0 C</td>
</tr>
<tr>
<td>9.</td>
<td>MA8391</td>
<td>Probability and Statistics</td>
<td>BS</td>
<td>4 L, 4 T, 0 P, 0 C</td>
</tr>
</tbody>
</table>
### PROFESSIONAL CORE (PC)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>BT8251</td>
<td>Biochemistry</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>BT8261</td>
<td>Biochemistry Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>BT8301</td>
<td>Stoichiometry</td>
<td>PC</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>BT8302</td>
<td>Applied Thermodynamics for Biotechnologists</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>BT8303</td>
<td>Basic Industrial Biotechnology</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>BT8304</td>
<td>Biogeneric Chemistry</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>BT8305</td>
<td>Cell Biology</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>BT8361</td>
<td>Microbiology Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>BT8311</td>
<td>Cell Biology Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>BT8402</td>
<td>Molecular Biology</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>11.</td>
<td>BT8403</td>
<td>Enzyme Technology and Bio-transformations</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>BT8404</td>
<td>Bioprocess Principles</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>13.</td>
<td>BT8412</td>
<td>Molecular Biology Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>14.</td>
<td>BT8501</td>
<td>Mass Transfer Operations</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>15.</td>
<td>BT8502</td>
<td>Analytical Methods and Instrumentation</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>16.</td>
<td>BT8503</td>
<td>Protein Engineering</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>17.</td>
<td>BT8511</td>
<td>Bioprocess Laboratory I</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>18.</td>
<td>BT8512</td>
<td>Analytical Methods and Instrumentation Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>19.</td>
<td>BT8651</td>
<td>Bioinformatics</td>
<td>PC</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>20.</td>
<td>BT8601</td>
<td>Genetic Engineering</td>
<td>PC</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>21.</td>
<td>BT8611</td>
<td>Bioprocess Laboratory II</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>22.</td>
<td>BT8612</td>
<td>Genetic Engineering Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>23.</td>
<td>BT8751</td>
<td>Downstream Processing</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>24.</td>
<td>BT8791</td>
<td>Immunology</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>25.</td>
<td>BT8711</td>
<td>Downstream Processing Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>26.</td>
<td>BT8712</td>
<td>Immunology Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

### EMPLOYABILITY ENHANCEMENT COURSES (EEC)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>HS8381</td>
<td>Interpersonal Skills/Listening and Speaking</td>
<td>EEC</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>HS8461</td>
<td>Advanced Reading and Writing</td>
<td>EEC</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>HS8581</td>
<td>Professional Communication</td>
<td>EEC</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>BT8811</td>
<td>Project Work</td>
<td>EEC</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>S. No.</td>
<td>SUBJECT AREA</td>
<td>CREDITS PER SEMESTER</td>
<td>TOTAL CREDITS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>--------------</td>
<td>----------------------</td>
<td>---------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
<td>V</td>
<td>VI</td>
<td>VII</td>
</tr>
<tr>
<td>1</td>
<td>HS</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>BS</td>
<td>12</td>
<td>10</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>ES</td>
<td>9</td>
<td>6</td>
<td>-</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>PC</td>
<td>-</td>
<td>5</td>
<td>20</td>
<td>11</td>
<td>13</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>PE</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>OE</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>EEC</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>23</td>
<td>24</td>
<td>22</td>
<td>10</td>
</tr>
</tbody>
</table>
OBJECTIVES:

- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will, enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills.

UNIT I SHARING INFORMATION RELATED TO ONESELF/FAMILY & FRIENDS 12


UNIT II GENERAL READING AND FREE WRITING 12

Reading - comprehension-pre-reading-post reading - comprehension questions (multiple choice questions and/or short questions/open-ended questions)-inductive reading - short narratives and descriptions from newspapers including dialogues and conversations (also used as short Listening texts) - register. Writing - paragraph writing - topic sentence - main ideas - free writing, short narrative descriptions using some suggested vocabulary and structures. Listening - telephonic conversations. Speaking - sharing information of a personal kind—greeting – taking leave. Language development – prepositions, conjunctions. Vocabulary development - guessing meanings of words in context.

UNIT III GRAMMAR AND LANGUAGE DEVELOPMENT 12

Reading - short texts and longer passages (close reading). Writing - understanding text structure - use of reference words and discourse markers-coherence-jumbled sentences. Listening - listening to longer texts and filling up the table - product description - narratives from different sources. Speaking - asking about routine actions and expressing opinions. Language development - degrees of comparison - pronouns - direct vs indirect questions. Vocabulary development – single word substitutes - adverbs.

UNIT IV READING AND LANGUAGE DEVELOPMENT 12

Reading - comprehension-reading longer texts - reading different types of texts - magazines. Writing - letter writing, informal or personal letters - e-mails - conventions of personal email. Listening - listening to dialogues or conversations and completing exercises based on them. Speaking - speaking about oneself - speaking about one’s friend. Language development - Tenses - simple present - simple past - present continuous and past continuous. Vocabulary development - synonyms - antonyms - phrasal verbs.

UNIT V EXTENDED WRITING 12

**OUTCOMES:**

At the end of the course, learners will be able to:

- Read articles of a general kind in magazines and newspapers.
- Participate effectively in informal conversations; introduce themselves and their friends and express opinions in English.
- Comprehend conversations and short talks delivered in English.
- Write short essays of a general kind and personal letters and emails in English.

**TEXT BOOKS:**


**REFERENCES**


**MA8151 ENGINEERING MATHEMATICS – I**

**OBJECTIVES:**

- The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

**UNIT I  DIFFERENTIAL CALCULUS**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable.

**UNIT II  FUNCTIONS OF SEVERAL VARIABLES**

UNIT III INTEGRAL CALCULUS 12
Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

UNIT IV MULTIPLE INTEGRALS 12

UNIT V DIFFERENTIAL EQUATIONS 12

TOTAL : 60 PERIODS

OUTCOMES:
After completing this course, students should demonstrate competency in the following skills:

- Use both the limit definition and rules of differentiation to differentiate functions.
- Apply differentiation to solve maxima and minima problems.
- Evaluate integrals both by using Riemann sums and by using the Fundamental Theorem of Calculus.
- Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.
- Evaluate integrals using techniques of integration, such as substitution, partial fractions and integration by parts.
- Determine convergence/divergence of improper integrals and evaluate convergent improper integrals.
- Apply various techniques in solving differential equations.

TEXT BOOKS:
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015. [For Units I & III - Sections 1.1, 2.2, 2.3, 2.5, 2.7(Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1(Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCES:
OBJECTIVES:
- To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT I  PROPERTIES OF MATTER

UNIT II  WAVES AND FIBER OPTICS

UNIT III  THERMAL PHYSICS

UNIT IV  QUANTUM PHYSICS

UNIT V  CRYSTAL PHYSICS
Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - crystal imperfections: point defects, line defects – Burger vectors, stacking faults – role of imperfections in plastic deformation - growth of single crystals: solution and melt growth techniques.

OUTCOMES:
Upon completion of this course,
- the students will gain knowledge on the basics of properties of matter and its applications,
- the students will acquire knowledge on the concepts of waves and optical devices and their applications in fibre optics,
- the students will have adequate knowledge on the concepts of thermal properties of
materials and their applications in expansion joints and heat exchangers,

- the students will get knowledge on advanced physics concepts of quantum theory and its applications in tunneling microscopes, and
- the students will understand the basics of crystals, their structures and different crystal growth techniques.

TEXT BOOKS:

REFERENCES:

CY8151 ENGINEERING CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:
- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.

UNIT I WATER AND ITS TREATMENT

UNIT II SURFACE CHEMISTRY AND CATALYSIS
UNIT III ALLOYS AND PHASE RULE 9

UNIT IV FUELS AND COMBUSTION 9

UNIT V ENERGY SOURCES AND STORAGE DEVICES 9
Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant - breeder reactor - solar energy conversion - solar cells - wind energy. Batteries, fuel cells and supercapacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H₂-O₂ fuel cell.

TOTAL: 45 PERIODS

OUTCOMES:
- The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.

TEXT BOOKS:

REFERENCES:

GE8151 PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C
3 0 0 3

OBJECTIVES:
- To know the basics of algorithmic problem solving
• To read and write simple Python programs.
• To develop Python programs with conditionals and loops.
• To define Python functions and call them.
• To use Python data structures — lists, tuples, dictionaries.
• To do input/output with files in Python.

UNIT I  ALGORITHMIC PROBLEM SOLVING  
Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II  DATA, EXPRESSIONS, STATEMENTS  
Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III  CONTROL FLOW, FUNCTIONS  
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV  LISTS, TUPLES, DICTIONARIES  
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT V  FILES, MODULES, PACKAGES  
Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

OUTCOMES:
Upon completion of the course, students will be able to
• Develop algorithmic solutions to simple computational problems
• Read, write, execute by hand simple Python programs.
• Structure simple Python programs for solving problems.
• Decompose a Python program into functions.
• Represent compound data using Python lists, tuples, dictionaries.
• Read and write data from/to files in Python Programs.

TOTAL : 45 PERIODS
TEXT BOOKS:

REFERENCES:

GE8152 ENGINEERING GRAPHICS

OBJECTIVES:
- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination)
Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREEHAND SKETCHING
Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.
Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE
Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.
UNIT III  PROJECTION OF SOLIDS  
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV  PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES  
Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT V  ISOMETRIC AND PERSPECTIVE PROJECTIONS  
Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

OUTCOMES:
On successful completion of this course, the student will be able to
- familiarize with the fundamentals and standards of Engineering graphics
- perform freehand sketching of basic geometrical constructions and multiple views of objects.
- project orthographic projections of lines and plane surfaces.
- draw projections and solids and development of surfaces.
- visualize and to project isometric and perspective sections of simple solids.

TOTAL: 90 PERIODS

TEXT BOOK:

REFERENCES:

Publication of Bureau of Indian Standards:
Upon completion of the course, students will be able to

- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.

Special points applicable to University Examinations on Engineering Graphics:
1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size. The examination will be conducted in appropriate sessions on the same day.

GE8161 PROBLEM SOLVING AND PYTHON PROGRAMMING
LABORATORY

OBJECTIVES:
- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python.

LIST OF PROGRAMS
1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton’s method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers
9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Simulate elliptical orbits in Pygame
13. Simulate bouncing ball using Pygame

PLATFORM NEEDED
Python 3 interpreter for Windows/Linux

OUTCOMES:
Upon completion of the course, students will be able to

- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.
BS8161 PHYSICS AND CHEMISTRY LABORATORY
(Common to all branches of B.E. / B.Tech Programmes) 0 0 4 2

OBJECTIVES:
- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter and liquids.

LIST OF EXPERIMENTS: PHYSICS LABORATORY (Any 5 Experiments)
1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young’s modulus by non-uniform bending method
3. (a) Determination of wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fiber.
5. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of band gap of a semiconductor
8. Determination of thickness of a thin wire – Air wedge method

TOTAL: 30 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able to
- apply principles of elasticity, optics and thermal properties for engineering applications.

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

OBJECTIVES:
- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by viscometry.

1. Estimation of HCl using Na$_2$CO$_3$ as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler’s method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline / thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
12. Pseudo first order kinetics-ester hydrolysis.
14. Determination of CMC.
15. Phase change in a solid.
1. Conductometric titration of strong acid vs strong base.
OUTCOMES:
- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

TOTAL: 30 PERIODS

TEXTBOOKS:

HS8251 TECHNICAL ENGLISH
L T P C
4 0 0 4

OBJECTIVES:
The Course prepares second semester engineering and Technology students to:
- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Develop their speaking skills to make technical presentations, participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialisation.

UNIT I INTRODUCTION TECHNICAL ENGLISH 12
Listening - Listening to talks mostly of a scientific/technical nature and completing information-gap exercises
Speaking – Asking for and giving directions
Reading – reading short technical texts from journals, newspapers
Writing – purpose statements – extended definitions – issue writing instructions – checklists-recommendations
Vocabulary Development – technical vocabulary
Language Development – subject verb agreement - compound words.

UNIT II READING AND STUDY SKILLS 12
Listening - Listening to longer technical talks and completing exercises based on them
Speaking – describing a process
Reading – reading longer technical texts – identifying the various transitions in a text
Paragraphing
Writing – interpreting charts, graphs
Vocabulary Development – vocabulary used in formal letters/emails and reports
Language Development – impersonal passive voice, numerical adjectives.

UNIT III TECHNICAL WRITING AND GRAMMAR 12
Listening - Listening to classroom lectures/talks on engineering/technology
Speaking – introduction to technical presentations
Reading – longer texts both general and technical, practice in speed reading
Writing – Describing a process, use of sequence words
Vocabulary Development – sequence words
Language Development – Misspelled words.

UNIT IV REPORT WRITING 12
Listening - Listening to documentaries and making notes
Speaking – mechanics of presentations
Reading – reading for detailed comprehension
Writing – email etiquette, job application – cover letter – Résumé preparation (via email and hard copy)
Vocabulary Development – finding suitable synonyms
Language Development – clauses, if conditionals.
UNIT V GROUP DISCUSSION AND JOB APPLICATIONS

Listening- TED/Ink talks; Speaking – participating in a group discussion -Reading– reading and understanding technical articles Writing– Writing reports- minutes of a meeting- accident and survey- Vocabulary Development- verbal analogies Language Development- reported speech .

TOTAL :60 PERIODS

OUTCOMES: At the end of the course learners will be able to:

- Read technical texts and write area- specific texts effortlessly.
- Listen and comprehend lectures and talks in their area of specialisation successfully.
- Speak appropriately and effectively in varied formal and informal contexts.
- Write reports and winning job applications.

TEXT BOOKS:

REFERENCES
2. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007

Students can be asked to read Tagore, Chetan Bhagat and for supplementary reading.

MA8251 ENGINEERING MATHEMATICS – II L T P C
4 0 0 4

OBJECTIVES:

- This course is designed to cover topics such as Matrix Algebra, Vector Calculus, Complex Analysis and Laplace Transform. Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering. Vector calculus can be widely used for modelling the various laws of physics. The various methods of complex analysis and Laplace transforms can be used for efficiently solving the problems that occur in various branches of engineering disciplines.

UNIT I MATRICES

UNIT II  VECTOR CALCULUS
Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT III  ANALYTIC FUNCTIONS
Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates – Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions \( w = z + c, \frac{1}{z}, \frac{1}{z^2} \) - Bilinear transformation.

UNIT IV  COMPLEX INTEGRATION

UNIT V  LAPLACE TRANSFORMS

TOTAL: 60 PERIODS

OUTCOMES:
After successfully completing the course, the student will have a good understanding of the following topics and their applications:

- Eigenvalues and eigenvectors, diagonalization of a matrix, Symmetric matrices, Positive definite matrices and similar matrices.
- Gradient, divergence and curl of a vector point function and related identities.
- Evaluation of line, surface and volume integrals using Gauss, Stokes and Green’s theorems and their verification.
- Analytic functions, conformal mapping and complex integration.
- Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.

TEXT BOOKS:

REFERENCES:

PH8254 PHYSICS OF MATERIALS
(Common to courses offered in Faculty of Technology except Fashion Technology)

L T P C
3 0 0 3

OBJECTIVES:
• To introduce the physics of various materials relevant to different branches of technology

UNIT I PREPARATION OF MATERIALS

UNIT II CONDUCTING MATERIALS

UNIT III SEMICONDUCTING MATERIALS

UNIT IV DIELECTRIC AND MAGNETIC MATERIALS

UNIT V NEW MATERIALS AND APPLICATIONS
conducting, semiconducting and photoresponsive polymers.

TOTAL : 45 PERIODS

OUTCOMES:
At the end of the course, the students will able to
- gain knowledge on phase diagrams and various material processing methods,
- acquire knowledge on basics of conducting materials, superconductors and their applications
- get knowledge on the functioning of semiconducting materials and their applications in LED and solar cells,
- understand the functioning of various dielectric and magnetic materials,
- have the necessary understanding on various advanced materials.

TEXT BOOKS:

REFERENCES

BE8252 BASIC CIVIL AND MECHANICAL ENGINEERING L T P C 4 0 0 4

OBJECTIVES:
- To impart basic knowledge on Civil and Mechanical Engineering.
- To familiarize the materials and measurements used in Civil Engineering.
- To provide the exposure on the fundamental elements of civil engineering structures.
- To enable the students to distinguish the components and working principle of power plant units, IC engines, and R & AC system.

A – OVER VIEW

UNIT I SCOPE OF CIVIL AND MECHANICAL ENGINEERING 10
Overview of Civil Engineering - Civil Engineering contributions to the welfare of Society – Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering

B – CIVIL ENGINEERING

UNIT II SURVEYING AND CIVIL ENGINEERING MATERIALS 10
determination of areas – contours - examples.

materials

UNIT III BUILDING COMPONENTS AND STRUCTURES 15
Foundations: Types of foundations - Bearing capacity and settlement – Requirement of good
foundations.

roofing – flooring – plastering – floor area, carpet area and floor space index - Types of Bridges
and Dams – water supply - sources and quality of water - Rain water harvesting - introduction to
high way and rail way.

C – MECHANICAL ENGINEERING

UNIT IV INTERNAL COMBUSTION ENGINES AND POWER PLANTS 15
Classification of Power Plants - Internal combustion engines as automobile power plant –
Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison
of four stroke and two stroke engines – Working principle of steam, Gas, Diesel, Hydro - electric
and Nuclear Power plants — working principle of Boilers, Turbines, Reciprocating Pumps (single
acting and double acting) and Centrifugal Pumps

UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 10
Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and
absorption system–Layout of typical domestic refrigerator–Window and Split type room Air
conditioner.

OUTCOMES:
On successful completion of this course, the student will be able to
• appreciate the Civil and Mechanical Engineering components of Projects.
• explain the usage of construction material and proper selection of construction materials.
• measure distances and area by surveying
• identify the components used in power plant cycle.
• demonstrate working principles of petrol and diesel engine.
• elaborate the components of refrigeration and Air conditioning cycle.

TOTAL: 60 PERIODS

TEXTBOOKS:
1. Shanmugam Gand Palanichamy MS,“Basic Civil and Mechanical Engineering”,Tata

REFERENCES:

OBJECTIVES
- To introduce students to the principles of Microbiology to emphasize structure and biochemical aspects of various microbes.
- To solve the problems in microbial infection and their control.

UNIT I INTRODUCTION 6
Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.

UNIT II MICROBES- STRUCTURE AND MULTIPLICATION 12
Structural organization and multiplication of bacteria, viruses, algae and fungi, with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages.

UNIT III MICROBIAL NUTRITION, GROWTH AND METABOLISM 12
Nutritional requirements of bacteria; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.

UNIT IV CONTROL OF MICROORGANISMS 6
Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti-fungal and anti-viral agents; mode of action and resistance to antibiotics; clinically important microorganisms.

UNIT V INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY 9
Primary metabolites; secondary metabolites and their applications; preservation of food; production of penicillin, alcohol, vitamin B-12; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control; biosensors

TOTAL: 45 PERIODS

TEXT BOOKS
OBJECTIVE

- To enable students learn the fundamentals of Biochemical Processes and Biomolecules.

UNIT I  INTRODUCTION TO BIOMOLECULES - CARBOHYDRATES  8
Basic principles of organic chemistry, role of carbon, types of functional groups, chemical, nature of water, pH and biological buffers, biomolecules.


UNIT II  STRUCTURE AND PROPERTIES OF OTHER BIOMOLECULES  12
Structure and properties of Important Biomolecules.
Lipids: fatty acids, glycerol, saponification, iodination, hydrogenation, phospholipids, glycolipids, sphingolipids, cholesterol, steroids, prostaglandins.
Protein: Amino Acids, Peptides, Proteins, measurement, structures, hierarchy of organization primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. Determine of primary structure.
Nucleic acids: purines, pyrimidines, nucleoside, nucleotide, RNA, DNA-Watson-Crick structure of DNA, reactions, properties, measurement, nucleoprotein complexes

UNIT III  METABOLISM CONCEPTS AND CARBOHYDRATE METABOLISM  8

UNIT IV  INTERMEDIARY METABOLISM AND REGULATION  12
Fatty acid synthesis and oxidation, reactions of amino acids, deamination, transamination and decarboxylation, urea cycle, Bioenergetics - High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, calculation of ATP yield during oxidation of glucose and fatty acids.

UNIT V  PROTEIN TRANSPORT AND DEGRADATION  5
Protein targeting, signal sequence, secretion; Folding, Chaperone and targeting of organelle proteins, Protein degradation, receptor-mediated endocytosis, turnover.

TOTAL: 45 PERIODS

OUTCOMES

- To ensure students have a strong foundation in the structure and reactions of Biomolecules.
- To introduce them to metabolic pathways of the major biomolecules and relevance to clinical conditions.
- To correlate Biochemical processes with Biotechnology applications.

TEXT BOOKS

REFERENCES

GE8261 ENGINEERING PRACTICES LABORATORY

OBJECTIVES:
To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE
Buildings:
- (a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:
(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
(b) Study of pipe connections requirements for pumps and turbines.
(c) Preparation of plumbing line sketches for water supply and sewage works.
(d) Hands-on-exercise:
   - Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:
(a) Study of the joints in roofs, doors, windows and furniture.
(b) Hands-on-exercise:
   Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE
Welding:
(a) Preparation of butt joints, lap joints and T-joints by Shielded metal arc welding.
(b) Gas welding practice
Basic Machining:
(a) Simple Turning and Taper turning
(b) Drilling Practice
Sheet Metal Work:
(a) Forming & Bending:
(b) Model making – Trays and funnels.
(c) Different type of joints.
Machine assembly practice:
(a) Study of centrifugal pump
(b) Study of air conditioner

Demonstration on:
(a) Smithy operations, upsetting, swaging, setting down and bending. Example – Production of hexagonal headed bolt.
(b) Foundry operations like mould preparation for gear and step cone pulley.
(c) Fitting – Exercises – Preparation of square fitting and V – fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE 13
1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
5. Measurement of energy using single phase energy meter.

IV ELECTRONICS ENGINEERING PRACTICE 16
1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 60 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- fabricate carpentry components and pipe connections including plumbing works.
- use welding equipments to join the structures.
- Carry out the basic machining operations
- Make the models using sheet metal works
- Illustrate on centrifugal pump, Air conditioner, operations of smithy, foundary and fittings
- Carry out basic home electrical works and appliances
- Measure the electrical quantities
- Elaborate on the components, gates, soldering practices.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL
1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings. 15 Sets.
2. Carpentry vice (fitted to work bench) 15 Nos.
4. Models of industrial trusses, door joints, furniture joints each
5. Power Tools: (a) Rotary Hammer 2 Nos
   (b) Demolition Hammer 2 Nos
   (c) Circular Saw 2 Nos
   (d) Planer 2 Nos
   (e) Hand Drilling Machine 2 Nos
   (f) Jigsaw 2 Nos

**MECHANICAL**
1. Arc welding transformer with cables and holders 5 Nos.
2. Welding booth with exhaust facility 5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc. 5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit. 2 Nos.
5. Centre lathe 2 Nos.
6. Hearth furnace, anvil and smithy tools 2 Sets.
7. Moulding table, foundry tools 2 Sets.
8. Power Tool: Angle Grinder 2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner One each.

**ELECTRICAL**
1. Assorted electrical components for house wiring 15 Sets
2. Electrical measuring instruments 10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp 1 each
4. Megger (250V/500V) 1 No.
5. Power Tools: (a) Range Finder 2 Nos
   (b) Digital Live-wire detector 2 Nos

**ELECTRONICS**
1. Soldering guns 10 Nos.
2. Assorted electronic components for making circuits 50 Nos.
3. Small PCBs 10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply

**BT8261 BIOCHEMISTRY LABORATORY**

**AIM**
- To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules (proteins, carbohydrates, lipids, metabolites etc.,) and laboratory analysis of the same in the body fluids.

**EXPERIMENTS**
1. General guidelines for working in biochemistry lab (theory)
2. Units of volume, weight, density and concentration measurements and their range in biological measurements. Demonstration of proper use of volume and weight measurement devices.
3. Accuracy, precision, sensitivity and specificity (theory)
4. Preparation of buffer –titration of a weak acid and a weak base.
5. Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars.
7. Protein estimation by Biuret and Lowry’s methods.
8. Protein estimation by Bradford and spectroscopic methods.
9. Extraction of lipids and analysis by TLC.
10. Estimation of nucleic acids by absorbance at 260 nm and hyperchromic effect (demo).

Equipment Needed for 20 Students
Autocalve 1
Hot Air Oven 1
Incubators 2
Light Microscopes 4
Incubator Shaker 1
Colorimeter 2
Laminar Flow Chamber 2

TOTAL: 60 PERIODS

Glassware:
Test tubes (at least 10 per student)
Beakers – 50 ml, 100 ml, 250 ml one each per student, 500 ml and 1000 ml at least 5 per batch of 20 students
Watch glasses one per student
Petridishes as required, glass cuvettes as needed
Burette – one per student
Glass pipette – one each in 0.5 ml, 1 ml, 5 ml and 10 ml with suitable pipette aid.
TLC plate as required for the experiment.

Chemicals: glucose, fructose, galactose, maltose, starch, amino acids, DNA, RNA, lipids and commercial enzymes as required. Other chemicals as per the requirement of the standard protocol and commercial kit procured from the vendor followed/ utilised by the department

TEXT BOOKS
1. Practical Biochemistry by R.C. Gupta and S. Bhargavan.
2. Introduction of Practical Biochemistry by David T. Phummer. (II Edition)

REFERENCES

MA8353 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
4 0 0 4

OBJECTIVE:
• To introduce the basic concepts of PDE for solving standard partial differential equations.
• To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
• To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
• To acquaint the student with Fourier transform techniques used in wide variety of situations.
• To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I  PARTIAL DIFFERENTIAL EQUATIONS
Formation of partial differential equations – Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II  FOURIER SERIES

UNIT III  APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS
Classification of PDE – Method of separation of variables - Fourier Series Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction.

UNIT IV  FOURIER TRANSFORMS

UNIT V  Z-TRANSFORMS AND DIFFERENCE EQUATIONS

OUTCOMES:
Upon successful completion of the course, students should be able to:
• Understand how to solve the given standard partial differential equations.
• Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
• Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.
• Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using
  Z transform techniques for discrete time systems.

**TEXT BOOKS:**

**REFERENCES:**

**BT8301 STOICHIOMETRY**

**OBJECTIVES:**
- The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics.
- This will enable the students to perform calculations pertaining to processes and operations.

**UNIT I BASIC CHEMICAL CALCULATIONS** (9 + 6)
Dimension – Systems of units esp. engineering FPS, Engineering MKS & SI systems – Conversion from one system to the other – composition of mixtures and solutions – mass fraction, mass %, mole fraction, mole %, mass ratios, molarity, molality, normality, ppm, composition by density.

**UNIT II IDEAL AND ACTUAL GAS EQUATIONS** (9 + 6)

**UNIT III MATERIAL BALANCE** (9 + 6)
Material balance concept – overall & component – material balance applications for evaporator, gas absorber without reaction, Distillation (Binary system), Liquid extraction, solid-liquid extraction, drying, crystallization, Humidification, Reverse Osmosis separation and Mixing Recycle and Bypass illustration
UNIT IV ENERGY BALANCE (9 + 6)
General energy balance equation for open systems, closed system sensible heat calculation, Heat required for phase change thermo chemistry, application of steam tables, Saturated and superheated steam application in bioprocess

UNIT V CHEMICAL REACTION (9 + 6)

TOTAL: 75 PERIODS

OUTCOMES:
Upon success completion of this course, the students will be able to:
- Solve problems related to units and conversions and fit the given data using the methodologies
- Solve problems related to material and energy balance concepts & design reactors for biochemical processes
- Apply their knowledge in the field of biochemical engineering from the principles of thermodynamics

TEXT BOOKS:

REFERENCES:

BT8302 APPLIED THERMODYNAMICS FOR BIOTECHNOLOGISTS L T P C
3 0 0 3

OBJECTIVE:
- To enable the students to learn about basic concepts of classical and statistical thermodynamics

UNIT I THERMODYNAMIC LAW AND PROPERTIES OF FLUIDS 9
First Law of thermodynamics, a generalized balance equation and conserved quantities, Volumetric properties of fluids exhibiting non ideal behavior; residual properties; estimation of thermodynamic properties using equations of state; calculations involving actual property exchanges; Maxwell’s relations and applications.

UNIT II SOLUTION THERMODYNAMICS 9
Partial molar properties; concepts of chemical potential and fugacity; ideal and non-ideal solutions; concepts and applications of excess properties of mixtures; activity coefficient; composition models; Gibbs Duhem equation.
UNIT III PHASE EQUILIBRIA
Criteria for phase equilibria; VLE calculations for binary and multi component systems; liquid-liquid equilibria and solid-solid equilibria.

UNIT IV CHEMICAL REACTION EQUILIBRIA
Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversion and yields for single and multiple reactions.

UNIT V THERMODYNAMIC DESCRIPTION OF MICROBIAL GROWTH AND PRODUCT FORMATION
Thermodynamics of microbial growth stoichiometry thermodynamics of maintenance, Calculation of the Operational Stoichiometry of a growth process at Different growth rates, Including Heat using the Herbert–Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation

OUTCOMES:
At the end of this course, the student would have the ability
- To explain the theoretical concepts of thermodynamics and how it applies to energy conversion in technological applications and biological systems.
- To demonstrate the capability to analyze the energy conversion performance in a variety of modern applications in biological systems.
- To design and carry out bioprocess engineering experiments, and analyze and interpret fundamental data to do the design and operation of bioprocesses.
- To describe the criteria when two phases coexist in equilibrium and the vapour liquid equilibrium calculations microbial growth and product formation.

TEXT BOOKS:

REFERENCE:

BT8303 BASIC INDUSTRIAL BIOTECHNOLOGY L T P C 3 0 0 3

OBJECTIVES:
- To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.
- The course prepares the students for the bulk production of commercially important modern Bioproducts, Industrial Enzymes, Products of plant and animal cell cultures

UNIT II PRODUCTION OF PRIMARY METABOLITES 9
Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids and alcohols.

UNIT III PRODUCTION OF SECONDARY METABOLITES 9
Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.

UNIT IV PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS 9
Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel, Cheese, Beer, SCP & Mushroom culture, Bioremediation.

UNIT V PRODUCTION MODERN BIOTECHNOLOGY PRODUCTS 9

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the students will be able

- To explain the steps involved in the production of bioproducts and methods to improve modern biotechnology.
- To apply basic biotechnological principles, methods and models to solve biotechnological tasks.
- To identify and debate the ethical, legal, professional, and social issues in the field of biotechnology.
- To design and deliver useful modern biotechnology products to the Society.

TEXT BOOKS:

REFERENCES:
5. Stanbury, P.F., A. Whitaker and S.J. Hall “Principles of Fermentation Technology”, II"
**BT8304 BIOORGANIC CHEMISTRY**  

**L T P C**  

3 0 0 3

**OBJECTIVES:**  
To enable the students  
- To know in detail about the elements of atom, charges and their bonding rule.  
- To understand the various kinetic properties and types of reaction mechanisms  
- To understand the possible bio-organic reactions involved in biosynthesis

**UNIT I  BONDING AND STEREOCHEMISTRY**  
Atoms Electrons and orbitals - Covalent Bonds - Octet rule - Polar covalant Bonds - Electronegativity- formal charge - Resonance Acids and Bases - Arrhenius and Bronsted Lowry Theories - Acid Base equilibria - SP3 hybridization - Conformations analysis ethane, butane and cyclohexane - Cis- trans isomerism. Stereochem activity around the tetrahedral carbon – optical activity - Conformation of the peptide bond.

**UNIT II  MECHANISMS OF SUBSTITUTION AND ADDITION REACTIONS**  
SN1 and SN2 reactions on tetrahedral carbon- nucleophiles- mechanism steric effects – nucleophilic addition on Acetals and ketals -Aldehyde and ketone groups – reactions of carbonyl group with amines- acid catalyzed ester hydrolysis – Saponification of an ester- hydrolysis of amides. Ester enolates - claisen -condensation – Michael condensation.

**UNIT III  KINETICS AND MECHANISM**  

**UNIT IV  CATALYSIS**  
Reactivity – Coenzymes – Proton transfer – metal ions – Intra molecular reactions – Covalent catalysis – Catalysis by organized aggregates and phases. Inclusion complexation

**UNIT V  BIOORGANIC REACTIONS**  
Timing of Bond formation and fission – Acyl group transfer – C-C bond formation and fission – Catalysis of proton transfer reactions – Transfer of hydride ion – Alkyl group. Transfer – Terpene biosynthesis – Merrifield state peptide synthesis – Sanger method for peptide and DNA sequencing

**OUTCOME:**  

TOTAL: 45 PERIODS
• On completion of this course, the students will learn the basics principles of chemical Bonding, Stereochemistry of Bio-organic molecules and their kinetics, mechanisms of reactions and catalysis.

TEXT BOOKS:

REFERENCE:

BT8305 CELL BIOLOGY L T P C
3 0 0 3

OBJECTIVES:
• To provide knowledge on the fundamentals of cell biology
• To help students understand the signalling mechanisms

UNIT I CELL STRUCTURE AND FUNCTION OF THE ORGANELLES 9

UNIT II CELL DIVISION, CANCER, APOPTOSIS AND IMMORTALIZATION OF CELLS 9
Cell cycle – Mitosis, Meiosis, Molecules controlling cell cycle, cancer, role of Ras and Raf in oncogenesis and apoptosis. Stem cells, Cell culture and immortalization of cells and its applications.

UNIT III TRANSPORT ACROSS CELL MEMBRANE 9

UNIT IV SIGNAL TRANSDUCTION 9
Receptors – extracellular signaling, Cell surface / cytosolic receptors and examples, Different classes of receptors antocrine / paracrine / endocrine models, Secondary messengers molecules.

UNIT V TECHNIQUES USED TO STUDY CELLS 9

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the students
• Would have deeper understanding of cell at structural and functional level.
• Would have broad knowledge on the molecular interaction between cells.
- Would demonstrate a clear understanding of the signal transduction, secondary messengers.
- Would develop skill on working principles of microscopy and identification of cell types.

**TEXT BOOKS:**

**REFERENCES:**

**BT8361 MICROBIOLOGY LABORATORY**

**OBJECTIVE:**
- To demonstrate various techniques to learn the morphology, identification and propagation of microbes

**Experiments**
1. Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques
2. Culture Media-Types and Use; Preparation of Nutrient broth and agar
3. Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid:Pour plates, streak plates, slants, stabs
5. Microscopic Methods in the Study of Microorganisms., Microscopic identification of yeast/moulder
6. Staining Techniques Simple, Differential- Gram’s Staining, spore /capsule staining
7. Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in Soil – TVC
8. Effect of Disinfectants- Phenol Coefficient
9. Antibiotic Sensitivity Assay
10. Growth Curve in Bacteria and Yeast
11. Effect of pH, Temperature, UV radiation on Growth Bacteria

**OUTCOMES:**
Students will be able to
- Understand the advanced technical information pertaining to laboratory bio-safety and preventive measures from pathogenic microorganism.
- Know the various aseptic techniques and sterilization methods.
- Develop the minimum skills to work on several important techniques for the study of microorganisms in the laboratory.

**TOTAL: 60 PERIODS**
Equipment Needed for 30 Students

Autoclave 1
Hot Air Oven 1
Incubators 2
Light Microscopes 4
Incubator Shaker 1
Colorimeter 2
Lamina Flow Chamber 2
Glassware
Petridish,
Test tubes
Microscopic slides
Inoculation loop
Gas burner

Chemicals and media
Bacterial culture media
Yeast culture media
70% ethanol
antibiotics
Crystal violet
Iodine
Safranin
India ink (capsule staining)
Immersion oil

TEXT BOOKS

BT8311 CELL BIOLOGY LABORATORY L T P C

0 0 4 2

OBJECTIVE:
- To demonstrate various techniques to learn the morphology, identification and propagation of cells

LIST OF EXPERIMENTS
1. Introduction to principles of sterile techniques and cell propagation
2. Principles of microscopy, phase contrast and fluorescent microscopy
3. Identification of given plant, animal and bacterial cells & their components by microscopy
4. Gram’s Staining
5. Leishman Staining
6. Giemsa Staining
7. Thin Layer Chromatography
8. Separation of Peripheral Blood Mononuclear Cells from blood
9. Osmosis and Tonicity
10. Tryphan Blue Assay
11. Staining for different stages of mitosis in AlliumCepa (Onion)

OUTCOMES:
This practical course will facilitate the students
- To understand the basic techniques to work with cells
- To demonstrate working principles of Microscopy
- To understand and perform cell staining techniques
- To identify the various stages of mitosis

REFERENCES:

Equipment Needed for 30 Students
Autoclave 1
Hot Air Oven 1
Incubators 2
Light Microscopes 4
Incubator Shaker 1
Colorimeter 2
Lamina Flow Chamber 2
Chemicals
Leishman stain
Phosphate buffered saline
Crystal violet
Gram’s iodine
Saffranin
Alcohol
Hypertonic solution (Freshly prepared)
Hypotonic solution (Freshly prepared)
Methanol (mobile phase)
Heparin
Trypan blue
Acetocalmine stain

HS8381 INTERPERSONAL SKILLS/LISTENING AND SPEAKING

OBJECTIVES: The Course will enable learners to:
- Equip students with the English language skills required for the successful undertaking of academic studies with primary emphasis on academic speaking and listening skills.
- Provide guidance and practice in basic general and classroom conversation and to engage in specific academic speaking activities.
- Improve general and academic listening skills.
- Make effective presentations.

UNIT I
Listening as a key skill - its importance - speaking - give personal information - ask for personal information - express ability - enquire about ability - ask for clarification Improving pronunciation - pronunciation basics taking lecture notes - preparing to listen to a lecture - articulate a complete
idea as opposed to producing fragmented utterances.

UNIT II
Listen to a process information- give information, as part of a simple explanation - conversation starters: small talk - stressing syllables and speaking clearly - intonation patterns - compare and contrast information and ideas from multiple sources- converse with reasonable accuracy over a wide range of everyday topics.

UNIT III
Lexical chunking for accuracy and fluency- factors influence fluency, deliver a five-minute informal talk - greet - respond to greetings - describe health and symptoms - invite and offer - accept - decline - take leave - listen for and follow the gist- listen for detail

UNIT IV
Being an active listener: giving verbal and non-verbal feedback - participating in a group discussion - summarizing academic readings and lectures conversational speech listening to and participating in conversations - persuade.

UNIT V
Formal and informal talk - listen to follow and respond to explanations, directions and instructions in academic and business contexts - strategies for presentations and interactive communication - group/pair presentations - negotiate disagreement in group work.

TOTAL: 30 PERIODS

OUTCOMES: At the end of the course Learners will be able to:

- Listen and respond appropriately.
- Participate in group discussions
- Make effective presentations
- Participate confidently and appropriately in conversations both formal and informal

TEXT BOOKS:

REFERENCES:

MA8391 PROBABILITY AND STATISTICS

4 0 0 4
OBJECTIVE:

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

UNIT I PROBABILITY AND RANDOM VARIABLES 12

UNIT II TWO-DIMENSIONAL RANDOM VARIABLES 12
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III TESTING OF HYPOTHESIS 12
Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means - Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS 12
One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design - 2² factorial design.

UNIT V STATISTICAL QUALITY CONTROL 12
Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

TOTAL: 60 PERIODS

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

- Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
- Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

TEXT BOOKS:

REFERENCES:

BT8401 FLUID MECHANICS AND HEAT TRANSFER OPERATIONS L T P C
4 0 0 4
OBJECTIVES:
- To introduce the students to the mechanics of fluids through a thorough understanding of the properties of the fluids, behaviour of fluids under static conditions. The dynamics of fluids is introduced through the control volume approach which gives an integrated understanding of the transport of mass, momentum and energy.
- To expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on vanes.

UNIT I FLUID PROPERTIES & FLUID MECHANICS

UNIT II FLOW OF FLUID THROUGH PACKINGS

UNIT III CONDUCTION HEAT TRANSFER

UNIT IV CONVECTION HEAT TRANSFER
Forced and natural convection – Dimensional analysis, Dimensional numbers, Convection heat transfer coefficient, Correlations for flow over plate, through tubes, over spheres and cylinders, Agitated systems, Packed columns, condensation phenomena, Film and drop wise condensation over tubes. Billing phenomena, heat transfer coefficient.

UNIT V RADIATION HEAT TRANSFER AND HEAT TRANSFER EQUIPMENTS

TOTAL: 60 PERIODS

OUTCOMES:
- The students will be able to get a basic knowledge of fluids in static, kinematic and dynamic equilibrium.
- They will also gain the knowledge of the applicability of physical laws in addressing problems in hydraulics.

TEXT BOOKS:

REFERENCE:

OBJECTIVES:
- Familiarize students with the cell and molecular biology of both Prokaryotes and Eukaryotes.
- This will be needed for any project work in modern biotechnology.
- By doing this course students will acquire basic fundamental knowledge and explore skills in molecular biology and become aware of the complexity and harmony of the cells.
- This course will emphasize the molecular mechanism of DNA replication, repair, transcription, protein synthesis and gene regulation in various organisms.

UNIT I CHEMISTRY OF NUCLEIC ACIDS

UNIT II DNA REPLICATION & REPAIR

UNIT III TRANSCRIPTION

UNIT IV TRANSLATION

UNIT V REGULATION OF GENE EXPRESSION
Organization of genes in prokaryotic and eukaryotic chromosomes, Hierarchical levels of gene regulation, Prokaryotic gene regulation –lac and trp operon, Regulation of gene expression with reference to λ phage life cycle.

TOTAL: 45 PERIODS

OUTCOMES:
By the end of this course, students should be able to:
- Describe the basic structure and biochemistry of nucleic acids and proteins and discriminate between them;
- Identify the principles of DNA replication, transcription and translation and explain how they relate to each other.
- Discuss clearly about gene organization and mechanisms of control the gene expression in various organisms.
- Articulate applications of molecular biology in the modern world

TEXT BOOKS:

REFERENCES:


BT8403 ENZYME TECHNOLOGY AND BIO-TRANSFORMATIONS

OBJECTIVES:
To 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

UNIT I INTRODUCTION TO ENZYMES
Classification of enzymes. Mechanisms of enzyme action; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory; role of entropy in catalysis.

UNIT II KINETICS OF ENZYME ACTION

UNIT III ENZYME IMMOBILIZATION AND BIOSENSORS
Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages, design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

UNIT IV PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES
Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes; development of enzymatic assays

UNIT V BIOTRANSFORMATION APPLICATIONS OF ENZYMES

OUTCOMES:
- The knowledge on enzyme and enzyme reactions will be the key step in to proceed towards various concepts in biotechnology.

TOTAL: 45 PERIODS
The theoretical and practical aspects of kinetics will provide the importance and utility of enzyme kinetics towards research.

The process of immobilization has been increased steadily in food, pharmaceutical and chemical industries and thus this study will provide simple and easy method of implementation.

Ideas on Processing, Production and Purification of enzymes at an industrial scale will be helpful to work technologically.

TEXT BOOKS:
1. Trevor Palmer, Enzymes II\textsuperscript{nd} Horwood Publishing Ltd

REFERENCES:
1. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc.
2. James M. Lee, Biochemical Engineering, PHI, USA.

BT8404 BIOPROCESS PRINCIPLES

OBJECTIVES:

- 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.

UNIT I OVERVIEW OF FERMENTATION PROCESSES
Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermentor (CSTR) and ancillaries, main parameters to be monitored and controlled in fermentation processes.

UNIT II RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS
Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization methods

UNIT III STERILIZATION KINETICS
Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of sterilization equipment - batch and continuous.

UNIT IV METABOLIC STOICHIOMETRY AND ENERGETICS
Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

UNIT V KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION 9

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course in Bioprocess Principles graduates will be able to
- Apply engineering principles to systems containing biological catalysts to meet the needs of the society.
- Convert the promises of molecular biology and genetic engineering into new processes to make bio-products in economically feasible way.

TEXT BOOKS:

REFERENCES:
4. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc.

GE8291 ENVIRONMENTAL SCIENCE AND ENGINEERING

OBJECTIVES:
- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth’s interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14
Definition, scope and importance of environment – need for public awareness - concept of an
ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION
Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES
Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT

UNIT V HUMAN POPULATION AND THE ENVIRONMENT
OUTCOMES:

- Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.
- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions
- Development and improvement in std. of living has lead to serious environmental disasters

TEXT BOOKS:


REFERENCES:


BT8411 CHEMICAL ENGINEERING LABORATORY FOR
BIOTECHNOLOGISTS

OBJECTIVES:

- To provide basic understanding of chemical engineering principles and operations
- Course will enable the students to apply the principles in other chemical engineering and biotechnology subjects offered in higher semesters

LIST OF EXPERIMENTS

1. Flow measurement - Orifice meter
2. Flow measurement - Venturimeter,
3. Flow measurement - Rotameter
4. Pressure drop in flow through pipes
5. Pressure drop in flow through packed column
6. Pressure drop in flow through fluidized beds
7. Characteristics of centrifuge pump
8. Filtration through plate and frame filter press
9. Filtration in leaf filter
10. Heat transfer characteristics in heat exchanger
11. Simple and steam distillation

OUTCOMES:

Upon completion of this practical course the student will
- Have knowledge on the basic principles of chemical engineering
- Be able to apply the skill of material balance and energy balance in unit operations unit process of chemical engineering and biotechnology
- Be able to analyze the principles of chemical engineering and its applications in chemical, mechanical and biological perspectives
- Understand the design and working principles of fluid moving machinery and transport phenomena

**Equipment Needed for 30 Students**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorimeter</td>
<td>2</td>
</tr>
<tr>
<td>Filter leaf</td>
<td>1</td>
</tr>
<tr>
<td>Orifice meter</td>
<td>1</td>
</tr>
<tr>
<td>Venturimeter</td>
<td>1</td>
</tr>
<tr>
<td>Rotameter</td>
<td>1</td>
</tr>
<tr>
<td>Glassware, Chemicals, Media as required</td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL: 60 PERIODS**

**BT8412  MOLECULAR BIOLOGY LABORATORY**

**OBJECTIVES:**
- Provide hands-on experience in performing basic molecular biology techniques.
- Introduce students to the theory behind in each technique and to describe common applications of each methodology in biological research. This will facilitate the students to take up specialized project in Molecular biology and will be a pre-requisite for research work.

**LIST OF EXPERIMENTS:**
1. Electrophoresis _ Agarose and Polyacrylamide Gel
2. Isolation of microbial DNA
3. Isolation of genomic DNA
4. Quantification of DNA (UV/ Vis) and analysis of purity
5. Restriction enzyme digestion & Ligation
6. Competent cells preparation
7. Transformation
8. Selection of recombinants – Antibiotic sensitivity assay
9. Plating of λ phage
10. Lambda phage lysis of liquid cultures

**TOTAL: 60 PERIODS**

**Equipment Needed for 30 Students**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrophoresis Kit</td>
<td>1</td>
</tr>
<tr>
<td>PCR</td>
<td>1</td>
</tr>
<tr>
<td>Incubators</td>
<td>2</td>
</tr>
<tr>
<td>Light Microscopes</td>
<td>4</td>
</tr>
<tr>
<td>Incubator Shaker</td>
<td>1</td>
</tr>
<tr>
<td>Spectrophotometer</td>
<td>2</td>
</tr>
<tr>
<td>Laminar Flow Chamber</td>
<td>2</td>
</tr>
</tbody>
</table>

**TOTAL: 60 PERIODS**
70% ethanol
Agarose
Polyacrylamide
Phosphate buffered saline
Tris HCl
TBE buffer
Magnesium chloride
EDTA
Lysozyme
Restriction enzyme
Cohesive end buffer
T4 DNA ligase
6X gel loading dye
Ice cold calcium chloride
LB medium broth
Antibiotics
Glycerol
Bromophenol blue
Xylene cynol
Ethidium bromide

OUTCOMES:
By the end of this course, students should be able to:

- Demonstrate knowledge and understanding of the principles underpinning important techniques in molecular biology.
- Demonstrate knowledge and understanding of applications of these techniques.
- Demonstrate the ability to carry out laboratory experiments and interpret the results.
- Students will be aware of the hazardous chemicals and safety precautions in case of emergency.

REFERENCE:

HS8461 ADVANCED READING AND WRITING

OBJECTIVES:
- Strengthen the reading skills of students of engineering.
- Enhance their writing skills with specific reference to technical writing.
- Develop students’ critical thinking skills.
- Provide more opportunities to develop their project and proposal writing skills.

UNIT I
Reading - Strategies for effective reading-Use glosses and footnotes to aid reading comprehension- Read and recognize different text types-Predicting content using photos and title
Writing-Plan before writing- Develop a paragraph: topic sentence, supporting sentences, concluding sentence –Write a descriptive paragraph

UNIT II
**Reading:** Read for details-Use of graphic organizers to review and aid comprehension  
**Writing:** State reasons and examples to support ideas in writing- Write a paragraph with reasons and examples- Write an opinion paragraph

**UNIT III**  
**Reading:** Understanding pronoun reference and use of connectors in a passage- speed reading techniques  
**Writing:** Elements of a good essay-Types of essays- descriptive-narrative- issue-based-argumentative-analytical.

**UNIT IV**  
**Reading:** Genre and Organization of Ideas  
**Writing:** Email writing- visumnes – Job application-project writing-writing convincing proposals.

**UNIT V**  
**Reading:** Critical reading and thinking- understanding how the text positions the reader- identify  
**Writing:** Statement of Purpose- letter of recommendation- Vision statement

**TOTAL:** 30 PERIODS

**OUTCOMES:** At the end of the course Learners will be able to:

- Write different types of essays.
- Write winning job applications.
- Read and evaluate texts critically.
- Display critical thinking in various professional contexts.

**TEXT BOOKS:**


**REFERENCES:**


**BT8501 MASS TRANSFER OPERATIONS**

**OBJECTIVES:**

- To define the principles of adsorption, absorption, leaching and drying extraction, distillation crystallization operations.
To begin the concept of membrane separation process and develop skills of the students in the area of mass transfer operations with emphasis on separation and purification of products.

**UNIT I  DIFFUSION AND MASS TRANSFER**  9
Molecular diffusion in fluids and solids; Interphase Mass Transfer; Mass Transfer coefficients; Analogies in Transport Phenomenon.

**UNIT II  GAS LIQUID OPERATIONS**  9
Principles of gas absorption; Single and Multi component absorption; Absorption with Chemical Reaction; Design principles of absorbers; Industrial absorbers; HTU, NTU concepts.

**UNIT III  VAPOUR LIQUID OPERATIONS**  9
V-L Equilibria; Simple, Steam and Flash Distillation; Continuous distillation; McCabe-Thiele & Onchon-Savarit Principles; Industrial distillation equipments, HETP, HTU and NTU concepts.

**UNIT IV  EXTRACTION OPERATIONS**  9
L-L equilibria, Staged and continuous extraction, Solid-liquid equilibria, Leaching Principles.

**UNIT V  SOLID FLUID OPERATIONS**  9
Adsorption equilibria – Batch and fixed bed adsorption; Drying-Mechanism-Drying curves- Time of Drying; Batch and continuous dryers.

**TOTAL: 45 PERIODS**

**OUTCOMES:**
Upon completion of this course the students will be able
- To demonstrate about gas -liquid, vapour-liquid and solid-liquid and liquid–liquid equilibrium.
- To classify and use the accurate engineering correlations of diffusion and mass transfer coefficients to model a separation process.
- To investigate a multi-stage equilibrium separation processes, simultaneous phase equilibrium and mass balances in continuous separation processes (absorbers, strippers, and distillation columns) and sizing continuous separation units.
- To design and construction with operating principles of process economics of separating equipments

**TEXT BOOKS:**

**REFERENCE:**
• To provide the students with the basics of bioreactor engineering.
• To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

UNIT I CONFIGURATION OF BIOREACTORS

Ideal reactors and its characteristics
Fed batch cultivation, Cell recycle cultivation, Cell recycle cultivation in waste water treatment, two stage cultivation Packed bed reactor, airlift reactor, introduction to fluidized bed reactor bubble column reactors

UNIT II BIOREACTOR SCALE – UP

Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors – microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed.

UNIT III BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS

Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors

UNIT IV MODELLING AND SIMULATION OF BIOPROCESSES

Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

UNIT V RECOMBINANT CELL CULTIVATION

Different host vector system for recombinant cell cultivation strategies and advantages. E.coli, yeast Pichia pastoris / Saccharomyces cerevisae, Animal cell cultivation, plant cell cultivation, Insect cell cultivation. High cell density cultivation, process strategies, reactor considerations in the above system

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of Bioprocess Engineering course graduates will be able to
• Select appropriate bioreactor configurations and operation modes based upon the nature of bioproducts and cell lines and other process criteria.
• Apply modeling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems.
• Plan a research career or to work in the biotechnology industry with strong foundation about bioreactor design and scale-up.
• Integrate research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology.

TEXT BOOKS:

2. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications

REFERENCES
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, Mcgraw Hill.
3. James M. Lee, Biochemical Engineering, PHI, USA.
5. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc

BT8502    ANALYTICAL METHODS AND INSTRUMENTATION        L T P C
                                      3 0 0 3

OBJECTIVES:
To enable the students
• To have a fundamental knowledge about the Light spectrum, Absorption, Fluorescence, NMR, Mass spectroscopy
• To acquire knowledge on the different chromatographic methods for separation of biological products.

UNIT I    INTRODUCTION TO SPECTROMETRY

UNIT II    MOLECULAR SPECTROSCOPY

UNIT III    MAGNETIC RESONANCE SPECTROSCOPY AND MASS SPECTROMETRY

UNIT IV    SEPARATION METHODS

UNIT V    ELECTRO ANALYSIS AND SURFACE MICROSCOPY

TOTAL: 45 PERIODS

OUTCOME:
On completion of the course, students will have a better understanding of spectroscopy and the separation techniques used for biological products.

**TEXT BOOKS:**

**REFERENCES:**

**BT8503 PROTEIN ENGINEERING**

**OBJECTIVES:**
To enable the students
- To identify the importance of protein biomolecules.
- To realize the structure-function relationships in proteins

**UNIT I  BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS**
Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure. Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

**UNIT II  PROTEIN ARCHITECTURE**

**UNIT III  TERTIARY STRUCTURE**
Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures. Quaternary structure: Modular nature, formation of complexes. Computer exercise on the above aspects

**UNIT IV  STRUCTURE-FUNCTION RELATIONSHIP**
DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp Repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers. Membrane proteins: General characteristics, Transmembrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding
catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications. Computer exercise on the above aspects

UNIT V PROTEOMICS
Introduction to the concept of proteome, components of proteomics, proteomic analysis, importance of proteomics in biological functions, protein-protein interactions and methods to study it: protein arrays, cross linking methods, affinity methods, yeast hybrid systems and protein arrays. Computer exercise on the above aspects

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, students will be able:
- To analyze the various interactions in protein makeup.
- To be familiar with different levels of protein structure.
- To know the role of functional proteins in various field of study.
- To practice the latest application of protein science in their research.

TEXT BOOKS:

REFERENCES:
7. Enzymatic conversion in Packed bed Column
8. Growth of Bacteria – Estimation of Biomass, Calculation of Specific Growth Rate, Yield Coefficient
9. Optimization by Plackett Burman Design
10. Optimization by Response Surface Methodology

TOTAL: 60 PERIODS

OUTCOMES:
At the end of this course, students will be able to:
- Explain about Enzyme kinetics and characterization and how to use them for practical applications.
- Evaluate the growth kinetics of microorganisms and become adept with medium optimization techniques.
- Determine an experimental objective, understand the theory behind the experiment, and operate the relevant equipment safely.
- Demonstrate good lab citizenry and the ability to work in team.

Equipment Needed for 20 Students
Autocalve 1
Hot Air Oven 1
Incubators 2
Light Microscopes 4
Incubator Shaker 1
Colorimeter 2
Laminar Flow Chamber 2

Chemicals
Invertase enzyme
Phosphate mono basic salt
Phosphate di basic salt
Sucrose
Sodium alginate
Calcium chloride
GOD/POD reagent
Nutrient broth
Glucose
Yeast extract
Cas aminoacid
Ammonium chloride
Glycine
Magnesium sulphate
Sodium chloride

REFERENCES:
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology,

BT8512 ANALYTICAL METHODS AND INSTRUMENTATION LABORATORY L T P C
OBJECTIVES:
To train the students
- To have a practical hands on experience on Absorption Spectroscopic methods
- To acquire experience in the purification by performing chromatography
- To validate and analysis using spectrometric and microscopic techniques

LIST OF EXPERIMENTS
1. Precision and validity in an experiment using absorption spectroscopy.
2. Validating Lambert-Beer’s law using KMnO4
3. Finding the molar absorbtivity and stoichiometry of the Fe (1,10 phenanthroline)3 using absorption spectrometry.
4. Finding the pKa of 4-nitrophenol using absorption spectroscopy.
5. UV spectra of nucleic acids.
6. Chemical actinometry using potassium ferrioxolate.
7. Estimation of SO4-- by nephelometry.
8. Estimation of Al3+ by Flourimetry.
10. Chromatography analysis using TLC.
11. Chromatography analysis using column chromatography.

TOTAL: 60 PERIODS

OUTCOME:
- The students would visualize and interpret the theory of spectroscopic methods by hands on experiments.

REFERENCES:

Equipment Needed for 20 Students
Colorimeter 2
Glassware, Chemicals, Media as required

PROFESSIONAL COMMUNICATION

OBJECTIVES:
The course aims to:
- Enhance the Employability and Career Skills of students
- Orient the students towards grooming as a professional
- Make them Employable Graduates
- Develop their confidence and help them attend interviews successfully

UNIT I
Introduction to Soft Skills— Hard skills & soft skills - employability and career Skills—Grooming as a professional with values—Time Management—General awareness of Current Affairs

UNIT II
Self-Introduction—organizing the material – introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice – presenting the visuals effectively – 5 minute presentations

UNIT III
Introduction to Group Discussion— Participating in group discussions – understanding group dynamics - brainstorming the topic – questioning and clarifying – GD strategies - activities to improve GD skills

UNIT IV
Interview etiquette – dress code – body language – attending job interviews – telephone/skype interview - one to one interview & panel interview – FAQs related to job interviews

UNIT V
Recognizing differences between groups and teams- managing time-managing stress- networking professionally- respecting social protocols-understanding career management-developing a long-term career plan-making career changes

TOTAL: 30 PERIODS

OUTCOMES:
At the end of the course Learners will be able to:
• Make effective presentations
• Participate confidently in Group Discussions.
• Attend job interviews and be successful in them.
• Develop adequate Soft Skills required for the workplace

Recommended Software
1. Open Source Software
2. Win English

REFERENCES:

BT8651 BIOINFORMATICS 3 2 0 4

OBJECTIVES:
• To improve the programming skills of the student
• To let the students know the recent evolution in biological science

UNIT I INTRODUCTION
Introduction to Operating systems, Linux commands, File transfer protocols ftp and telnet, Introduction to Bioinformatics and Computational Biology, Biological sequences, Biological databases, Genome specific databases, Data file formats, Data life cycle, Database management system models, Basics of Structured Query Language (SQL).
UNIT II SEQUENCE ALIGNMENT (9 + 6)
Sequence Analysis, Pair wise alignment, Dynamic programming algorithms for computing edit distance, string similarity, shotgun DNA sequencing, end space free alignment. Multiple sequence alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST, PSIBLAST and PHIBLAST algorithms.

UNIT III PHYLOGENETIC METHODS (9 + 6)
Introduction to phylogenetics, Distance based trees UPGMA trees, Molecular clock theory, Ultrametric trees, Parsimonious trees, Neighbour joining trees, trees based on morphological traits, Bootstrapping. Protein Secondary structure and tertiary structure prediction methods, Homology modeling, abinitio approaches, Threading, Critical Assessment of Structure Prediction, Structural genomics.

UNIT IV PROTEIN STRUCTURE ANALYSIS (9 + 6)

UNIT V PERL PROGRAMMING (9 + 6)
Basics of PERL programming for Bioinformatics: Data types: scalars and collections, operators, Program control flow constructs, Library Functions: String specific functions, User defined functions, File handling.

TOTAL: 75 PERIODS

OUTCOMES:
Upon completion of this course, students will be able to
- Develop bioinformatics tools with programming skills.
- Apply computational based solutions for biological perspectives.
- Pursue higher education in this field.
- Practice life-long learning of applied biological science.

TEXT BOOKS:
1. Introduction to Bioinformatics by Arthur K. Lesk, Oxford University Press.
5. Beginning Perl for Bioinformatics: An introduction to Perl for Biologists by James Tindall, O'Reilley Media

REFERENCE:
OBJECTIVES:
- To discuss the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.
- To explain the heterologous expression of cloned genes in different hosts.

UNIT I BASICS OF RECOMBINANT DNA TECHNOLOGY 12

UNIT II DNA LIBRARIES 12
Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Chromosomal walking, Screening of DNA libraries using nucleic acid probes and antisera.

UNIT III SEQUENCING AND AMPLIFICATION OF DNA 12
Maxam Gilbert’s and Sanger’s methods of DNA sequencing. Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, inverse PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons. Site directed mutagenesis.

UNIT IV ORGANIZATION AND STRUCTURE OF GENOMES 12
Organization and structure of genomes, Genome sequencing methods, Conventional and shotgun genome sequencing methods, Next generation sequencing technologies, Ordering the genome sequence, Genetic maps and Physical maps, STS content based mapping, Restriction Enzyme Finger Printing, Hybridization mapping, Radiation Hybrid Maps, Optical mapping. ORF finding and functional annotation.

UNIT V CURRENT STATUS OF GENOME SEQUENCING PROJECTS 12
Current status of genome sequencing projects, Introduction to Functional genomics, Microarrays, Serial Analysis of Gene expression (SAGE), Subtractive hybridization, DIGE, TOGA, Yeast Two hybrid System, Comparative Genomics, Proteogenomics, Web resources for Genomics, Applications of genome analysis and genomics.

TOTAL: 60 PERIODS

OUTCOMES:
- The students after completing this course would be aware of how to clone commercially important genes.
- The students would be aware of how to produce the commercially important recombinant proteins.
- The students would be aware of gene and genome sequencing techniques.
- The students would be aware of microarrays, Analysis of Gene expression and proteomics.

TEXT BOOKS:

REFERENCES:

BT8691 APPLIED CHEMICAL REACTION ENGINEERING

OBJECTIVES:
- To provide the basic concepts of types of reactions, variable affecting the rate of reaction, predicting the rate equations for different types of reactions.
- To provide the information about different reactor systems, deriving the performance equations and predicting the rate equations in chemical reaction engineering system.

UNIT I SCOPe OF CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING 9
Broad outline of chemical reactors; rate equations; concentration and temperature dependence; development of rate equations for different homogeneous reactions. Industrial scale reactors.

UNIT II IDEAL REACTORS 9
Isothermal batch, flow, semi-batch reactors; performance equations for single reactors; multiple reactor systems; multiple reactions.

UNIT III NON IDEAL REACTORS 9
RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow.

UNIT IV GAS-SOLID, GAS-LIQUID REACTIONS 9
Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.

UNIT V FIXED BED AND FLUID BED REACTORS 9
G/L reactions on solid catalysis; trickle bed, slurry reactors; three phase-fluidized beds; reactors for fluid-fluid reactions; tank reactors.

TOTAL: 45 PERIODS

OUTCOMES:
The student will be able to
- Write the rate equation for any type of reaction.
- Design reactors for heterogeneous reactions and optimize operating conditions.
- Relate and calculate the conversions, concentrations and rates in a reaction and identify, formulate and solve chemical engineering problems.

TEXT BOOKS:

REFERENCES:

OBJECTIVES:
- The course applies earlier learned knowledge about mass transfer in bio reactors and sterilization kinetics.
- Skills and knowledge gained is useful by analogy when solving problems typical for the bio industry or for research

LIST OF EXPERIMENTS:
1. Batch Sterilization kinetics
2. Batch cultivation with exhaust gas analysis.
3. Estimation of KLa – Dynamic Gassing-out method,
4. Estimation of KLa – Sulphite Oxidation Method
5. Estimation of KLa – Power Correlation Method
6. Fed batch cultivation and Total cell retention cultivation
7. Photobioreactor
8. Residence time distribution
9. Estimation of Overall Heat Transfer Coefficient
10. Estimation of Mixing Time in reactor

TOTAL: 60 PERIODS

OUTCOMES:
At the end of this course,
- Graduates gain ability to investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems.
- Graduates become creative, innovative and adaptable engineers as leaders or team members in their organizations and society.
- Graduates perform competently in chemical and bioprocess industries and become important contributors to national development.
- Graduates will demonstrate advancement in their careers through increasing professional responsibility and continued life-long learning.

Equipment Needed for 30 Students
Electrophoresis Kit 1
Reactors 6
Incubators 2
Light Microscopes 1
Incubator Shaker 1
Spectrophotometer 2
Laminar Flow Chamber 1
chemicals
Sodium sulfite
Starch
Disodium disulfate
Copper sulphate
Potassium iodide
Glucose
GOD kit
Nutrient medium
Ammonium chloride
Magnesium sulphate
Sodium chloride
sodium mono basic salt
sodium di basic salt

REFERENCES:
3. James M. Lee, Biochemical Engineering, PHI, USA.

BT8612 GENETIC ENGINEERING LABORATORY L T P C
0 0 4 2

OBJECTIVES:
- Provide hands-on experience in performing basic recombinant DNA techniques.
- Introduce students to the theory behind in each techniques and to describe common applications of each methodology in biological research.

LIST OF EXPERIMENTS
1. Preparation of plasmid DNA
2. Elution of DNA from agarose gels
3. Restriction digestion
4. Ligation of DNA into expression vectors
5. Transformation & Selection of recombinants – Blue white screening assay
6. Optimisation of time of inducer for recombinant protein expression
7. Expression of protein profiling by SDS - PAGE
8. Western blotting, Southern blotting
9. PCR amplification of genes
10. Colony lysate PCR.

OUTCOMES:
By the end of this course, students should be able to:
- Describe the main principles, methods for preparation and cloning of DNA in various organisms.
- Express clearly about the gene amplification and methods for analysis of DNA, such as hybridization, restriction analysis and gene expressions.
- Use genetic and biotechnological techniques to manipulate genetic materials and develops new and improved living organisms.
- Students will be aware of the hazardous chemicals and safety precautions in case of emergency.
Equipment Needed for 30 Students

- Electrophoresis Kit 1
- PCR 1
- Incubators 2
- Light Microscopes 4
- Incubator Shaker 1
- Spectrophotometer 2
- Laminar Flow Chamber 2
- Tris – EDTA buffer
- RNase
- Isopropyl alcohol
- Potassium acetate
- Agarose
- Restriction enzyme
- Lambda DNA
- 10X Tango buffer
- 10X cohesive buffer
- T4 DNA ligase
- Loading dye
- Antibiotics
- Glycerol
- Bromophenol blue
- Ethidium bromide
- PCR kit
- sodium dodecyl sulfate
- TEMED
- ammonium persulfate
- commassie brilliant blue
- nitrocellulose membrane
- polyacrylamide
- tween 20
- bovine serum albumin (BSA)
- Tris buffered saline (TBS)
- Phosphate buffered saline
- Horseradish peroxidase (HRP)
- saline-sodium citrate (SSC) buffer
- hybridization probe

REFERENCES:

GE8077 TOTAL QUALITY MANAGEMENT

OBJECTIVE:
- To facilitate the understanding of Quality Management principles and process.
UNIT I  INTRODUCTION  9

UNIT II  TQM PRINCIPLES  9
Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III  TQM TOOLS AND TECHNIQUES I  9
The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV  TQM TOOLS AND TECHNIQUES II  9
Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V  QUALITY MANAGEMENT SYSTEM  9

OUTCOME:
• The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

TEXT BOOK:

REFERENCES:
4. ISO9001-2015 standards
OBJECTIVES:
To enable the students to
- Understand the methods to obtain pure proteins, enzymes and in general about product development R & D
- Have depth knowledge and hands on experience with on Downstream processes required in multi-factorial manufacturing environment in a structured and logical fashion

UNIT I INTRODUCTION 9

UNIT II PHYSICAL METHODS OF SEPARATION 9
Unit operations for solid-liquid separation - filtration and centrifugation.

UNIT III ISOLATION OF PRODUCTS 9
Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation – ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods.

UNIT IV PRODUCT PURIFICATION 9
Chromatography – principles, instruments and practice, adsorption, reverse phase, ion exchange, size exclusion, hydrophobic interaction, bio-affinity and pseudo affinity chromatographic techniques.

UNIT V FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS 9
Crystallization, drying and lyophilization in final product formulation.

TOTAL: 45 PERIODS

OUTCOMES:
Upon success completion of this course, the students will be able to:
- Define the fundamentals of downstream processing for product recovery
- Understand the requirements for successful operations of downstream processing
- Describe the components of downstream equipment and explain the purpose of each
- Apply principles of various unit operations used in downstream processing and enhance problem solving techniques

TEXT BOOKS:

REFERENCES:

BT8791 IMMUNOLOGY L T P C 3 0 0 3
OBJECTIVES:
- To discuss the structure, functions and integration of immune system.
- To explain the antigen-antibody interactions and how the immune system is protecting the body from foreign pathogens/germs.
- To explain various techniques of monoclonal and engineered antibodies (important therapeutic molecules) production, for treating most of the human diseases.

UNIT I INTRODUCTION TO IMMUNE SYSTEM
Organisation and classification of immune system – immune cells and organs; innate and acquired immunity; Toll receptors and responses, classification of antigens – chemical and molecular nature; haptens, adjuvants; cytokines; complement pathway, antigen presenting cells; major histocompatibility complex

UNIT II HUMORAL AND CELLULAR IMMUNITY
Development, maturation, activation, regulation, differentiation and classification of T-cells and B-cells, antigen processing and presentation, theory of clonal selection, TCR; antibodies: structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions

UNIT III IMMUNITY AGAINST PATHOGENS AND TUMORS
Inflammation; protective immune responses to virus, bacteria, fungi and parasites; tumor antigens, tumor immune response, tumor diagnosis, tumor immunotherapy

UNIT IV IMMUNE TOLERANCE AND HYPERSENSITIVITY
Immune tolerance, Immuno deficiencies; Transplantation – genetics of transplantation; laws of transplantation; Allergy and hypersensitivity – Types of hypersensitivity, Autoimmunity, Auto immune disorders and diagnosis

UNIT V APPLIED IMMUNOLOGY
Monoclonal antibodies, engineering of antibodies; Classification of Vaccines, methods of vaccine development, immunodiagnostic methods (Immuno diffusion ELISA, FACS), immune modulatory drugs

TOTAL: 45 PERIODS

OUTCOMES:
- The students after completing the course would be aware of immune system structure and functions.
- The students would be aware of immunity to various pathogens
- The students would be aware of the principles behind the production of therapeutic/ diagnostic molecules.
- The students would be aware of the concepts and mechanism behind tumour development, allergy and hypersensitivity reactions.

TEXT BOOKS:

REFERENCES:

BT8711 DOWNSTREAM PROCESSING LABORATORY L T P C
0 0 4 2

OBJECTIVES:
To provide hands on training in Down stream processing through simple experimentations in the laboratory. This will be a pre-requisite for project work.
The objectives of this course is to practice the students
- To understand the nature of the end product, its concentration, stability and degree of purification required
- To design processes for the recovery and subsequent purification of target biological products.

LIST OF EXPERIMENTS:
1. Solid liquid separation – centrifugation
2. Solid liquid separation - microfiltration
3. Cell disruption techniques – ultrasonication or French pressure cell or Dynomill
4. Precipitation – ammonium sulphite precipitation
5. Ultra filtration separation
6. Aqueous two phase extraction of biologicals
7. High resolution purification – affinity chromatography
8. High resolution purification – ion exchange chromatography
9. Product polishing – spray drying or freeze drying
10. Size exclusion chromatography

TOTAL: 60 PERIODS

List of Equipment for 30 students
Centrifuge 1
Cross flow filtration set up 2
FPLC 1
Sonicator or French press or Dynomill 1

OUTCOMES:
Upon success completion of this course, the students would have
- Acquired knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.
- Learned cell disruption techniques to release intracellular products
- Learned various techniques like evaporation, extraction, precipitation, membrane separation for concentrating biological products

75
• Learned the basic principles and techniques of chromatography to purify the biological products and formulate the products for different end uses.

REFERENCES:

BT8712 IMMUNOLOGY LABORATORY L T P C
0 0 4 2

OBJECTIVES:
• To give practical training in the functioning of immune system.
• To give laboratory training in different immunological and immunotechnological techniques.

LIST OF EXPERIMENTS
1. Identification of immune cells in a blood smear
2. Identification of blood group
3. Testing for typhoid antigens by Widal test
4. Immunodiffusion – Ouchterlony Double Diffusion
5. Immunoelectrophoresis – Rocket or Counter Current Immunoelectrophoresis
6. Enzyme Linked ImmunoSorbent Assay (ELISA)
7. Isolation of peripheral blood mononuclear cells
8. Isolation of monocytes from blood
9. Immunofluorescence
10. Identification of t cells by T-cell rosetting using sheep RBC.

TOTAL: 60 PERIODS

OUTCOMES:
• The students would be aware of immune system cells and tissues.
• The students would have knowledge on immunological/clinical tests.
• The students would be able to isolate lymphocytes and monocytes.
• The students would be able to identify various immune system cells.

List of Equipments for 30 students
Elisa reader 1
Microscopes 8
Microwave Owen 1
Hot plate 4
Vortex mixer 4
Table top refrigerated Centrifuge 1
Fluorescent microscope 1

REFERENCES
OBJECTIVE:
- To objective of the project is to make use of the knowledge gained by the student at various stages of the degree programme.

The students are assigned project work related to product/process development, solution to the technical problems in industry and current research at national and international level. The student is required to submit a report at the end of semester based on the findings. The evaluation is made as per the Regulations of University.

OBJECTIVES:
- To enable the students
  - To gain structural knowledge of biological systems.
  - To understand transport and dynamic properties of biological systems.

UNIT I  MOLECULAR STRUCTURE OF BIOLOGICAL SYSTEMS  9

UNIT II  CONFORMATION OF NUCLEIC ACIDS  9

UNIT III  CONFORMATION OF PROTEINS  9

UNIT IV  CELLULAR PERMEABILITY AND ION – TRANSPORT  9
Ionic conductivity – transport across ion channels – mechanism - ion pumps- proton transfer – nerve conduction – techniques of studying ion transport and models.

UNIT V  ENERGETICS & DYNAMICS OF BIOLOGICAL SYSTEMS  9

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, students will be able:
- To analyze the various forces responsible for biological molecular structure.
To be familiar with different levels of conformation in biomolecules.
To gain the knowledge of cellular permeability and ion transport.
To understand the dynamics of biological systems.

TEXT BOOKS:

REFERENCE:

BT8002 SYMBOLIC MATHEMATICS L T P C
3 0 0 3

OBJECTIVE:
- This course will help the students to learn MATLAB, its operators and loops, data flow, Program Design and Development and their virtual instrumentation.

UNIT I INTRODUCTION TO MATLAB

UNIT II DATA AND DATA FLOW IN MATLAB
Data types- Matrix, string -cell and structure- Creating, accessing elements and manipulating of data of different types - File Input-Output- Matlab files- Text files- Binary files - Mixed text binary files- Communication with external devices- Serial port- Parallel port- Sound card-Video input

UNIT III FUNCTIONS & FILES
Elementary Mathematical Functions - User Defined Functions - Advanced Function Programming - Working with Data Files, Introduction to Numerical Methods -Linear algebra numerical integration and differentiation- solving systems of ODE’s and interpolation of data.

UNIT IV PROGRAMMING TECHNIQUES & DATA VISUALIZATION AND STATISTICS
Program Design and Development - Relational Operators and Logical Variables Logical Operators and Functions - Conditional Statements -Loops - Basic statistical tools in Matlab, XY-plotting functions - Subplots and Overlay plots - Special Plot types – Interactive plotting - Designing GUI interfaces using Matlab’s GUIDE interface.

UNIT V FUNDAMENTALS OF VIRTUAL INSTRUMENTATION & DATA ACQUISITION
Concept of virtual instrumentation (VI)– LabVIEW software- basics- Creating, Editing and debugging a VI in LabVIEW- Creating a sub VI- Loops and charts- data acquisition with LabVIEW- plug-in DAQ boards- Organization of the DAQ VI System- Performing analog input and analog output- Scanning multiple analog channels- Driving the digital I/Os- Buffered data acquisition
OUTCOME:
- Upon completion of this course, students will be able design programs and understand virtual instrumentation and data design.

TEXT BOOKS:

ONLINE MATLAB TUTORIALS AND REFERENCES:
1. Tutorials offered by The Mathworks. The creators of Matlab.
2. Introductory Matlab material from Indiana University
3. A practical introduction to Matlab from Michigan Tec
4. Links to Matlab tutorials, references, books, packages, etc. - The Math Department at UIC

MATLAB guides Provided with the Matlab installation
1. Getting Started with Matlab
2. Using Matlab
3. Using Graphs in Matlab
4. Using GUIs in Matlab

For links to these documents visit Dr. Randy Jost’s web page (USU ECE Department). For other links related to Matlab

BT8003 PRINCIPLES OF FOOD PROCESSING

OBJECTIVES:
To enable the students
- To know about the constituents and additives present in the food.
- To gain knowledge about the microorganisms, which spoil food and food borne diseases.
- To know different techniques used for the preservation of foods.

UNIT I FOOD AND ENERGY
Constituents of food – carbohydrates, lipids, proteins, water, vitamins and minerals, dietary sources, role and functional properties in food, contribution to organoleptic and textural characteristics.

UNIT II FOOD ADDITIVES
Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids.

UNIT III MICROORGANISMS ASSOCIATED WITH FOOD
Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; fermented foods and food chemicals, single cell protein.

UNIT IV FOOD BORNE DISEASES
Classification – food infections – bacterial and other types; food intoxications and poisonings – bacterial and non-bacterial; food spoilage – factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products

UNIT V  FOOD PRESERVATION  9
Principles involved in the use of sterilization, pasteurization and blanching, thermal death curves of microorganisms, canning; frozen storage-freezing characteristics of foods, microbial activity at low temperatures, factors affecting quality of foods in frozen storage; irradiation preservation of foods.

OUTCOMES:
Through this subject the student can understand about
- Different constituents present in food and microorganism involved in processing of food.
- Principles and different preservations techniques of food can also be known.
- Unit operations in modern food processing and impact of the process on food quality

REFERENCES:

BT8004  ADVANCED BIOCHEMISTRY  L T P C  3 0 0 3

OBJECTIVES:
- To orient towards the application of knowledge acquired in solving clinical problems.
- To provide a base for molecular modelling and drug designing

UNIT I  METABOLISM OF AMINO ACIDS  9
Biosynthesis of Gly, Ser and Cys; Biosynthesis of six essential amino acids (Met, Thr, Lys, Ile,Val, Leu) and regulation of branched chain amino acids (concerted inhibition, allosteric regulation and enzyme multiplicity, sequential feedback) from oxaloacetate and pyruvate; Biosynthesis of aromatic amino acids. Metabolic disorders associated with branched chain and aromatic amino acid degradation. Important molecules derived from amino acids (auxins, DOPA, Serotonin, porphyrins, T3, T4, Adrenaline, Noradrenaline, histamine, GABA, polyamines etc)

UNIT II  PROTEIN TRANSPORT AND DEGRADATION  9
Protein targeting, signal sequence, secretion; Folding, Chaperons and targeting of organelle proteins, Protein degradation, receptor-mediated endocytosis, turnover.

UNIT III  BIOCHEMISTRY OF MUSCLE CONTRACTION  9
Contractile proteins, Actin, Myosin, Actin Polymerization, acto-myosin complexes, mechanism of myosin ATPase activity, excitation – contraction coupling nad relaxation, microtubules, microfilaments and their role in organelle movements.

UNIT IV  VITAMINS AND COENZYMES  9

UNIT V  HORMONES


OUTCOMES:
Upon completion of advanced biochemistry, students will be able

- To recognize how fundamental chemical principles and reactions are utilized in biochemical Processes.
- To apply knowledge gained in food and drug industries.
- To define various metabolic concepts for applying them to solve clinical problems.
- To summarize the knowledge of biomolecules to use them in biotechnology industry

TEXT BOOKS:

REFERENCES:

GE8071  DISASTER MANAGEMENT

OBJECTIVES:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR).
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

UNIT I  INTRODUCTION TO DISASTERS

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don’ts during various types of Disasters.
UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR)

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processes and Framework at State and Central Level-- State Disaster Management Authority (SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

OUTCOMES:
The students will be able to

- Differentiate the types of disasters, causes and their impact on environment and society
- Assess vulnerability and various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India, Scenarious in the Indian context, Disaster damage assessment and management.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:
To provide the fundamentals of animal cell culture, details of the diseases and therapy

- To offer the knowledge about the micromanipulation and transgenic animals

UNIT I ANIMAL CELL CULTURE
Introduction to basic tissue culture techniques; chemically defined and serum free media; animal cell cultures, their maintenance and preservation; various types of cultures suspension cultures, continuous flow cultures, immobilized cultures; somatic cell fusion; cell cultures as a source of valuable products; organ cultures.

UNIT II ANIMAL DISEASES AND THEIR DIAGNOSIS
Bacterial and viral diseases in animals; monoclonal antibodies and their use in diagnosis; molecular diagnostic techniques like PCR, in-situ hybridization; northern and southern blotting; RFLP.

UNIT III THERAPY OF ANIMAL DISEASES
Recombinant cytokines and their use in the treatment of animal infections; monoclonal antibodies in therapy; vaccines and their applications in animal infections; gene therapy for animal diseases.

UNIT IV MICROMANIPULATION OF EMBRYO’S
What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.

UNIT V TRANSGENIC ANIMALS
Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; stem cell cultures in the production of transgenic animals.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this subject the student will be able to

- Understand the animal cell culture, animal diseases and its diagnosis
- Gain the knowledge for therapy of animal infections
- Know the concepts of micromanipulation technology and transgenic animal technology
- Use the knowledge gained in this section to apply in the field of clinical research

TEXT BOOKS:

REFERENCE:
UNIT I   INTRODUCTION

UNIT II   KINETIC MODELING
Kinetic modeling of biochemical reactions, describing dynamics with ODEs, rate equations, deriving a rate equation, incorporating regulation of enzyme activity by effectors, E-cell platform and erythrocyte modeling.

UNIT III   FLUX BALANCE ANALYSIS

UNIT IV   NETWORK MOTIFS AND MODELS
Network motifs, Feed forward loop network motif. Gene circuits, robustness of models, Chemotaxis model, Integration of data from multiple sources: Building genome scale models.

UNIT V   RESOURCES AND SBML
Tools and databases for modeling: Pathway databases KEGG, EMP, Metacyc, Enzyme kinetics database BRENDA, Gene expression databases, Biomodels database, Basics of Systems Biology Markup Language (SBML), SBML editors.

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:
1. Foundations of Systems Biology Edited by Hiroaki Kitano (MIT Press)

BT8071   BIOLOGICAL SPECTROSCOPY

OBJECTIVES:
- To deliver the knowledge of spectroscopic techniques and its functions
- To provide the technical information of spectroscopy for biological applications

UNIT I   OPTICAL ROTATORY DISPERSION

84

UNIT II TYPES OF NUCLEAR MAGNETIC RESONANCE
9

UNIT III TYPES OF MASS SPECTROMETRY
9
Ion sources sample introduction – mass analyzers and ion detectors – bimolecular mass spectrometry – peptide and protein analysis – carbohydrates and small molecules – specific applications.

UNIT IV X-RAY DIFFRACTION
9

UNIT V SPECIAL TOPICS AND APPLICATIONS
9
Electron microscopy – transmission and scanning electron microscopy – scanning tunnelling and atomic force microscopy – combinatorial chemistry and high throughput screening methods.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the student would be able to understand and apply
- Basics of optical rotary dispersion methods and nuclear magnetic resonance
- Principles and applications of mass spectrometry and X-ray diffraction
- Microscopic techniques and its applications
- Spectroscopic techniques for various biological applications

TEXT BOOKS:

REFERENCES:
OBJECTIVE:

- To develop a fundamental knowledge of the physical principles that govern the transport of momentum, energy and mass, with emphasis on the mathematical formulation of the conservation principles.

UNIT I TRANSPORT PHENOMENA BY MOLECULAR MOTION

Vectors/Tensors, Newton’s law of viscosity, Newtonian & Non-Newtonian fluids, rheological models, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Fourier’s law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Fick’s law of diffusion, Temperature, pressure and composition dependence of diffusivity, Kinetic theory of diffusivity.

UNIT II ONE DIMENSIONAL MOMENTUM TRANSPORT

Shell Momentum balances, boundary conditions, velocity profiles, average velocity, momentum flux at the surfaces, of Newtonian and non-Newtonian for flow of a falling film, flow through circular tube, slits, flow through an Annulus, Adjacent flow of two Immiscible fluids. Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal) their applications in fluid flow problems.

UNIT III ONE DIMENSIONAL HEAT TRANSPORT

Shell energy balances, boundary conditions, temperature profiles, average temperature, energy fluxes at surfaces for different types of heat sources such as electrical, nuclear viscous and chemical. Equations of change (non-isothermal), equation of motion for forced and free convection, equation of energy (non-isothermal).

UNIT IV ONE DIMENSIONAL MASS TRANSPORT

Shell mass balances, boundary conditions, concentration profiles, average concentration, mass flux at surfaces for Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction, Diffusion into a falling liquid film, Diffusion and chemical reaction in porous catalyst stand the effectiveness factor, equation of continuity for binary mixtures, equation of change to set up diffusion problems for simultaneous heat and mass transfer.

UNIT V TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW

Turbulence phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface. Introduction to macroscopic balances for isothermal flow systems, non-isothermal systems and multicomponent systems.

TOTAL: 45 PERIODS

OUTCOME:

- Students would gain the knowledge of fundamental connections between the conservation laws in heat, mass, and momentum in terms of vector and tensor fluxes. The students would be able to understand the mechanism of fluids in motion under different conditions.

TEXT BOOKS:

REFERENCES:

OBJECTIVES:
• To impart comprehensive understanding of the chemical basis of drug action including physicochemical and steric properties of drug.
• To study the classification, chemical nomenclature, generic names and synthesis of various medicinal agents.
• To understand the structure activity relationship, biochemical/molecular basis of mechanism of action and uses of drug.

UNIT I PRINCIPLES OF MEDICINAL CHEMISTRY

UNIT II DRUGS ACTING ON SYNAPTIC AND NEURO-EFFECTOR JUNCTION SITES
Classification, biochemical/molecular basis of mechanism of action, structure activity relationship including stereo chemical aspects, physiochemical properties and synthesis of selected drugs belonging to the class of Cholinergics, Anticholinergics, Anticholinesterases and Adrenergics.

UNIT III DRUGS ACTING ON THE CENTRAL NERVOUS SYSTEM
Classification, biochemical/molecular basis of mechanism of action, structure activity relationship and synthesis of Hypnotics and Sedatives, Opioid analgesics, Anticonvulsants and Psychopharmacological agents (neuroleptics, antidepressants, anxiolytics).

UNIT IV DRUGS ACTING ON CARDIOVASCULAR SYSTEM
Structural basis of mechanism of action, structure activity relationship including stereo chemical aspects, physiochemical properties, and synthesis of selected drugs belonging to the class of anti-anginal, vasodilators, calcium channel blockers and cardiac glycosides.

UNIT V AUTOCOIDS
Synthetic procedures, mode of action, uses, structure activity relationship including physicochemical properties of the following classes of drugs Antihistamines, Eicosanoids, Analgesic-antipyretics, Anti-inflammatory (non-steroidal) agents.

TOTAL: 45 PERIODS

OUTCOMES:
The student will be able to
• Gain an appreciation of importance of the physical properties of drugs with respect to the ionization, solubility and efficacy of drugs, understand how changes in the chemical structure of drugs affect efficacy.
• Obtain a working knowledge of chemical structures and nomenclature, to develop the ability to suggest suitable techniques to synthesis different drug molecules.
• Understand how current drugs were developed and demonstrate the importance of chemistry in the development and application of therapeutic drugs.

TEXT BOOKS:

REFERENCES:

GE8075 INTELLECTUAL PROPERTY RIGHTS LT PC 3 0 0 3

OBJECTIVE:
• To give an idea about IPR, registration and its enforcement.

UNIT I INTRODUCTION 9
Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO – TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II REGISTRATION OF IPRs 10
Meaning and practical aspects of registration of CopyRights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III AGREEMENTS AND LEGISLATIONS 10

UNIT IV DIGITAL PRODUCTS AND LAW 9
UNIT V  ENFORCEMENT OF IPRs
Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

TOTAL: 45 PERIODS

OUTCOME:
- Ability to manage Intellectual Property portfolio to enhance the value of the firm.

TEXT BOOKS:

REFERENCES:

BT8007  CANCER BIOLOGY  L T P C
3 0 0 3

OBJECTIVES:
To enable the students to understand
- Basic biology of cancer
- Impact of antibodies against cancer in the human body leading to more effective treatments
- Enhanced immunology based detection methods and imaging techniques
- Development of cell based and cytokine based immunotherapy against cancer.

UNIT I  FUNDAMENTALS OF CANCER BIOLOGY  9
Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer. Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.

UNIT II  PRINCIPLES OF CARCINOGENESIS  9

UNIT III  PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER  9

UNIT IV  PRINCIPLES OF CANCER METASTASIS  9
Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.

UNIT V  NEW MOLECULES FOR CANCER THERAPY  9
Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy.

TOTAL: 45 PERIODS

OUTCOMES:
The course would facilitate the students

- To appreciate the role of immune system in cancer
- To describe self – tolerance machinery and immune surveillance
- To understand the cancer microenvironment and its influence on immune cells
- To have awareness on medical applications of cytokines and immune cells against cancer

TEXT BOOKS:

REFERENCES:

BT8008 MOLECULAR PATHOGENESIS OF INFECTIOUS DISEASES L T P C
3 0 0 3

OBJECTIVES:
To enable the students

- To understand about the microbial toxins and modern molecular pathogenesis
- To know about the host pathogen interaction and identifying virulence factors
- To control pathogens by modern approaches.

UNIT I OVERVIEW
5
Historical perspective - discovery of microscope, Louis Pasteur’s contributions, Robert Koch’s postulates, early discoveries of microbial toxins, toxic assays, vaccines, antibiotics and birth of molecular genetics and modern molecular pathogenesis studies, Various pathogen types and modes of entry.

UNIT II HOST-DEFENSE AGAINST PATHOGENS AND PATHOGENIC STRATEGIES 8
Attributes & components of microbial pathogenesis, Host defense: skin, mucosa, cilia, secretions, physical movements, limitation of free iron, antimicrobial compounds, mechanism of killing by humoral and cellular defense mechanisms, complements, inflammation process, general disease symptoms, Pathogenic adaptations to overcome the above defenses.

UNIT III MOLECULAR PATHOGENESIS (WITH SPECIFIC EXAMPLES) 16
Virulence, virulence factors, virulence- associated factors and virulence lifestyle factors, molecular genetics and gene regulation in virulence of pathogens, Vibrio Cholerae: Cholera toxin, co-regulated pili, filamentous phage, survival E.coli pathogens: Enterotoxigenic E.coli (ETEC), labile & stable toxins, Enteroto- pathogenic E.coli (EPEC), type III secretion, cytoskeletal changes, intimate attachment; Enterohaemorrhagic E.coli (EHEC), mechanism of bloody diarrhoea and Hemolytic Uremic Syndrome, Enteroaggregative E.coli (EAEC). Shigella: Entry, macrophage apoptosis, induction of macropinocytosis, uptake by epithelial cells, intracellular spread, inflammatory response, tissue damage Plasmodium: Life cycle, erythrocyte stages, transport mechanism and processes to support the rapidly growing schizont, parasitiparous vacuoles, and knob protein

UNIT IV EXPERIMENTAL STUDIES ON HOST-PATHOGEN INTERACTIONS 8
Virulence assays: adherence, invasion, cytopathic, cytotoxic effects. Criteria & tests in identifying virulence factors, attenuated mutants, molecular characterization of virulence factors, signal transduction & host responses

UNIT V APPROACHES TO CONTROL PATHOGENS 8
Classical approaches based on serotyping. Modern diagnosis based on highly conserved virulence factors, immuno & DNA-based techniques. New therapeutic strategies based on recent findings on molecular pathogenesis of a variety of pathogens, Vaccines - DNA, subunit and cocktail vaccines.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the student will be able to understand the
- Host pathogen interactions at the level of cellular and molecular networks.
- Diagnosis of diseases through the examination of molecules.
- Modern therapeutic strategies on various pathogens.

REFERENCES:

BT8009 BIOPHARMACEUTICAL TECHNOLOGY

OBJECTIVES:
The aim of the course is to give strong foundation and advanced information on biopharmaceutical aspects in relation to drug development.
This course provides core responsibilities for the development and monitoring of the drug and the preparation of medicines according to the norms.
- To gain knowledge in physicochemical properties, pharmacology and the formulation of commonly used biopharmaceuticals.

UNIT I INTRODUCTION 9
Pharmaceutical industry & development of drugs ; types of therapeutic agents and their uses; economics and regulatory aspects .

UNIT II DRUG ACTION, METABOLISM AND PHARMACOKINETICS 9
Mechanism of drug action; physico-chemical principles of drug metabolism; radioactivity; pharmacokinetics.
UNIT III MANUFACTURE OF DRUGS, PROCESS AND APPLICATIONS 9
Types of reaction process and special requirements for bulk drug manufacture.

UNIT IV PRINCIPLES OF DRUG MANUFACTURE 9
Compressed tablets; dry and wet granulation; slugging or direct compression; tablet presses; coating of tablets; capsule preparation; oval liquids – vegetable drugs – topical applications; preservation of drugs; analytical methods and other tests used in drug manufacture; packing techniques; quality management; GMP.

UNIT V BIOPHARMACEUTICALS 9
Various categories of therapeutics like vitamins, laxatives, analgesics, contraceptives, antibiotics, hormones and biologicals.

OUTCOMES:
The course would facilitate the students to
- The knowledge gained in this course would be used to understand and evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market.
- This course paves a ways to the students to acquire knowledge on novel biotechnological and pharmaceutical products, current medicines and their applications in therapeutic and diagnostic fields.
- Demonstrate knowledge and understanding of current topical and newly emerging aspects of pharmaceutical biotechnology.
- Understand the legal steps involved in progressing a new drug to market. Grasping the current regulatory acts and safety norms of the modern pharmaceutical industries.

TEXT BOOK:

REFERENCES:

BT8010 BIOENTREPRENEURSHIP 9
UNIT I
- Should You Become an Entrepreneur? What Skills Do Entrepreneurs Need?
- Identify and Meet a Market Need
- Entrepreneurs in a Market Economy
- Select a Type of Ownership

UNIT II
- Develop a Business Plan

UNIT III
- Choose Your Location and Set Up for Business
• Market Your Business
• Hire and Manage a Staff

UNIT IV: 9
• Finance, Protect and Insure Your Business
• Record Keeping and Accounting
• Financial Management

UNIT V 9
• Meet Your Legal, Ethical, Social Obligations
• Growth in Today’s Marketplace

TOTAL: 45 PERIODS

TEXT BOOK

GE8076 PROFESSIONAL ETHICS IN ENGINEERING L T P C
3 0 0 3

OBJECTIVE:
• To enable the students to create an awareness on Engineering Ethics and Human Values, to
  instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I  HUMAN VALUES 10
Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for
others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation –
Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and
meditation for professional excellence and stress management.

UNIT II  ENGINEERING ETHICS 9
Senses of ‘Engineering Ethics’ – Variety of moral issues – Types of inquiry – Moral dilemmas –
Moral Autonomy – Kohlberg’s theory – Gilligan’s theory – Consensus and Controversy – Models of
professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of
ethical Theories.

UNIT III  ENGINEERING AS SOCIAL EXPERIMENTATION 9
Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics –
A Balanced Outlook on Law.

UNIT IV  SAFETY, RESPONSIBILITIES AND RIGHTS 9
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk -
Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest –
– Discrimination.

UNIT V  GLOBAL ISSUES 8
OUTCOME:
- Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

TEXT BOOKS:

REFERENCES:

Web sources:
1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org

BT8011 MARINE BIOTECHNOLOGY L T P C 3 0 0 3

UNIT I  INTRODUCTION TO MARINE ENVIRONMENT

UNIT II  IMPORTANT MARINE ORGANISMS

UNIT III  MARINE ENVIRONMENTAL BIOTECHNOLOGY
9

UNIT IV  MARINE PHARMACOLOGY  9
Medicinal compound from marine flora and fauna – marine toxins, antiviral and antimicrobial agents.

UNIT V  AQUACULTURE TECHNOLOGY  9
Important of coastal aquaculture – marine fishery resources – common fishing crafts and gears – aquafarm design and construction.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Recent advances in marine biotechnology volume 3 – M.Fingerman, R. Nagabhushanam Mary – Frances Thomson.
2. Recent advances marine biotechnology volume 2 – M.Fingerman, R.Nagabhushanam Mary – Frances Thomson

BT8012  BIOETHICS  L T P C  3 0 0 3

OBJECTIVE:
- The course will provide Fundamental ethical to Advanced clinical trial management including drug development and trial planning; Project management in clinical trials; Consent and data protection; Quality assurance and governance.

UNIT I  INTRODUCTION TO CLINICAL TRIALS  9
Fundamentals of clinical trials; Basic statistics for clinical trials; Clinical trials in practice; Reporting and reviewing clinical trials; Legislation and good clinical practice - overview of the European directives and legislation governing clinical trials in the 21st century; International perspectives; Principles of the International Committee on Harmonisation (ICH)-GCP.

UNIT II  REGULATIONS OF CLINICAL TRIALS  9
Drug development and trial planning - pre-study requirements for clinical trials; Regulatory approvals for clinical trials; Consort statement; Trial responsibilities and protocols - roles and responsibilities of investigators, sponsors and others; Requirements of clinical trials protocols; Legislative requirements for investigational medicinal products.

UNIT III  MANAGEMENT AND ETHICS OF CLINICAL TRIALS  9
Project management in clinical trials - principles of project management; Application in clinical trial management; Risk assessment; Research ethics and Bioethics - Principles of research ethics; Ethical issues in clinical trials; Use of humans in Scientific Experiments; Ethical committee system including a historical overview; the informed consent; Introduction to ethical codes and conduct; Introduction to animal ethics; Animal rights and use of animals in the advancement of medical technology; Introduction to laws and regulation regarding use of animals in research.

UNIT IV  INFORMED CONSENT  9
Consent and data protection-the principles of informed consent; Consent processes; Dataprotection; Legislation and its application; Data management – Introduction to trial masterfiles and essential documents; Data management.

UNIT V QUALITY CONTROL AND GUIDELINES
Quality assurance and governance - quality control in clinical trials; Monitoring and audit; Inspections; Pharmacovigilance; Research governance; Trial closure and pitfalls-trial closure; Reporting and legal requirements; Common pitfalls in clinical trial management.

TOTAL: 45 PERIODS

OUTCOME:
• The students will acquire knowledge in all aspect of clinical trials, management and ethical standards required to conduct clinical trials.

REFERENCES:
1. Lee, Chi-Jen; etal., "Clinical Trials or Drugs and Biopharmaceuticals." CRC / Taylor &Francis, 2011.

BT8013 METABOLIC ENGINEERING L T P C
3 0 0 3

OBJECTIVES:
• To provide a quantitative basis, based on thermodynamics, enzyme kinetics, for the understanding of metabolic networks in single cells and at the organ level.
• To enable the students to use organisms to produce valuable substances on an industrial scale in cost effective manner.

UNIT I INTRODUCTION TO EXAMPLES OF PATHWAY MANIPULATION - QUALITATIVE TREATMENT

UNIT II MATERIAL BALANCES AND DATA CONSISTENCY
Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, yield coefficients and linear rate equations, analysis of over determined systems- identification of gross measurement errors. Introduction to MATLAB®

UNIT III METABOLIC FLUX ANALYSIS
Theory, overdetermined systems, underdetermined systems- linear programming, sensitivity analysis, methods for the experimental determination of metabolic fluxes by isotope labeling, applications of metabolic flux analysis.

UNIT IV METABOLIC CONTROL ANALYSIS
Fundamentals of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations

UNIT V ANALYSIS OF METABOLIC NETWORKS 9
Control of flux distribution at a single branch point, Grouping of reactions, case studies, extension of control analysis to intermetabolite, optimization of flux amplifications, consistency tests and experimental validation.

TOTAL: 45 PERIODS

OUTCOMES:
After completion of metabolic engineering, students will be able
- To learn stoichiometry and energetics of metabolism.
- To apply practical applications of metabolic engineering in chemical, energy, medical and environmental fields.
- To integrate modern biology with engineering principles.
- To design a system, component, or process to meet desired needs.

TEXT BOOKS:

REFERENCES:
UNIT IV DIABETES AND OBESITY
Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Paediatric and adolescent obesity – Weight control and BMI

UNIT V RESPIRATORY DISEASES
Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking – Diagnosis - Pulmonary function testing

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:

BT8015 STRUCTURAL BIOLOGY

OBJECTIVES:
To enable the students:
- Gain structural knowledge on proteins.
- Understand energetics and kinetics of proteins.

UNIT I PROTEIN STRUCTURE

UNIT II PROTEIN THERMODYNAMICS AND ENERGETICS

UNIT III PROTEIN KINETICS

UNIT IV CONFORMATIONAL DYNAMICS AND RELATIONSHIP TO FUNCTION
Fluctuation-dissipation theorem - Dynamics of polymeric chains - Dynamics of folded proteins: Gaussian network model - Contribution of nonlinear effects to equilibrium dynamics.

UNIT V COMPUTATIONAL STRUCTURAL BIOLOGY
Protein Models: Force fields and their derivation - The rugged energy surface: the difficulty to fold a protein - Methods for conformational search – energy and free energy as criteria of stability.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, students will:
- Be familiar with various mechanisms and driving forces in protein folding.
• Understand the dynamics relationship to protein function.
• Identify the computational approach in structural biology.

TEXT BOOKS:

REFERENCES:

BT8016 GENOMICS AND PROTEOMICS

OBJECTIVE:
• To provide the students a broader knowledge on the structure and function of genomes, the technologies developed for genomics, functional genomics and proteomics.

UNIT I INTRODUCTION
Introduction to genome, transcriptome, and proteome; Overview of genomes of bacteria, archae, and eukaryote; Genomes of organelles.

UNIT II GENOME MAPPING AND SEQUENCING
Genetic and physical mapping, Linkage analysis, RFLP, SNP, SSLP, Restriction mapping, STS mapping, FISH, Top-down and bottom-up sequencing strategies, Whole genome sequencing, Gap closure, Pooling strategies.

UNIT III FUNCTIONAL GENOMICS
Genome annotation, ORF and functional prediction, Gene finding, Substractive DNA library screening, Differential display and Representational difference analysis, SAGE,TOGA, Introduction to DNA microarray.

UNIT IV TECHNIQUES IN PROTEOMICS
In-vitro and in vivo-labeling of proteins, One and two-dimensional gel electrophoresis, Detection of proteins on SDS gels, Protein cleavage, Edman protein microsequencing, Mass spectrometry-principles of MALDI-TOF, Peptide mass fingerprinting.

UNIT V PROTEIN PROFILING
Large-scale protein profiling using proteomics, Post-translational modifications, Phosphoprotein and glycoprotein analyses; Analysis of protein-protein interactions, Protein microarrays.

TOTAL: 45 PERIODS
The students would have gained a better understanding of the organization of genomes in multiple levels of taxa, and the methodologies and approaches used for the study of structural and functional genomics. The students would have also acquired knowledge on various genome mapping and sequencing methods, genomic markers, microarray technology and methods for proteomics.

TEXT BOOKS:

REFERENCES:

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

**REFERENCES:**

**GE8073**

**FUNDAMENTALS OF NANOSCIENCE**

**L T P C**

3 0 0 3

**OBJECTIVE:**
- To learn about basis of nanomaterial science, preparation method, types and application

**UNIT I**

**INTRODUCTION**
Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

**UNIT II**

**GENERAL METHODS OF PREPARATION**
Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

**UNIT III**

**NANOMATERIALS**

**UNIT IV**

**CHARACTERIZATION TECHNIQUES**

**UNIT V**

**APPLICATIONS**

OUTCOMES:
• Will familiarize about the science of nanomaterials
• Will demonstrate the preparation of nanomaterials
• Will develop knowledge in characteristic nanomaterial

TEXT BOOKS:

REFERENCES:

BT8018 PLANT BIOTECHNOLOGY

OBJECTIVES:
• To give the details of plant cells and its functions
• To provide the basics of agrobacterium and applications of plant biotechnology

UNIT I ORGANIZATION OF GENETIC MATERIAL
Genetic material of plant cells – nucleosome structure and its biological significance; junk and repeat sequences; outline of transcription and translation.

UNIT II CHLOROPLAST & MITOCHONDRIA
Structure, function and genetic material; rubisco synthesis and assembly, coordination, regulation and transport of proteins. Mitochondria: Genome, cytoplasmic male sterility and import of proteins.

UNIT III NITROGEN FIXATION
Nitrogenase activity, nod genes, nif genes, bacteroids.

UNIT IV AGROBACTERIUM & VIRAL VECTORS

UNIT V APPLICATION OF PLANT BIOTECHNOLOGY

TOTAL: 45 PERIODS
Outline of plant tissue culture, transgenic plants, herbicide and pest resistant plants, molecular pharming, therapeutic products.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course, the student would be able
- To understand the fundamentals of plant cells, structure and functions
- To learn the nitrogen fixation mechanism and significance of viral vectors
- To gain the knowledge about the plant tissue culture and transgenic plants
- To use of the gained knowledge for the development of therapeutic products

TEXT BOOKS:

REFERENCES:

BT8019 PROCESS EQUIPMENTS AND PLANT DESIGN

OBJECTIVES:
- To develop key concepts and techniques to design, process equipment in a process plant.
- To train the students to utilize these key concepts to make design and operating decisions.

UNIT I HEAT EXCHANGERS, CONDENSERS, EVAPORATORS

UNIT II STORAGE VESSEL FOR VOLATILE AND NON VOLATILE FLUIDS, PRESSURE VESSEL STRUCTURE
Design of the following equipments as per ASME, ISI codes, drawing according to scale; monoblock and multiplayer vessels, combustion details and supporting structure.

UNIT III EXTRACTOR, DISTILLATION AND ABSORPTION TOWER
Construction details and assembly drawing; Plate and Packed Extraction Towers; Plate and Packed absorption Towers; Plate and Packed Distillation Towers.

UNIT IV PUMPS, MECHANICAL SEALS, VALVES AND SWITCHES
Various types of pumps, Principle of working, construction, usages, advantages and disadvantages; Various types of seals, effectiveness, usages; Pneumatic Seals; Gate, Globe and Butterfly Valves, their material of construction; Pneumatically Controlled Valves.

UNIT V PIPING, PLANT LAY OUT AND DESIGN
Various types of Piping, material of construction, their usage; Pipe lay out; Modern Plant Design and case Studies.

TOTAL: 45 PERIODS
OUTCOMES:
Upon success completion of this course, the students
- Will understand the working principles of heat exchanger, condensers and evaporators and develop a data sheet
- Will acquire basic knowledge to draw and design of storage vessel and pressure vessel as per ASME and ISI codes
- Will understand the construction and assembly drawing of extraction towers, distillation towers and absorption towers
- Would have learned working principles, constructions, usage of various pump, seals, valves and pipes

REFERENCES:

BT8020 BIOCONJUGATE TECHNOLOGY AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:
To enable the students
- To understand the functional targets and chemistry of active groups.
- To gain knowledge about the linkers and cleavable reagent systems.
- To know about enzyme, nucleic acid modification and its application in bioconjugation

UNIT I FUNCTIONAL TARGETS

UNIT II CHEMISTRY OF ACTIVE GROUPS
Amine reactive chemical reactions – Thiol reactive chemical reactions – carboxylate reactive chemical reactions – hydroxyl reactive chemical reactions – aldehyde and ketone reactive chemical reactions – Photoreactive chemical reactions.

UNIT III BIOCONJUGATE REAGENTS

UNIT IV ENZYME AND NUCLEIC ACID MODIFICATION AND CONJUGATION
Properties of common enzymes – Activated enzymes for conjugation – biotinylated enzymes – chemical modification of nucleic acids – biotin labeling of DNA- enzyme conjugation to DNA – Fluorescent of DNA.

UNIT V BIOCONJUGATE APPLICATIONS

TOTAL: 45 PERIODS
OUTCOMES:
Upon completion of this course, the student would know about

- Joining of two molecules to form a hybrid conjugate with the help of linkers.
- Active groups of various chemical reactions and targets of the functional groups.
- Antibody modification and conjugation.

REFERENCE:

BT8021 GENETICS

AIM:
- To give an understanding on the fundamentals of conventional genetics and its relevance in disease and therapy

OBJECTIVES:
- To describe various genetic laws, learn the chromosome structure function and understand methodologies for cytogenetic applications

UNIT I BACTERIAL GENETICS
Transformation, Transduction, Conjugation – mapping, fine structure mapping in merozygotes-plasmids and episomes

UNIT II CLASSICAL GENETICS
Mendel’s principles and experiments, segregation, multiple alleles – Independent Assortments, Genotypic interactions, epistasis and Sex chromosomes, Sex determination, Dosage compensation, sex linkage and pedigree analysis

UNIT III APPLIED GENETICS
Chromosome organization, structure and variation in prokaryotes and eukaryotes, Giant chromosomes – polytene and lampbrush, deletion, inversion, translocation, duplication. variation in chromosomal numbers – aneuploidy, euploidy, polyploidy, Ames test, karyotyping, Linkage, Crossing over – cytological basis of crossing over, chromosome mapping – two and three factor cross – interference, somatic cell hybridization

UNIT IV POPULATION GENETICS
Hardy-Weinberg equilibrium, Extensions of Hardy- Weinberg equilibrium, non random mating, population analysis, Models for population genetics. Mutation and Migration size, Genetic variation and Sociobiology

UNIT V GENETIC DISEASES
Inborn errors of metabolism, Sickle cell, hemochromatosis, cystic fibrosis, hypogonadotrophic hypogonadism, Gaucher’s disease, achondroplasia, phenylketonuria, Huntington’s Disease, Cystic fibrosis, hemoglobinopathies, Age-related macular degeneration, Obesity, Type 2 diabetes, Psychiatric disease, including missing heritability, autism

TOTAL: 45 PERIODS
TEXT BOOKS:

REFERENCES:

PY8071 CLINICAL TRIALS

OBJECTIVES:
● To highlight the epidemiologic methods, study design, protocol preparation
● To gain knowledge in the basic bio-statistical techniques involved in clinical research.
● To describe the principles involved in ethical, legal and regulatory issues in clinical trials.

UNIT I ROLE OF CLINICAL TRIALS IN NEW DRUG DEVELOPMENT
Drug Discovery, regulatory guidance and governance, pharmaceutical manufacturing, nonclinical research, clinical trials, post-marketing surveillance, ethical conduct during clinical trials.

UNIT II FUNDAMENTALS OF TRIAL DESIGN
Randomised clinical trials, uncontrolled trials. Protocol development, endpoints, patient selection, source and control of bias, randomization, blinding, sample size and power.

UNIT III ALTERNATE TRIAL DESIGNS
Crossover design, factorial design, equivalence trials, bioequivalence trials, non-inferiority trials, cluster randomized trials, multi-center trials.

UNIT IV BASICS OF STATISTICAL ANALYSIS
Types of data and normal distribution, significance tests and confidence intervals, comparison of means, comparison of proportions, analysis of survival data, subgroup analysis, regression analysis, missing data.

UNIT V REPORTING OF TRIALS
Overview of reporting, trial profile, presenting baseline data, use of tables, figures, critical appraisal of report, meta-analysis.

TOTAL: 45 PERIODS

OUTCOMES:
The student will be able to
● Explain key concepts in the design of clinical trials.
● Describe study designs used, identify key issues in data management for clinical trials.
● Describe the roles of regulatory affairs in clinical trials.
OBJECTIVE:
• To sensitize the Engineering students to various aspects of Human Rights.

UNIT I

UNIT II

UNIT III
Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.

UNIT IV
Human Rights in India – Constitutional Provisions / Guarantees.

UNIT V

TOTAL: 45 PERIODS

OUTCOME:
• Engineering students will acquire the basic knowledge of human rights.

REFERENCES:

GE8072 FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT 3 0 0 3

OBJECTIVES:
- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

UNIT III DESIGN AND TESTING 9

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9

UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9
RIGHTS AND CONFIDENTIALITY – SECURITY AND CONFIGURATION MANAGEMENT.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able to:

- Define, formulate and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

TEXTBOOKS:
1. Book specially prepared by NASSCOM as per the MoU.

REFERENCES:

BT8022 NEUROBIOLOGY AND COGNITIVE SCIENCES

OBJECTIVES:
To enable the students
- To know the general organization of brain and physiological and cognitive processes.
- To apply the molecular, cellular, and cognitive bases of learning and memory.

UNIT I NEUROANATOMY
What are central and peripheral nervous systems; Structure and function of neurons; types of neurons; Synapses; Glial cells; myelination; Blood Brain barrier; Neuronal differentiation; Characterization of neuronal cells; Meninges and Cerebrospinal fluid; Spinal Cord.

UNIT II NEUROPHYSIOLOGY
Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission; information representation and coding by neurons.

UNIT III NEUROPHARMACOLOGY
Synaptic transmission, neurotransmitters and their release; fast and slow neurotransmission; characteristics of neurites; hormones and their effect on neuronal function.

UNIT IV APPLIED NEUROBIOLOGY
Basic mechanisms of sensations like touch, pain, smell and taste; neurological mechanisms of vision and audition; skeletal muscle contraction.
UNIT V  BEHAVIOUR SCIENCE  9
Basic mechanisms associated with motivation; control of feeding, sleep, hearing and memory; Disorders associated with the nervous system.

OUTCOMES:
Upon completion of this course, students will be able:
- To know the anatomy and organization of nervous systems.
- To understand the function of nervous systems.
- To analyze how drugs affect cellular function in the nervous system.
- To understand the basic mechanisms associated with behavioral science.

TOTAL: 45 PERIODS

REFERENCE:

BT8023  TISSUE ENGINEERING  L T P C
3 0 0 3

OBJECTIVES:
To enable the students
- To learn the fundamentals of tissue engineering and tissue repairing
- To acquire knowledge on clinical applications of tissue engineering
- To understand the basic concept behind tissue engineering focusing on the stem cells, biomaterials and its applications

UNIT I  INTRODUCTION  9
Introduction to tissue engineering: Basic definition; current scope of development; use in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology, number viability, motility and functions. Measurement of tissue characteristics ,appearance, cellular component, ECM component, mechanical measurements and physical properties.

UNIT II  TISSUE ARCHITECTURE  9
Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence of events. Basic wound healing Applications of growth factors: VEGF/angiogenesis, Basic properties, Cell-Matrix& Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.

UNIT III  BIOMATERIALS  9
Biomaterials: Properties of biomaterials ,Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials, Modifications of Biomaterials, Role of Nanotechnology.

UNIT IV  BASIC BIOLOGY OF STEM CELLS  9
Stem Cells: Introduction, hematopoietic differentiation pathway Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation,Stem cell systems- Liver, neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoetic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pleuripotent stem cells.
UNIT V  CLINICAL APPLICATIONS


OUTCOMES:
Upon completion of this course, the students would get

- Ability to understand the components of the tissue architecture
- Opportunity to get familiarized with the stem cell characteristics and their relevance in medicine
- Awareness about the properties and broad applications of biomaterials
- Overall exposure to the role of tissue engineering and stem cell therapy in Organogenesis

TEXT BOOKS:

REFERENCES:

BT8091  INSTRUMENTATION AND PROCESS CONTROL  L T P C
3 0 0 3

AIM :
- To familiarize the students with concepts of process dynamics and control leading to control system design.

OBJECTIVE:
- To introduce dynamic response of open and closed loop systems, control loop components and stability of control systems along with instrumentation.
Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

UNIT II OPEN LOOP SYSTEMS
Laplace transformation, application to solve ODEs. Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

UNIT III CLOSED LOOP SYSTEMS
Closed loop control systems, development of block diagram for feed-back control systems servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability

UNIT IV FREQUENCY RESPONSE
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings

UNIT V ADVANCED CONTROL SYSTEMS
Introduction to advanced control systems, cascade control, feed forward control, Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes

TOTAL: 45 PERIODS

OUTCOMES:
The students will be able to
Understand the response of various control systems

TEXT BOOKS:

REFERENCES:

BT8024 BIOSAFETY AND HAZARD MANAGEMENT

AIM:
- To introduce awareness on the importance of plant safety and risk analysis

OBJECTIVE:
- Students learn about implementation of safety procedures, risk analysis and assessment, hazard identification
UNIT I INTRODUCTION
Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling

UNIT II QUALITY CHECKS
Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety

UNIT III RISK ANALYSIS
Overall risk analysis--emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment – rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

UNIT IV SAFETY AUDITS
Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras- Vizag Bopal analysis.

UNIT V HAZARDOUS OPERATIONS
Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system.

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:

OBJECTIVE:
• The students who would have learnt the science of immunology will now be able to apply the science for the development of relevant immunotechnology.
UNIT II ANTIBODIES
Monoclonal antibodies and their use in diagnostics; ELISA; Agglutination tests; Antigen detection assay; Plaque Forming Cell Assay.

UNIT III CELLULAR IMMUNOLOGY
PBMC separation from the blood; identification of lymphocytes based on CD markers; FACS; Lymphoproliferation assay; Mixed lymphocyte reaction; Cr51 release assay; macrophage cultures; cytokine bioassays- IL2, gamma IFN, TNF alpha.; HLA typing.

UNIT IV VACCINE TECHNOLOGY
Basic principles of vaccine development; protein based vaccines; DNA vaccines; Plant based vaccines; recombinant antigens as vaccines; reverse vaccinology

UNIT V DEVELOPMENT OF IMMUNOTHERAPEUTICS
Engineered antibodies; catalytic antibodies; idiotypic antibodies; combinatorial libraries for antibody isolation.

OUTCOME:
- Having learnt the technology of applied immunology the students will be able to develop immunotherapeutic products and vaccines will be ready for the industry or become an entrepreneur.

REFERENCES:

BT8026 STEM CELL TECHNOLOGY
OBJECTIVE:
- The course objectives are imparting the basic knowledge of students about stem cell, culturing and its clinical applications.

UNIT I STEM CELLS AND TYPES
Stem cells: Definition, Classification, Sources and Properties –Types of stem cells: methods of isolation, study of stem cells and their viability IPSC, embryonic stem cells, cancer stem cells. – Preservations of Stem cell. Embryonic stem cell: Isolation, Culturing, Differentiation, Properties – Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties

UNIT II STEM CELLS IN PLANTS AND ANIMALS
Stem cell and founder zones in plants –particulary their roots – stem cells of shoot meristems of higher plants. Skeletal muscle stem cell – Mammary stem cells – intestinal stem cells – keratinocyte stem cells of cornea – skin and hair follicles –tumour stem cells.
UNIT III  STEM CELLS DIFFERENTIATION  9
Factors influencing proliferation, physical, chemical and molecular methods for differentiation of stem cells – hormonal role in differentiation.

UNIT IV  REGENERATION AND EXPERIMENTAL METHODS  9
Germ cells, hematopoietic organs, and kidney, cord blood transplantation, donor selection, HLA matching, patient selection, peripheral blood and bone marrow transplantation. - Stem cell Techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging

UNIT V  APPLICATION AND ETHICAL ISSUES  9
Stem cell Therapy for neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns, skin ulcers, muscular dystrophy and orthopaedic applications. Stem cell policy and ethics, stem cell research: Hype, hope and controversy.

TEXT BOOKS:

REFERENCES: