DEPARTMENT OF CHEMICAL ENGINEERING
ANNA UNIVERSITY, CHENNAI

Vision:

Department of Chemical Engineering strives to become well known in India by creating quality chemical engineers who will be highly successful in academia, industries and research. The research motive is to develop sustainable technologies for the betterment of society.

Mission:

1. To disseminate high quality Chemical Engineering Education
2. To perform high impact research for the benefit of community
3. To collaborate with industries for innovative concepts/ideas
4. To develop quality engineers and technocrats with inter-disciplinary skills
1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- To inculcate conceptual knowledge in the fields of Chemical Engineering.
- To impart problem solving, analytical skills in the contemporary processes.
- To expedite state of art laboratory facility to offer practical Knowledge.
- To design and develop eco-friendly sustainable technologies with the aid of computational skills
- To facilitate the ability to learn, innovate and communicate technical developments for the benefit of humanity
- To disseminate the knowledge related to intellectual property ownership rights, ethics, professionalism, entrepreneurship, and their societal impact.

2. PROGRAMME OUTCOMES (POs):

After going through the four years of study, our Chemical Engineering Graduates will exhibit ability to:

<table>
<thead>
<tr>
<th>PO</th>
<th>Graduate attribute</th>
<th>Programme Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO1</td>
<td>Engineering knowledge</td>
<td>Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.</td>
</tr>
<tr>
<td>PO2</td>
<td>Problem analysis</td>
<td>Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.</td>
</tr>
<tr>
<td>PO3</td>
<td>Design / development of solutions</td>
<td>Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.</td>
</tr>
<tr>
<td>PO4</td>
<td>Conduct investigations of complex problems</td>
<td>Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.</td>
</tr>
<tr>
<td>PO5</td>
<td>Modern tool usage</td>
<td>Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.</td>
</tr>
<tr>
<td></td>
<td>PO6</td>
<td>The Engineer and society</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>PO7</td>
<td>Environment and sustainability</td>
</tr>
<tr>
<td></td>
<td>PO8</td>
<td>Ethics</td>
</tr>
<tr>
<td></td>
<td>PO9</td>
<td>Individual and team work</td>
</tr>
<tr>
<td></td>
<td>PO10</td>
<td>Communication</td>
</tr>
<tr>
<td></td>
<td>PO11</td>
<td>Project management and finance</td>
</tr>
<tr>
<td></td>
<td>PO12</td>
<td>Life-long learning</td>
</tr>
</tbody>
</table>

3. PROGRAM SPECIFIC OUTCOMES (PSOs):

   By the completion of Chemical Engineering Programme the student will have following Program-specific outcomes.

1. Graduates will have a strong foundation in engineering, science and current Chemical Engineering practices and will have experience in solving structured and unstructured problems using conventional and innovative solutions.

2. Graduates will be able to effectively describe the Chemical Engineering problem, analyze the data, develop potential solutions, evaluate these solutions, and present the results using their oral, written and electronic media skills.

3. Graduates will have an understanding of ethical and professional responsibilities of an engineer and the impact of engineering solutions on society and the global environment.
4. MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVE WITH PROGRAMME OUTCOMES

<table>
<thead>
<tr>
<th>PROGRAMME EDUCATIONAL OBJECTIVES</th>
<th>PROGRAMME OUTCOMES</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PS01</th>
<th>PS02</th>
<th>PS03</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>II</td>
<td></td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>III</td>
<td></td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>IV</td>
<td></td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>V</td>
<td></td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>VI</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

5. MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

<table>
<thead>
<tr>
<th>YEAR 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester 1</td>
</tr>
<tr>
<td>Course Name</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Technical English</td>
</tr>
<tr>
<td>Engineering Mathematics I</td>
</tr>
<tr>
<td>Engineering Physics</td>
</tr>
<tr>
<td>Engineering Chemistry</td>
</tr>
<tr>
<td>Engineering Graphics</td>
</tr>
<tr>
<td>Basic Sciences Laboratory</td>
</tr>
<tr>
<td>Workshop Practices Laboratory</td>
</tr>
</tbody>
</table>

<p>| Semester 2 |</p>
<table>
<thead>
<tr>
<th>Course Name</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PS01</th>
<th>PS02</th>
<th>PS03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering Mathematics II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem Solving and Python Programming</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basics of Electrical and Electronics Engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering Mechanics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Principles of Chemical Engineering</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Problem Solving and Python Programming Laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical and Electronics Engineering Laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability and Statistics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<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>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Elective - Humanities I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical Engineering for Technologists</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Organic Chemistry</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Process Calculations</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Fluid Mechanics for Chemical Engineers</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Organic Chemistry Laboratory</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Mechanical Engineering Laboratory</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Elective - Humanities II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Sciences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audit Course - I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Transfer</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Chemical Engineering Thermodynamics I</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Mechanical Operations</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Chemical Technology</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Fluid Mechanics Laboratory</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Mechanical Operations</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Principles of Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audit Course - II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Engineering Thermodynamics II</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Mass Transfer I</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Chemical Reaction Engineering I</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Professional Elective 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Transfer Laboratory</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Computational Chemical Engineering Laboratory</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Internship /Industrial Training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Reaction Engineering II</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Mass Transfer II</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Process Dynamics and Control</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Professional Elective 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional Elective 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open Elective 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Control Laboratory for Chemical Engineers</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Mass Transfer Laboratory</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Internship / Training (Minimum 4 Weeks)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport Phenomena</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Process Equipment Design</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Professional Elective 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional Elective 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open Elective II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Reaction Engineering Laboratory</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Comprehension</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Internship / Training (Minimum 4 Weeks)</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Project – I</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Project – II</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
### CURRICULA AND SYLLABI FOR I TO VIII SEMESTERS

(Applicable to Students admitted from the Academic Year 2020-2021 onwards)

#### SEMESTER I

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Code No.</th>
<th>Course Title</th>
<th>Category</th>
<th>Periods Per Week</th>
<th>Total Contact Periods</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>THEORY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>HS5151</td>
<td>Technical English</td>
<td>HSMC</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>MA5158</td>
<td>Engineering Mathematics I</td>
<td>BSC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>PH5151</td>
<td>Engineering Physics</td>
<td>BSC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>CY5151</td>
<td>Engineering Chemistry</td>
<td>BSC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>GE5151</td>
<td>Engineering Graphics</td>
<td>ESC</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>PRACTICALS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>BS5161</td>
<td>Basic Sciences Laboratory</td>
<td>BSC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>7.</td>
<td>GE5162</td>
<td>Workshop Practices Laboratory</td>
<td>ESC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td>1</td>
<td>12</td>
</tr>
</tbody>
</table>

#### SEMESTER II

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Code No.</th>
<th>Course Title</th>
<th>Category</th>
<th>Periods Per Week</th>
<th>Total Contact Periods</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>THEORY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>HS5251</td>
<td>Professional communication</td>
<td>HSMC</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>MA5252</td>
<td>Engineering Mathematics II</td>
<td>BSC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>GE5153</td>
<td>Problem Solving and Python Programming</td>
<td>ESC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>EE5251</td>
<td>Basics of Electrical and Electronics Engineering</td>
<td>ESC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>GE5152</td>
<td>Engineering Mechanics</td>
<td>ESC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>CH5201</td>
<td>Principles of Chemical Engineering</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PRACTICALS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>GE5161</td>
<td>Problem Solving and Python Programming Laboratory</td>
<td>ESC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>8.</td>
<td>EE5261</td>
<td>Electrical and Electronics Engineering Laboratory</td>
<td>ESC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>19</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>
### SEMESTER III

<table>
<thead>
<tr>
<th>SI. NO.</th>
<th>CODE NO.</th>
<th>COURSE TITLE</th>
<th>CATEG ORY</th>
<th>PERIODS PER WEEK</th>
<th>TOTAL CONTACT PERIODS</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>THEORY</td>
<td>1.</td>
<td>MA5354 Probability and Statistics</td>
<td>BSC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>Elective - Humanities I</td>
<td>HSMC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>CH5301 Mechanical Engineering for Technologists</td>
<td>ESC</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>CY5252 Organic Chemistry</td>
<td>BSC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>5.</td>
<td>CH5302 Process Calculations</td>
<td>PCC</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>6.</td>
<td>CH5303 Fluid Mechanics for Chemical Engineers</td>
<td>PCC</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>PRACTICALS</td>
<td>7.</td>
<td>CY5361 Organic Chemistry Laboratory</td>
<td>BSC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>8.</td>
<td>CH5311 Mechanical Engineering Laboratory</td>
<td>ESC</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<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>3</td>
<td></td>
<td></td>
</tr>
<tr>
<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>
</tr>
</tbody>
</table>

### SEMESTER IV

<table>
<thead>
<tr>
<th>SI. NO.</th>
<th>CODE NO.</th>
<th>COURSE TITLE</th>
<th>CATEG ORY</th>
<th>PERIODS PER WEEK</th>
<th>TOTAL CONTACT PERIODS</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>THEORY</td>
<td>1.</td>
<td>Elective - Humanities II</td>
<td>HSMC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>GE5251 Environmental Sciences</td>
<td>BSC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>Audit Course -I*</td>
<td>AC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>CH5401 Heat Transfer</td>
<td>PCC</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>5.</td>
<td>CH5402 Chemical Engineering Thermodynamics I</td>
<td>PCC</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>6.</td>
<td>CH5403 Mechanical Operations</td>
<td>PCC</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>7.</td>
<td>CH5404 Chemical Technology</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PRACTICALS</td>
<td>8.</td>
<td>CH5411 Fluid Mechanics for Chemical Engineering Laboratory</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>9.</td>
<td>CH5412 Mechanical Operations Laboratory</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<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>3</td>
<td></td>
<td></td>
</tr>
<tr>
<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>
</tr>
</tbody>
</table>

* Audit Course is optional
### SEMESTER V

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Code No.</th>
<th>Course Title</th>
<th>Category</th>
<th>Periods Per Week</th>
<th>Total Contact Periods</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MG5451</td>
<td>Principles of Management</td>
<td>HSMC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Audit Course -II*</td>
<td>AC</td>
<td>3 0 0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>CH5501</td>
<td>Chemical Engineering Thermodynamics II</td>
<td>PCC</td>
<td>2 1 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>CH5502</td>
<td>Mass Transfer I</td>
<td>PCC</td>
<td>2 1 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>CH5503</td>
<td>Chemical Reaction Engineering I</td>
<td>PCC</td>
<td>2 1 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Professional Elective I</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Professional Elective II</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Professional Elective III</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

#### PRACTICALS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Code No.</th>
<th>Course Title</th>
<th>Category</th>
<th>Periods Per Week</th>
<th>Total Contact Periods</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>CH5511</td>
<td>Heat Transfer Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>CH5512</td>
<td>Computational Chemical Engineering Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>CH5713</td>
<td>Internship / Training ¹, ²</td>
<td>EEC</td>
<td>- - -</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**TOTAL** | **21 3 8** | **32** | **25**  

* Audit Course is optional  
¹Minimum of 2 weeks at the end of 5th semester and 6th semester each, or a minimum of 4 weeks at the end of 6th semester.  
²Assessment for Internship / Training will be done during 7th semester.

### SEMESTER VI

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Code No.</th>
<th>Course Title</th>
<th>Category</th>
<th>Periods Per Week</th>
<th>Total Contact Periods</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CH5601</td>
<td>Chemical Reaction Engineering II</td>
<td>PCC</td>
<td>2 1 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>CH5602</td>
<td>Mass Transfer II</td>
<td>PCC</td>
<td>2 1 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>CH5603</td>
<td>Process Dynamics and Control</td>
<td>PCC</td>
<td>2 1 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Professional Elective IV</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Professional Elective V</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Professional Elective VI</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>CH5611</td>
<td>Open Elective I</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

#### PRACTICALS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Code No.</th>
<th>Course Title</th>
<th>Category</th>
<th>Periods Per Week</th>
<th>Total Contact Periods</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>CH5611</td>
<td>Process Control Laboratory for Chemical Engineers</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>CH5612</td>
<td>Mass Transfer Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>CH5713</td>
<td>Internship / Training (Minimum 4 Weeks)#</td>
<td>EEC</td>
<td>- - -</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**TOTAL** | **18 3 8** | **29** | **25**  

* Assessment for Internship / Training will be done during 7th semester
<table>
<thead>
<tr>
<th>SI. NO.</th>
<th>CODE NO.</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>PERIODS PER WEEK</th>
<th>TOTAL CONTACT PERIODS</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>CH5751</td>
<td>Transport Phenomena</td>
<td>PCC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>CH5701</td>
<td>Process Equipment Design</td>
<td>PCC</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>GE5451</td>
<td>Total Quality Management</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>Professional Elective VII</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Open Elective II</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>CH5711</td>
<td>Chemical Reaction Engineering</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>CH5712</td>
<td>Comprehension</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>8.</td>
<td>CH5713</td>
<td>Internship / Industrial Training</td>
<td>EEC</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Minimum 4 Weeks)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>CH5714</td>
<td>Project – I</td>
<td>EEC</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>13</td>
<td>3</td>
<td>14</td>
</tr>
</tbody>
</table>

**SEVERAL VIII**

<table>
<thead>
<tr>
<th>SI. NO.</th>
<th>CODE NO.</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>PERIODS PER WEEK</th>
<th>TOTAL CONTACT PERIODS</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CH5811</td>
<td>Project – II</td>
<td>EEC</td>
<td>0</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>16</td>
</tr>
</tbody>
</table>

**TOTAL NO. OF CREDITS: 172**
# B. TECH. CHEMICAL ENGINEERING
## PROFESSIONAL ELECTIVE [PEC]

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Code No.</th>
<th>Course title</th>
<th>Periods per week</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lecture</td>
<td>Tutorial</td>
</tr>
<tr>
<td>1.</td>
<td>CH5001</td>
<td>Drugs and Pharmaceutical Technology</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>CH5002</td>
<td>Electrochemical Engineering</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>CH5003</td>
<td>Energy Technology</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>CH5004</td>
<td>Frontiers of Chemical Engineering</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>CH5005</td>
<td>Modern Separation Techniques</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>CH5006</td>
<td>Optimization of Chemical Processes</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>7.</td>
<td>CH5007</td>
<td>Petroleum Refining and Petrochemicals</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td>CH5008</td>
<td>Polymer Technology</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>9.</td>
<td>CH5009</td>
<td>Process Modeling and Simulation</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>10.</td>
<td>AS5073</td>
<td>Process Plant Utilities</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>11.</td>
<td>CH5010</td>
<td>Chemical Process Design</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>12.</td>
<td>CH5011</td>
<td>Materials of Construction</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>13.</td>
<td>CH5012</td>
<td>Biochemical Engineering</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>14.</td>
<td>GE5071</td>
<td>Disaster Management</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>15.</td>
<td>CH5013</td>
<td>Industrial Process Plant Safety</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>16.</td>
<td>CH5014</td>
<td>Instrumental Methods of Analysis</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>17.</td>
<td>CH5015</td>
<td>Process Engineering Economics</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
### HUMANITIES AND SOCIAL SCIENCES (HSMC) – MANAGEMENT AND OTHERS

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course No.</th>
<th>Course Title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>HS5151</td>
<td>Technical English</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>HS5251</td>
<td>Professional Communication</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>MG5451</td>
<td>Principles of Management</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total Credits</strong></td>
<td></td>
<td></td>
<td></td>
<td>11</td>
</tr>
</tbody>
</table>

### HSMC– ELECTIVES – HUMANITIES I (ODD SEMESTER)

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Periods per week</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lecture</td>
<td>Tutorial</td>
</tr>
<tr>
<td>1.</td>
<td>HU5171</td>
<td>Language and Communication</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>HU5172</td>
<td>Values and Ethics</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>HU5173</td>
<td>Human Relations at Work</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>HU5174</td>
<td>Psychological Process</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>HU5175</td>
<td>Education, Technology and Society</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>HU5176</td>
<td>Philosophy</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>7.</td>
<td>HU5177</td>
<td>Applications of Psychology in Everyday Life</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

### HSMC– ELECTIVES – HUMANITIES II (EVEN SEMESTER)

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Periods per week</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lecture</td>
<td>Tutorial</td>
</tr>
<tr>
<td>1.</td>
<td>HU5271</td>
<td>Gender Culture and Development</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>HU5272</td>
<td>Ethics and Holistic Life</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>HU5273</td>
<td>Law and Engineering</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>HU5274</td>
<td>Film Appreciation</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>HU5275</td>
<td>Fundamentals of Language and Linguistics</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>HU5276</td>
<td>Understanding Society and Culture through Literature</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Course Code</td>
<td>Course Title</td>
<td>L</td>
<td>T</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>--------------------------------</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1.</td>
<td>MA5158</td>
<td>Engineering Mathematics I</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>PH5151</td>
<td>Engineering Physics</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>CY5151</td>
<td>Engineering Chemistry</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>BS5161</td>
<td>Basic Science Laboratory</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>MA5252</td>
<td>Engineering Mathematics II</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>MA5354</td>
<td>Probability and Statistics</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>7.</td>
<td>GE5251</td>
<td>Environmental Sciences</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td>CY5252</td>
<td>Organic Chemistry</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>9.</td>
<td>CY5361</td>
<td>Organic Chemistry Laboratory</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total Credits** 28
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GE5151</td>
<td>Engineering Graphics</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>GE5162</td>
<td>Workshop Practices Laboratory</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>GE5153</td>
<td>Problem Solving and Python Programming</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>EE5251</td>
<td>Basics of Electrical and Electronics</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>GE5152</td>
<td>Engineering Mechanics</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>EE5261</td>
<td>Electrical and Electronics Engineering</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>GE5161</td>
<td>Problem Solving and Python Programming</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>CH5301</td>
<td>Mechanical Engineering for Technologists</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>CH5311</td>
<td>Mechanical Engineering Laboratory</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total Credits** 22

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CH5201</td>
<td>Principles of Chemical Engineering</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CY5252</td>
<td>Organic Chemistry</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CH5302</td>
<td>Process Calculations</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>CH5303</td>
<td>Fluid Mechanics for Chemical Engineers</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>CH5401</td>
<td>Heat Transfer</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>CY5361</td>
<td>Organic Chemistry Laboratory</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>CH5402</td>
<td>Chemical Engineering Thermodynamics I</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>CH5403</td>
<td>Mechanical Operations</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>9.</td>
<td>CH5404</td>
<td>Chemical Technology</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>10.</td>
<td>CH5411</td>
<td>Fluid Mechanics for Chemical Engineering Laboratory</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>11.</td>
<td>CH5412</td>
<td>Mechanical Operations Laboratory</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>12.</td>
<td>CH5501</td>
<td>Chemical Engineering Thermodynamics II</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>13.</td>
<td>CH5502</td>
<td>Mass Transfer I</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>14.</td>
<td>CH5503</td>
<td>Chemical Reaction Engineering I</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>15.</td>
<td>CH5511</td>
<td>Heat Transfer Laboratory</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>16.</td>
<td>CH5601</td>
<td>Chemical Reaction Engineering II</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>17.</td>
<td>CH5512</td>
<td>Computational Chemical Engineering Laboratory</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>18.</td>
<td>CH5602</td>
<td>Mass Transfer II</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>19.</td>
<td>CH5603</td>
<td>Process Dynamics and Control</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>20.</td>
<td>CH5611</td>
<td>Process Control Laboratory for Chemical Engineers</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>21.</td>
<td>CH5612</td>
<td>Mass Transfer Laboratory</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>22.</td>
<td>CH5751</td>
<td>Transport Phenomena</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>23.</td>
<td>CH5701</td>
<td>Process Equipment Design</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>24.</td>
<td>CH5711</td>
<td>Chemical Reaction Engineering Laboratory</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>25.</td>
<td>CH5712</td>
<td>Comprehension</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>26.</td>
<td>GE5451</td>
<td>Total Quality Management</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits** 64
### EMPLOYABILITY ENHANCEMENT COURSES (EEC)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>CODE No.</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CH5713</td>
<td>Internship / Training (Minimum 4 Weeks)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>CH5714</td>
<td>Project I</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CH5811</td>
<td>Project II</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>8</td>
</tr>
</tbody>
</table>

Total Credits: 13

### AUDIT COURSES (AC)

Registration for any of these courses is optional to students

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Periods per week</th>
<th>Credits</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lecture</td>
<td>Tutorial</td>
<td>Practical</td>
</tr>
<tr>
<td>1.</td>
<td>AD5091</td>
<td>Constitution of India</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>AD5092</td>
<td>Value Education</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>AD5093</td>
<td>Pedagogy Studies</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>AD5094</td>
<td>Stress Management by Yoga</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>AD5095</td>
<td>Personality Development Through Life Enlightenment Skills</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>AD5096</td>
<td>Unnat Bharat Abhiyan</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7.</td>
<td>AD5097</td>
<td>Essence of Indian Knowledge Tradition</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td>AD5098</td>
<td>Sanga Tamil Literature Appreciation</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

4/5
# SUMMARY

## Name of the Programme

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Credits per Semester</th>
<th>Credits Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Humanities and Social Sciences Including Management Courses (HSMC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Basic Science Course [BSC]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Engineering Science Course [ESC]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Professional Core Courses [PCC]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Professional Elective [PEC]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Open Elective Courses [OEC]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Employability Enhancement Courses [EEC]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Audit Course (AC) (Non Credit)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Credits per Semester

<p>| | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
<td>V</td>
<td>VI</td>
<td>VII</td>
<td>VIII</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>9</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>16</td>
<td>13</td>
<td>13</td>
<td>14</td>
<td></td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

<p>| | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>25</td>
<td>21</td>
<td>22</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>8</td>
<td>172</td>
</tr>
</tbody>
</table>
OBJECTIVES:
The first semester English course entitled ‘Technical English ’ aims to,
- Familiarise first year students of engineering and technology with the fundamental aspects of technical English.
- Develop all the four language skills by giving sufficient practice in the use of the skills in real life contexts.
- Enhance the linguistic and communicative competence of first year engineering and technology students.

UNIT I  INTRODUCING ONESELF  12
Listening: Listening and filling a form, listening to speeches by specialists from various branches of engineering and completing activities such as answering questions, identifying the main ideas of the listening text, style of the speaker (tone and tenor) – Speaking: Introducing oneself –introducing friend/family
- Reading: Descriptive passages (from newspapers / magazines)- Writing: Writing a paragraph (native place, school life)- Grammar: Simple present, present continuous – Vocabulary Development: One word substitution

UNIT II  DIALOGUE WRITING  12
Listening: Listening to conversations (asking for and giving directions) – Speaking: making conversation using (asking for directions, making an enquiry), Role plays-dialogues- Reading: Reading a print interview and answering comprehension questions- Writing: Writing a checklist, Dialogue writing- Grammar: Simple past – question formation (Wh- questions, Yes or No questions, Tag questions)- Vocabulary Development: Stress shift, lexical items related to the theme of the given unit.

UNIT III  FORMAL LETTER WRITING  12
Listening: Listening to speeches by famous people and identifying the central message of the speech – answering multiple-choice questions)- Speaking: Giving short talks on a given topic- Reading: Reading motivational essays on famous engineers and technologists (answering open-ended and closed questions)- Writing: Writing formal letters/emails (Complaint letters)- Grammar: Future Tense forms of verbs, subject and verb agreement-Vocabulary Development: Collocations – Fixed expressions

UNIT IV  WRITING COMPLAINT LETTERS  12

UNIT V  WRITING DEFINITIONS AND PRODUCT DESCRIPTION  12
Listening: Listening to a product description (labeling and gap filling) exercises- Speaking: Describing a product and comparing and contrasting it with other products- Reading: Reading graphical material for comparison (advertisements)- Writing: Writing Definitions (short and long) – compare and contrast paragraphs- Grammar: Adjectives – Degrees of comparison - compound nouns- Vocabulary Development: Use of discourse markers – suffixes (adjectival endings).

Learning Outcomes
At the end of the course the students will have gained,
- Exposure to basic aspects of technical English.
- The confidence to communicate effectively in various academic situations.
- Learnt the use of basic features of Technical English

TOTAL : 60 PERIODS
Textbook:

Assessment Pattern
- Assessments will assess all the four skills through both pen and paper and computer based tests.
- Assessments can be pen and paper based, quizzes.
OBJECTIVES:
- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

UNIT I  MATRICES

UNIT II  DIFFERENTIAL CALCULUS

UNIT III  FUNCTIONS OF SEVERAL VARIABLES

UNIT IV  INTEGRAL CALCULUS
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 V  MULTIPLE INTEGRALS

TOTAL : 60 PERIODS

OUTCOMES:
At the end of the course the students will be able to
- Use the matrix algebra methods for solving practical problems.
- Apply differential calculus tools n solving various application problems.
- Able to use differential calculus ideas on several variable functions.
- Apply different methods of integration in solving practical problems.
- Apply multiple integral ideas in solving areas, volumes and other practical problems.
TEXTBOOKS:

REFERENCES:
OBJECTIVE
- To make the students understand the importance of mechanics.
- To equip the students on the knowledge of electromagnetic waves.
- To introduce the basics of oscillations, optics and lasers.
- To enable the students understanding the importance of quantum physics.
- To elucidate the application of quantum mechanics towards the formation of energy bands in crystalline materials.

UNIT I MECHANICS

UNIT II ELECTROMAGNETIC WAVES
- Gauss’s law – Faraday’s law - Ampere’s law - The Maxwell’s equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

UNIT III OSCILLATIONS, OPTICS AND LASERS

UNIT IV BASIC QUANTUM MECHANICS
- Photons and light waves - Electrons and matter waves - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization - Particle in a infinite potential well - Normalization, probabilities and the correspondence principle.

UNIT V APPLIED QUANTUM MECHANICS
- The harmonic oscillator - Barrier penetration and quantum tunneling - Tunneling microscope - Resonant diode - Finite potential wells - particle in a three dimensional box - Bloch’s theorem for particles in a periodic potential, Kronig-Penney model and origin of energy bands.

TOTAL: 45 PERIODS

OUTCOMES:
After completion of this course, the students should able to
- Understanding the importance of mechanics.
- Express the knowledge of electromagnetic waves.
- Know the basics of oscillations, optics and lasers.
- Understanding the importance of quantum physics.
- Apply quantum mechanical principles towards the formation of energy bands in crystalline materials.
TEXT BOOKS:

REFERENCES:
OBJECTIVES:
- To introduce the basic concepts of polymers, their properties and some of the important applications.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To facilitate the understanding of the laws of photochemistry, photo processes and instrumentation & applications of spectroscopic techniques.
- To familiarize the operating principles and applications of energy conversion, its processes and storage devices.
- To inculcate sound understanding of water quality parameters and water treatment techniques.

UNIT I  POLYMER CHEMISTRY

UNIT II  NANOCHEMISTRY

UNIT III  PHOTOCHEMISTRY AND SPECTROSCOPY

UNIT IV  ENERGY CONVERSIONS AND STORAGE
Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant – fast breeder reactor. Solar energy conversion - solar cells. Wind energy. Batteries - types of batteries – primary battery (dry cell), secondary battery (lead acid, nickel-cadmium and lithium-ion-battery). Fuel cells – H₂-O₂ and microbial fuel cell. Explosives – classification, examples: TNT, RDX, Dynamite; Rocket fuels and propellants – definition and uses.

UNIT V  WATER TECHNOLOGY

TOTAL: 45 PERIODS
OUTCOMES:
- To recognize and apply basic knowledge on different types of polymeric materials, their general preparation methods and applications to futuristic material fabrication needs.
- To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
- To identify and apply suitable spectroscopic technique for material analysis and study different forms of photochemical reactions.
- To recognize different forms of energy resources and apply them for suitable applications in energy sectors.
- To demonstrate the knowledge of water and their quality in using at different industries.

TEXT BOOKS:

REFERENCE BOOKS:
COURSE OBJECTIVES: The main learning objective of this course is to prepare the students for:

1. Drawing free hand sketches of basic geometrical shapes and multiple views of objects.
2. Drawing orthographic projections of lines and planes.
3. Drawing orthographic projections of solids.
4. Drawing development of the surfaces of objects.
5. Drawing isometric and perspective views of simple solids.

CONCEPTS AND CONVENTIONS (NOT FOR EXAMINATION) 1

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 FREE HANDSKETCHING 14

Basic Geometrical constructions, Curves used in engineering practices-Conics – Construction of ellipse, parabola and hyperbola by different methods – 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- Free hand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACES 15

Orthographic projection- principles-Principle 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 trapezoidal 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 15

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to both the principal planes by rotating object method and auxiliary plane method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 15

Sectioning of 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. Development of lateral surfaces of solids with cut-outs and holes.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 1

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 and miscellaneous problems. Perspective projection of simple solids-Prisms pyramids and cylinders by visual ray method and vanishing point method.
Introduction to drafting packages and demonstration of their use

TOTAL- 75 PERIODS

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

1. Draw free hand sketching of basic geometrical shapes and multiple views of objects.
2. Draw orthographic projections of lines and planes
3. Draw orthographic projections of solids
4. Draw development of the surfaces of objects
5. Draw isometric and perspective views of simple solids.

TEXT BOOKS:


REFERENCES:


Publication of Bureau of Indian Standards:


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.
4. The students will be permitted to use appropriate scale to fit solution within A3 size.
5. The examination will be conducted in appropriate sessions on the same day.
PHYSICS LABORATORY: (Any Seven Experiments)

OBJECTIVES
- To inculcate experimental skills to test basic understanding of physics of materials including properties of matter, thermal and optical properties.
- To induce the students to familiarize with experimental determination of velocity of ultrasonic waves and band gap determination.

LIST OF EXPERIMENTS:
1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of disc
2. Non-uniform bending - Determination of young's modulus
3. Uniform bending – Determination of young's modulus
4. Lee's disc Determination of thermal conductivity of a bad conductor
5. Potentiometer-Determination of thermo e.m.f of a thermocouple
6. Laser- Determination of the wave length of the laser using grating
7. Air wedge - Determination of thickness of a thin sheet/wire
8. a) Optical fibre - Determination of Numerical Aperture and acceptance angle  
   b) Compact disc- Determination of width of the groove using laser.
10. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
11. Post office box - Determination of Band gap of a semiconductor.
13. Photoelectric effect
14. Michelson Interferometer.
16. Melde's string experiment

TOTAL: 30 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able
- To determine various moduli of elasticity and also various thermal and optical properties of materials.
- To determine the velocity of ultrasonic waves, band gap determination and viscosity of liquids.

CHEMISTRY LABORATORY: (Minimum of 8 experiments to be conducted)

OBJECTIVES:
- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and polymers by spectroscopy and viscometry methods.
LIST OF EXPERIMENTS:
1. Estimation of HCl using Na₂CO₃ 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-Phenanthrolone / thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
12. Pseudo first order kinetics-ester hydrolysis.
14. Phase change in a solid.

TOTAL: 30 PERIODS

OUTCOMES:
- To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.
- To determine the amount of metal ions through volumetric and spectroscopic techniques
- To determine the molecular weight of polymers by viscometric method.
- To quantitatively analyse the impurities in solution by electroanalytical techniques
- To design and analyse the kinetics of reactions and corrosion of metals

TEXTBOOKS:
COURSE OBJECTIVES: The main learning objective of this course is to provide hands on training to the students in:
1. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common household wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

GROUP – A (CIVIL & ELECTRICAL)

PART I CIVIL ENGINEERING PRACTICES 15

PLUMBING WORK:
  a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
  b) Preparing plumbing line sketches.
  c) Laying pipe connection to the suction side of a pump
  d) Laying pipe connection to the delivery side of a pump.
  e) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WOOD WORK:
  a) Sawing,
  b) Planning and
  c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:
  a) Studying joints in door panels and wooden furniture
  b) Studying common industrial trusses using models.

PART II ELECTRICAL ENGINEERING PRACTICES 15

WIRING WORK:
  a) Wiring Switches, Fuse, Indicator and Lamp etc. such as in basic household,
  b) Wiring Stair case light.
  c) Wiring tube – light.
  d) Preparing wiring diagrams for a given situation.

Wiring Study:
  a) Studying an Iron-Box wiring.
  b) Studying a Fan Regulator wiring.
  c) Studying an Emergency Lamp wiring.

GROUP – B (MECHANICAL AND ELECTRONICS)

PART III MECHANICAL ENGINEERING PRACTICES 15

WELDING WORK:
  a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
  b) Practicing gas welding.
BASIC MACHINING WORK:
   a) (simple) Turning.
   b) (simple) Drilling.
   c) (simple) Tapping.

ASSEMBLY WORK:
   a) Assembling a centrifugal pump.
   b) Assembling a household mixer.
   c) Assembling an air conditioner.

SHEET METAL WORK:
   a) Making of a square tray

FOUNDRY WORK:
   a) Demonstrating basic foundry operations.

PART IV ELECTRONIC ENGINEERING PRACTICES 15

SOLDERING WORK:
   a) Soldering simple electronic circuits and checking continuity.

ELECTRONIC ASSEMBLY AND TESTING WORK:
   a) Assembling and testing electronic components on a small PCB.

ELECTRONIC EQUIPMENT STUDY:
   a) Studying a FM radio.
   b) Studying an electronic telephone.

TOTAL (P: 60) = 60 PERIODS

COURSE OUTCOMES: Upon completion of this course, the students will be able to:
1. Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.
2. Wire various electrical joints in common household electrical wire work.
3. Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.
4. Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.
COURSE OBJECTIVES
The course entitles ‘professional communication’ aims to,
- Improve the relevant language skills necessary for professional communication.
- Develop linguistic and strategic competence in workplace context.
- Enhance language proficiency and thereby the employability of budding engineers and technologists.

UNIT I TECHNICAL COMMUNICATION 12
Listening: Listening to telephone conversations (intent of the speaker and note taking exercises)- Speaking: Role play exercises based on workplace contexts, introducing oneself- Reading: Reading the interview of an achiever and completing exercises (skimming, scanning and predicting)- Writing: Writing a short biography of an achiever based on given hints- Grammar: Asking and answering questions, punctuation in writing, prepositional phrases- Vocabulary Development: use of adjectives.

UNIT I SUMMARY WRITING 12
Listening: Listening to talks/lectures both general and technical and summarizing the main points- Speaking: Participating in debates- Reading: Reading technical essays/articles and answering comprehension questions; Writing: Summary writing- Grammar: Participle forms, relative clauses- Vocabulary Development: Use of compound words, abbreviations and acronyms.

UNIT III PROCESS DESCRIPTION 12
Listening: Listening to a process description and drawing a flowchart- Speaking: Participating in Group Discussions, giving instructions- Reading: Reading instruction manuals- Writing: Writing process descriptions- Writing instructions- Grammar: Use of imperatives, active and passive voice, sequence words- Vocabulary Development: Technical jargon

UNIT IV REPORT WRITING 12
Listening: Listening to a presentation and completing gap-filling exercises- Speaking: Making formal presentations- Reading: Reading and interpreting charts/tables and diagrams- Writing: Interpreting charts/tables and diagrams, writing a report- Grammar: Direct into indirect speech, use of phrases- Vocabulary Development: reporting words

UNIT V WRITING JOB APPLICATIONS 12
Listening: Listening to a job interview and completing gap-filling exercises- Speaking: Mock interview, telephone interviews- Reading: Reading a job interview, SOP, company profile and completing comprehension exercises- Writing: job applications and resumes and SOPs- Grammar: Present perfect and continuous tenses- Vocabulary Development: Technical vocabulary

TOTAL : 60 PERIODS

LEARNING OUTCOMES
At the end of the second semester the learners should be able to,
- Read and comprehend technical texts effortlessly.
- Write reports of a technical kind.
- Speak with confidence in interviews and thereby gain employability

Textbook

Assessment Pattern
- Assessments will assess all the four skills through both pen and paper and computer based tests.
- Assessments can be pen and paper based, quizzes.
OBJECTIVES:

- To acquaint the students with the concepts of vector calculus which naturally arises in many engineering problems.
- To develop an understanding of the standard techniques of complex variable theory in particular analytic function and its mapping property.
- To familiarize the students with complex integration techniques and contour integration techniques which can be used in real integrals.
- To acquaint the students with Differential Equations which are significantly used in Engineering problems.
- To make the students appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I  VECTOR CALCULUS  

UNIT II  ANALYTIC FUNCTION  
Analytic functions – Necessary and sufficient conditions for analyticity - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions - Bilinear transformation \( w = c + z, \ ax, \ 1/z, \ z^2 \).

UNIT III  COMPLEX INTEGRATION  

UNIT IV  DIFFERENTIAL EQUATIONS  
Method of variation of parameters – Method of undetermined coefficients – Homogenous equations of Euler’s and Legendre’s type – System of simultaneous linear differential equations with constant coefficients.

UNIT V  LAPLACE TRANSFORMS  

TOTAL : 60 PERIODS

OUTCOMES:

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

- Calculate grad, div and curl and use Gauss, Stokes and Greens theorems to simplify calculations of integrals.
- Construct analytic functions and use their conformal mapping property in application problems.
• Evaluate real and complex integrals using the Cauchy's integral formula and residue theorem.
• Apply various methods of solving differential equation which arise in many application problems.
• Apply Laplace transform methods for solving linear differential equations.

TEXTBOOKS:

REFERENCES:
OBJECTIVES:
- To know the basics of algorithmic problem solving.
- To develop Python programs with conditionals and loops.
- To define Python functions and use function calls.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT I INTRODUCTION TO COMPUTING AND PROBLEM SOLVING  9
Pseudocodes and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms –
Introduction to Python Programming – Python Interpreter and Interactive Mode – Variables and

Suggested Activities:
- Developing Pseudocodes and flowcharts for real life activities such as railway ticket booking
  using IRCTC, admission process to undergraduate course, academic schedules during a
  semester etc.
- Developing algorithms for basic mathematical expressions using arithmetic operations.
- Installing Python.
- Simple programs on print statements, arithmetic operations.

Suggested Evaluation Methods:
- Assignments on pseudocodes and flowcharts.
- Tutorials on Python programs.

UNIT II CONDITIONALS AND FUNCTIONS  9
Operators – Boolean Values – Operator Precedence – Expression – Conditionals: If-Else Constructs
– Loop Structures/Iterative Statements – While Loop – For Loop – Break Statement – Function Call
and Returning Values – Parameter Passing – Local and Global Scope – Recursive Functions.

Suggested Activities:
- Simple Python program implementation using Operators, Conditionals, Iterative Constructs
  and Functions.
- Implementation of a simple calculator.
- Developing simple applications like calendar, phone directory, to-do lists etc.
- Flow charts for GCD, Exponent Functions, Fibonacci Series using conditionals and iterative
  statements.
- External learning - Recursion vs. Iteration.

Suggested Evaluation Methods:
- Tutorials on the above activities.
- Group Discussion on external learning.

UNIT III SIMPLE DATA STRUCTURES IN PYTHON 10
Introduction to Data Structures – List – Adding Items to a List – Finding and Updating an Item –
Slices – List Methods – List Loop – Mutability – Aliasing – Tuples: Creation, Accessing, Updating,
Deleting Elements in a Tuple, Tuple Assignment, Tuple as Return Value, Nested Tuples, Basic Tuple
Operations – Sets.

Suggested Activities:
- Implementing python program using lists, tuples, sets for the following scenario:
  Simple sorting techniques
  Student Examination Report
  Billing Scheme during shopping.
• External learning - List vs. Tuple vs. Set – Implementing any application using all the three data structures.

Suggested Evaluation Methods:
• Tutorials on the above activities.
• Group Discussion on external learning component.

UNIT IV  STRINGS, DICTIONARIES, MODULES  10

Suggested Activities:
• Implementing Python program by importing Time module, Math package etc.
• Creation of any package (student’s choice) and importing into the application.

Suggested Evaluation Methods:
• Tutorials on the above activities.

UNIT V  FILE HANDLING AND EXCEPTION HANDLING  7
Introduction to Files – File Path – Opening and Closing Files – Reading and Writing Files – File Position – Exception: Errors and Exceptions, Exception Handling, Multiple Exceptions.

Suggested Activities:
• Developing modules using Python to handle files and apply various operations on files.
• Usage of exceptions, multiple except blocks -for applications that use delimiters like age, range of numerals etc.
• Implementing Python program to open a non-existent file using exceptions.

Suggested Evaluation Methods:
• Tutorials on the above activities.
• Case Studies.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, students will be able to:
1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Write simple Python programs for solving problems.
4. Decompose a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries etc.
6. Read and write data from/to files in Python programs.

TEXT BOOK:

REFERENCES:
OBJECTIVES:

- To understand the basic concepts of electric circuits, magnetic circuits and wiring.
- To understand the operation of AC and DC machines.
- To understand the working principle of electronic devices and circuits.

UNIT I BASIC CIRCUITS AND DOMESTIC WIRING


UNIT II THREE PHASE CIRCUITS AND MAGNETIC CIRCUITS


UNIT III ELECTRICAL MACHINES


UNIT IV BASICS OF ELECTRONICS

Intrinsic semiconductors, Extrinsic semiconductors – P-type and N-type, P-N junction, VI Characteristics of PN junction diode, Zener effect, Zener diode, Zener diode Characteristics-Rectifier circuits-Wave shaping.

UNIT V CURRENT CONTROLLED AND VOLTAGE CONTROLLED DEVICES

Working principle and characteristics - BJT, SCR, JFET, MOSFET.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 To be able to understand the concepts related with electrical circuits and wiring.

CO2 To be able to study the different three phase connections and the concepts of magnetic circuits.

CO3 Capable of understanding the operating principle of AC and DC machines.

CO4 To be able to understand the working principle of electronic devices such as diode and zener diode.

CO 5 To be able to understand the characteristics and working of current controlled and voltage controlled devices.
TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.
2. Applying the concept of reaction forces (non-concurrent coplanar and noncoplanar forces) and moment of various support systems with rigid bodies in 2D and 3D in equilibrium. Reducing the force, moment, and couple to an equivalent force - couple system acting on rigid bodies in 2D and 3D.
3. Applying the concepts of locating centroids/center of gravity of various sections / volumes and to find out area moments of inertia for the sections and mass moment of inertia of solids.
4. Applying the concepts of frictional forces at the contact surfaces of various engineering systems.
5. Applying the various methods of evaluating kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

UNIT I  STATICS OF PARTICLES  (9+3)


UNIT II  EQUILIBRIUM OF RIGID BODIES  (9+3)


UNIT III  DISTRIBUTED FORCES  (9+3)

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration.

Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia, Radius of Gyration of an Area, Parallel-Axis Theorem, Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV  FRICITION  (9+3)


UNIT V  DYNAMICS OF PARTICLES  (9+3)

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

1. Apply the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.
2. Apply the concept of reaction forces (non-concurrent coplanar and noncoplanar forces) and moment of various support systems with rigid bodies in 2D and 3D in equilibrium. Reducing the force, moment, and couple to an equivalent force - couple system acting on rigid bodies in 2D and 3D.
3. Apply the concepts of locating centroids / center of gravity of various sections / volumes and to find out area moments of inertia for the sections and mass moment of inertia of solids.
4. Apply the concepts of frictional forces at the contact surfaces of various engineering systems.
5. Apply the various methods of evaluating kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

TEXT BOOKS:


REFERENCES:

CH5201 PRINCIPLES OF CHEMICAL ENGINEERING

OBJECTIVE:
The course is aimed to
- Introduce and provide an overview of Chemical Engineering

UNIT I
Chemistry, Chemical Engineering and Chemical Technology; Historical overview of Chemical Engineering; Chemical Engineering in everyday life; Greatest achievements of Chemical Engineering.

UNIT II

UNIT III
Concept of Unit Processes and Unit Operations; Description and representation of different Unit Processes and Unit Operations; Designing of equipments; Flow sheet representation of process plants, Evolution of an Industry – Sulphuric acid and Soda ash manufacture. Plant visit to a chemical industry.

UNIT IV
Role of Basic Sciences in Chemical Engineering; Role of Computers and their Applications; Role of Chemical Engineers in the area of Food, Medical, Energy, Environmental, Biochemical, Electronics etc.

UNIT V
Paradigm shifts in Chemical Engineering; Range of scales in Chemical Engineering; Opportunities for Chemical Engineers; Future of Chemical Engineering.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the history and development of chemical industry since origin.
CO2: Understand the basic transport process in chemical engineering.
CO3: Understand various unit operations and unit processes and to represent a chemical industry in terms of process flow diagram.
CO4: Understand the need of basic sciences and computers in chemical engineering.
CO5: Understand the role and functions of chemical engineers in the engineering industry and to know the basics of interdisciplinary engineering fields.
CO6: Know the future challenges in chemical engineering.
TEXT BOOKS:

REFERENCES:
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the history and development of chemical industry since origin.</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the basic transport process in chemical engineering.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand various unit operations and unit processes and to represent a chemical industry in terms of process flow diagram.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the need of basic sciences and computers in chemical engineering.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the role and functions of chemical engineers in the engineering industry and to know the basics of interdisciplinary engineering fields.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CO6</td>
<td>Know the future challenges in chemical engineering.</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES:
- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To articulate where computing strategies support in providing Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

EXPERIMENTS:
1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same.
2. Python programming using simple statements and expressions.
3. Scientific problems using Conditionals and Iterative loops.
4. Implementing real-time/technical applications using Lists, Tuples.
5. Implementing real-time/technical applications using Sets, Dictionaries.
6. Implementing programs using Functions.
7. Implementing programs using Strings.
9. Implementing real-time/technical applications using File handling.
10. Implementing real-time/technical applications using Exception handling.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

OUTCOMES:
On completion of the course, students will be able to:
- Develop algorithmic solutions to simple computational problems
- Develop and execute simple Python programs.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.
- Represent compound data using Python data structures.
- Apply Python features in developing software applications.
OBJECTIVES

1. To impart hands on experience in verification of circuit laws and measurement of circuit parameters
2. To train the students in performing various tests on electrical motors.
3. It also gives practical exposure to the usage of CRO, power sources & function generators

List of Experiments

1. Verification of Kirchhoff’s Law.
2. Steady state response of AC and DC circuits (Mesh, Node Analysis)
3. Frequency response of RLC circuits.
5. Regulation of single phase transformer.
6. Performance characteristics of DC shunt generator.
7. Performance characteristics of single phase induction motor.
8. Characteristics of PN diode and Zener diode
9. Characteristics of Zener diode
10. Half wave and full wave Rectifiers
11. Application of Zener diode as shunt regulator.
12. Characteristics of BJT and JFET

TOTAL: 60 PERIODS

OUTCOMES:

1. To become familiar with the basic circuit components and know how to connect them to make a real electrical circuit;
2. Ability to perform speed characteristic of different electrical machines
3. Ability to use logic gates and Flip flops
OBJECTIVES
To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
To understand the basic probability concepts with respect to two dimensional random variables along with the relationship between the random variables and the significance of the Central Limit theorem.
To apply the small/large sample tests through Tests of hypothesis.
To understand the concept of analysis of variance and use it to investigate factorial dependence.
To monitor a process and detect a situation when the process is out of control.

UNIT I  RANDOM VARIABLES  12
Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Weibull and Normal distributions – Functions of a random variable.

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  TESTS OF SIGNIFICANCE  12
Type I and Type II errors – Tests for single mean, proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances – Chi-square test for goodness of fit – Independence of attributes – Non-parametric tests: Test for Randomness and Rank – Sum test (Wilcoxon test).

UNIT IV  DESIGN OF EXPERIMENTS  12
Completely Randomized Design – Randomized Block Design – Latin Square Design – factorial design – Taguchi’s robust parameter design.

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

TOTAL: 60 PERIODS

OUTCOMES
- To analyze the performance in terms of probabilities and distributions achieved by the determined solutions
- To be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis
- To apply the basic principles underlying statistical inference (estimation and hypothesis testing)
- To demonstrate the knowledge of applicable large sample theory of estimators and tests
- To obtain a better understanding of the importance of the methods in modern industrial processes.
TEXT BOOKS:

REFERENCES:
The course is aimed to
- Impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines

UNIT I
Basic concepts and hints; Zeroth law; First Law of Thermodynamics - Statement and application; Steady flow energy equation-problems- Second law of Thermodynamics – Kelvin - Plank statement and Clausius statement- problems; Limitations; Heat Engine, Refrigerator and Heat Pump, Available energy, Equivalence entropy; Reversibility: Entropy charts; Third law of Thermodynamics - Statement.

UNIT II
Expressions for work done, Internal energy and heat transfer for Constant Pressure, Constant Volume, Isothermal, Adiabatic and Polytropic processes-Derivations and problems; Free expansion and Throttling process.

UNIT III
Carnot cycle; Stirling cycle; Joule cycle; Otto cycle; Diesel cycle; Dual Combustion Cycle - Derivations and problems.

UNIT IV
Engine nomenclature and classification; SI Engine; CI Engine; Four Stroke cycle, Two stroke cycle; Performance of I.C.Engine; Brake power, Indicated power, Brake thermal efficiency, Indicated Thermal Efficiency, Volumetric efficiency, Specific fuel consumption. Steam - Properties of steam; Dryness fraction; latent heat; Total heat of wet steam; Dry steam; Superheated steam. Use of steam tables; volume of wet steam, volume of superheated steam; External work of evaporation; Internal energy; Entropy of vapour, Expansion of vapour, Rankine cycle.

UNIT V
Definition of Kinematic Links, Pairs and Kinematic Chains; Working principle of Slider Crank mechanism and inversions; Double slider crank mechanism and inversions. Flywheel-Turning moment Diagram; Fluctuation of Energy. Belt and rope drives; Velocity ratio; Slip; Creep; Ratio of tensions; Length of belt; Power Transmitted; gear trains-types.

TOTAL: 30 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the basic concepts and Laws of thermodynamics and its applications
CO2: Understand the various processes with its derivation and gaining knowledge of various processes in Chemical Industries
CO3: Understand the various thermodynamic cycles with its derivation
CO4: Understand the Engine applications and flywheel in Industries
CO5: Understand the applications of various drives like belts, gear drives in Chemical Process Industries
CO6: Understand the properties of steam and its applications in Chemical Process Industries
TEXT BOOKS:

REFERENCES:
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the basic concepts and Laws of thermodynamics and its applications</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the various processes with its derivation and gaining knowledge of various processes in Chemical Industries</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the various thermodynamic cycles with its derivation</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the Engine applications and flywheel in Industries</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the applications of various drives like belts, gear drives in Chemical Process Industries</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand the properties of steam and its applications in Chemical Process Industries</td>
<td>3</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
The course is aimed to
- Learn various reaction mechanisms, preparation of organic compounds and their properties. This will be a precursor for the study on Chemical Reaction Engineering

UNIT I
Introduction – various definitions and classifications of carbohydrates – Configurations of aldoses and ketoses up to six carbon atoms- D and L configurations – Anomerism- Epimerism- Preparation, Chemical properties, different structures (Fisher, Haworth, Pyranose and Furanose) and Uses of Monosaccharides (Glucose & Fructose). Ascending in carbohydrate series – (Aldo pentose to aldo hexose by Kiliani- Fischer, Improved Kiliani Fischer, Wolfrom and Sowden methods) – Descending in carbohydrate series (Aldo hexose to aldo pentose by Ruff, Wohl and Mac Donald methods) - aldose to isomeric Ketose – Ketose to isomeric Aldose – Aldose to epimer

UNIT II
Different preparative methods, Physical & Chemical properties (Oxidation, reduction, Electrophilic and nucleophilic) and Uses of Pyrrole, Furan, Furfural, Tetrahydro Furan, Thiophene, Indole, Pyridine, Quinoline and Isoquinoline. Conversion of THF into Nylon 6-6

UNIT III
Preparations of Benzil from benzyl aldehydes - Furl from furfural, Vannilin from catechol through guaiacol, Gramine from indole, N-acetyl-5- bromoindoline from indole, Salol from phenol, Alanine from propionic acid, Heterauxin from indole - Uses, Preparation of Chloramphenicol (by Baltz and Long’s method)- Uses Reaction and mechanism of acylind condensation, Baeyer-Villigar reaction, Gabriel’s synthesis of phthalimide, Bartoli Indole synthesis

UNIT IV
Preparation and Synthetic utilities of Grignard reagent, Ethyl aceto acetate and Malonic ester for obtaining possible higher alkanes, alkenes, alkynes, acids, esters, aldehydes, ketones, alcohols, higher normal dicarboxylic acids, diketones and cyclic compounds etc.

UNIT V
Synthesis of Malonyl urea, Phenacetin, Isoniazid, Para amino benzoic acid (PABA), Tryptophan Isopentaquine, chloroquine (precursors from m-chloroaniline and Ethyl aceto acetate) - Sulphanilamide from aniline, chloro benzene, and p- toluene sulphonamide - Sulphapyridine from N- ASC and p-nitrochlorobenzene.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the preparation and classifications of carbohydrates
CO2: Understand the physical and chemical properties of heterocyclic compounds
CO3: Understand the various methods for preparing synthetic intermediates
CO4: Understand the various synthesis mechanisms
CO5: Understand the procedure for synthesizing alkanes, alkynes and various cyclic compounds
CO6: Understand the basic chemistry in pharmaceutical industry
TEXT BOOKS:

REFERENCES:
Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the preparation and classifications of carbohydrates</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the physical and chemical properties of heterocyclic compounds</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the various methods for preparing synthetic intermediates</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the various synthesis mechanisms</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the procedure for synthesizing alkanes, alkenes and various cyclic compounds</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand the basic chemistry in pharmaceutical industry</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Overall CO

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
**CH5302 PROCESS CALCULATIONS**

**OBJECTIVE:**
The course is aimed to
- Acquire knowledge in concept of solving basic calculations in chemical engineering and to systematically formulate and solve material and energy balance problems found in the refining and chemical industries

**UNIT I UNITS AND CONVERSIONS**  5
System and conversion of units, Dimensional consistency, Basic chemical calculations: Density, concentration, Pressure, Flow rates, Degrees of freedom.

**UNIT II MATERIAL BALANCE**  12
Material balances-Introduction, Single unit system- Material balance problems without reactions, Material balance with reactions and material balance for multi-unit systems

**UNIT III IDEAL AND REAL GASES**  12
Ideal gases, Real gases- Equation of state, Real gases- Compressibility charts, Real gas mixtures, Multi phase equilibrium- phase diagram and phase rule, Single component two phase systems, multi component vapor liquid equilibrium, Combustion processes.

**UNIT IV ENERGY BALANCE**  10
Energy balances-Introduction, Energy balances without reaction, steady and unsteady state condition, Energy balances with chemical reaction, Humidity chart and their applications.

**UNIT V MATERIAL AND ENERGY BALANCE**  6
Steady and unsteady state material and energy balances. Solving material and energy balances using process simulators.

**TOTAL: 45 PERIODS**

**OUTCOMES:**
On the completion of the course students are expected to
- CO1: Understand the concepts of dimensional consistency and effective application of units and dimensions.
- CO2: Analyze a problem statement and balance the material flowing through single and various operations.
- CO3: Understand the gas behavior and its properties and vapor-liquid pattern
- CO4: Understand general energy balance, simplify and apply to open and closed systems
- CO5: Write material and energy balance for unsteady state how material and energy balances are formulated for equation- and modular based flow sheeting codes
- CO6: Apply the knowledge to process flow sheeting in industries

**TEXT BOOKS:**
REFERENCES:
Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the concepts of dimensional consistency and effective application of units and dimensions.</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Analyze a problem statement and balance the material flowing through single and various operations.</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the gas behavior and its properties and vapor-liquid pattern</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand general energy balance, simplify and apply to open and closed systems</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>Write material and energy balance for unsteady state how material and energy balances are formulated for equation- and modular based flow sheeting codes</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Apply the knowledge to process flow sheeting in industries</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE:
The course is aimed to
- Acquire a sound knowledge on fluid properties, fluid statics, dynamic characteristics of fluid flow, flow measurement, pressure drop calculations in fluid flow systems, and performance characteristics of fluid machineries

UNIT I
Methods of analysis and description - fluid as a continuum – Velocity and stress field - Newtonian and non-Newtonian fluids – Classification of fluid motion.

UNIT II
Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid - application to manometer – Differential analysis of fluid motion – continuity, equation of motions, Bernoulli equation and Navier-Stokes equation.

UNIT III
The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi-theorem - non-dimensional action of the basic equations - similitude – relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies

UNIT IV
Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds.

UNIT V
Flow measurement - Constant and variable head meters; Velocity measurement techniques; Type and characteristics of valves; Classification, performance characteristics and sizing of pumps, compressors.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the fundamental properties of fluids, stress-strain relationship in fluids, and its characteristics under static conditions and establish force balance in static systems.

CO2: Apply Bernoulli principle, Navier-Stokes equation and compute pressure variation in static fluid.

CO3: Use of dimensional analysis to derive relationships among process or system variables. Further they would develop dimensionless groups that help in scale-up studies.

CO4: Understand the different types of flow conditions in fixed bed and fluidized beds.

CO5: Describe function of flow metering devices, apply Bernoulli equation to determine the performance of flow-metering devices and also analyze the performance aspects of fluid machinery such as pumps, compressors and valves.

CO6: Understand the impact of technology change and also develop responsibilities to the professional engineering practices.
TEXT BOOKS:

REFERENCES:
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CO1</strong></td>
<td></td>
</tr>
<tr>
<td>Understand the fundamental properties of fluids, stress-strain relationship in fluids, and its characteristics under static conditions and establish force balance in static systems.</td>
<td>3</td>
</tr>
<tr>
<td><strong>CO2</strong></td>
<td></td>
</tr>
<tr>
<td>Apply Bernouli principle, Navier - Stokes equation and compute pressure variation in static fluid.</td>
<td>-</td>
</tr>
<tr>
<td><strong>CO3</strong></td>
<td></td>
</tr>
<tr>
<td>Use of dimensional analysis to derive relationships among process or system variables. Further they would develop dimensionless groups that help in scale-up studies.</td>
<td>-</td>
</tr>
<tr>
<td><strong>CO4</strong></td>
<td></td>
</tr>
<tr>
<td>Understand the different types of flow conditions in fixed bed and fluidized beds.</td>
<td>3</td>
</tr>
<tr>
<td><strong>CO5</strong></td>
<td></td>
</tr>
<tr>
<td>Describe function of flow metering devices, apply Bernoulli equation to determine the performance of flow-metering devices and also analyze the performance aspects of fluid machinery such as pumps, compressors and valves.</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand the impact of technology change and also develop responsibilities to the professional engineering practices.</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

| Overall CO | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 2 | 3 | 3 | 3 |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES
The course is aimed to
- To learn basic principles involved in analysis and synthesis of different organic derivatives.
- To identify the functional groups
- To know the separation of organic mixtures
- To prepare simple organic compounds
- To study the preparation of dyes

LIST OF EXPERIMENTS
1. Identification and characterization of various functional groups by their characteristic reactions:
   a) alcohol, b) aldehyde, c) ketone, d) carboxylic acid, e) phenol f) primary, secondary and tertiary amines
2. Preparation of solid derivatives: a) 2,4 tri nitro phenyl hydrazone for aldehydes and ketones, b) acetyl and benzoyl derivatives for amine and phenol c) diazotization of aromatic amine
3. Preparation of Methyl red and Fluorescein
4. Separation of organic mixtures: a) aldehyde and acid, b) amine and phenol
5. Recrystallization of benzoic acid and acetanilide
7. Detection of peroxide in ether and its removal

COURSE OUTCOMES:
On completion of the course students are expected to
CO1: Conduct simple experiments to identify the functional group
CO2: Prepare derivatives for aldehydes, ketones, sugars, amine and phenol
CO3: Analyzing various procedure to separate organic mixtures
CO4:Steps to carry out recrystallization
CO5:Preparation of synthetic organic compounds like
   a) Naphthalene – Nitro naphthalene – 4 nitro – 1 – amino naphthalene
   b) Benzene – Benzil – benzylc acid.

REFERENCE:
2. Practical chemistry, V K Ahluwalia, University press. 2011
4. Practical Organic Chemistry by Dey and Raman
# Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
<th>PSO4</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Conduct simple experiments to identify the functional group.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<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></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Prepare derivatives for aldehydes, ketones, sugars, amine and phenol</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>1</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>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Analyzing various procedure to separate organic mixtures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</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>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Steps to carry out recrystallization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<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></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>Preparation of synthetic organic compounds like a) Naphthalene – Nitro naphthalene – 4 nitro – 1 – amino naphthalene b) Benzene – Benzil – benzylic acid.</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</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>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE:
The course is aimed to
- Impart practical knowledge in operating IC engines and conduct experiments. To understand test procedures in testing material for engineering applications

LIST OF EXPERIMENTS*
1. Port timing diagram
2. Valve timing diagram
3. Study of 2,4 stroke I C Engines
4. Load test on 4-stroke petrol engine
5. Performance test on 4-stroke single cylinder diesel engine
6. Performance test on 4-stroke twin cylinder diesel engine
7. Heat balance test on diesel engines
8. Tension test
9. Compression test
10. Deflection test
11. Hardness test (Rockwell and Brinell)
12. Spring test
13. Torsion test
14. Impact test

EQUIPMENTS REQUIRED
1. Single cylinder diesel engine coupled with Electrical loading
2. Single cylinder diesel engine coupled with Electrical loading with temperature indicators
3. Single cylinder slow speed diesel engine coupled with Mechanical loading
4. Twin cylinder diesel engine coupled with Electrical loading with Heat balance test setup
5. Single cylinder petrol engine coupled with Electrical loading
6. Two stroke IC Engine model
7. Four stroke IC Engine model
8. Small IC Engine models for study
9. UTM and Hardness test apparatus

*Minimum 10 experiments shall be offered

TOTAL: 30 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Determine Brake power, Indicated power and frictional power of single cylinder diesel engines.
CO2: Determine Brake power, Indicated power and frictional power of twin cylinder diesel engines.
CO3: Determine Brake power, Indicated power and frictional power of single cylinder petrol engines.
CO4: Evaluate the heat distribution from engine and preparing heat balance chart.
CO5: Estimate the engine performance with mechanical loading
CO6: Estimate the PTD and VTD of two and four stroke engines
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO 12</th>
<th>PSO</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Determine Brake power, Indicated power and frictional power of single cylinder diesel engines.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>Determine Brake power, Indicated power and frictional power of twin cylinder diesel engines.</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Determine Brake power, Indicated power and frictional power of single cylinder petrol engines.</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Evaluate the heat distribution from engine and preparing heat balance chart.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Estimate the engine performance with mechanical loading</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Estimate the PTD and VTD of two and four stroke engines</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
SEMESTER IV

GE5251  ENVIRONMENTAL SCIENCES  L T P C  3 0 0 3

OBJECTIVES:

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and non-renewable resources, causes of their degradation and measures to preserve them.
- To familiarize the influence of societal use of resources on the environment and introduce the legal provisions, National and International laws and conventions for environmental protection.
- To inculcate the effect of population dynamics on human and environmental health and inform about human right, value education and role of technology in monitoring human and environmental issues.

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 – bio geographical 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  8
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 – soil 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  10
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 47 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  7
UNIT V  HUMAN POPULATION AND THE ENVIRONMENT


TOTAL: 45 PERIODS

OUTCOMES:

CO1: To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.

CO2: To identify the causes, effects and environmental pollution and natural disasters and contribute to the preventive measures in the immediate society.

CO3: To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.

CO4: To recognize different forms of energy and apply them for suitable applications in for technological advancement and societal development.

CO5: To demonstrate the knowledge of societal activity on the long and short term environmental issues and abide by the legal provisions, National and International laws and conventions in professional and personal activities and to identify and analyse effect of population dynamics on human value education, consumerism and role of technology in environmental issues.

TEXT BOOKS:


REFERENCE BOOKS:

## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO 2</th>
<th>PO 3</th>
<th>PO 4</th>
<th>PO 5</th>
<th>PO 6</th>
<th>PO 7</th>
<th>PO 8</th>
<th>PO 9</th>
<th>PO 10</th>
<th>PO 11</th>
<th>PO 12</th>
<th>PSO 1</th>
<th>PSO 2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>To identify the causes, effects and environmental pollution and natural disasters and contribute to the preventive measures in the immediate society.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>To recognize different forms of energy and apply them for suitable applications in for technological advancement and societal development.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>To demonstrate the knowledge of societal activity on the long and short term environmental issues and abide by the legal provisions, National and International laws and conventions in professional and personal activities and to identify and analyse effect of population dynamics on human value education, consumerism and role of technology in environmental issues.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<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></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<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>-</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
The course is aimed to

- Teach the fundamental concepts of heat transfer viz., conduction, convection, radiation, boiling and condensation and its application to the students

UNIT I

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer; One dimensional steady state heat conduction through plane and composite walls, hollow cylinder and spheres - Thermal conductivity measurement-effect of temperature on thermal conductivity; Heat transfer in extended surfaces; Transient heat conduction

UNIT II

Concepts of heat transfer by convection - Natural and forced convection, Hydrodynamic and thermal Boundary layers; analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Coulburn analogy. Dimensional analysis in heat transfer, heat transfer coefficient for flow through a pipe, flow past flat plate, and flow through packed beds and fluidized beds

UNIT III

Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling

UNIT IV

Evaporation- single and multiple effect operation, material and Energy balance in evaporators, boiling point elevation, Duhring's rule. Radiation heat transfer - Black body radiation, Emissivity, Stefan - Boltzman law, Plank's law, radiation between surfaces.

UNIT V

Heat Exchangers – classification and design, overall and individual film coefficients, mean temperature difference, LMTD correction factor for multiple pass exchanger, NTU and efficiency of Heat exchangers

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to

CO1: To familiarize the students with the fundamental concepts of Heat Transfer. provide the student with knowledge about heat transfer by conduction in solids for steady state

CO2: Students will understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows

CO3: The course gives the student insight about boundary layer flow, laminar and turbulent flows

CO4: Students will be able to calculate and use overall heat transfer coefficients in designing heat exchangers

CO5: The course provides the student with knowledge about heat transfer with phase change (boiling and condensation) and evaporation

CO6: Students will understand radiative heat transfer including blackbody radiation and Kirchoff's law, and will be able to solve radiative problems apply knowledge of heat transfer to solve thermal engineering problems
TEXT BOOKS:

REFERENCES:
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes Statements</th>
<th>PO 1</th>
<th>PO 2</th>
<th>PO 3</th>
<th>PO 4</th>
<th>PO 5</th>
<th>PO 6</th>
<th>PO 7</th>
<th>PO 8</th>
<th>PO 9</th>
<th>PO 10</th>
<th>PO 11</th>
<th>PO 12</th>
<th>PSO 1</th>
<th>PSO 2</th>
<th>PSO 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>To familiarize the students with the fundamental concepts of Heat Transfer, provide the student with knowledge about heat transfer by conduction in solids for steady state.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Students will understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows.</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>The course gives the student insight about boundary layer flow, laminar and turbulent flows.</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Students will be able to calculate and use overall heat transfer coefficients in designing heat exchangers.</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>The course provides the student with knowledge about heat transfer with phase change (boiling and condensation) and evaporation.</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>Students will understand radiative heat transfer including blackbody radiation and Kirchhoff’s law, and will be able to solve radiative problems, apply knowledge of heat transfer to solve thermal engineering problems.</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
The course is aimed to
- Learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

UNIT I
Terminologies of thermodynamics, the variables and quantities of thermodynamics, characteristics of systems and processes, energy classifications, point and path functions, energy in transition work and heat. zeroth law; temperature scales

UNIT II
The first law of thermodynamics, statements of first law for the flow and non-flow processes. PVT behaviour of fluids; Mathematical representation of PVT behaviour; Generalized compressibility factor correlation; Generalized equations of state

UNIT III
Joule’s experiment, energy balance for closed systems, mass and energy balance for open systems, Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, second law of thermodynamics for a control volume, Third law of thermodynamics, entropy from a microscopic point of view.

UNIT IV
Thermodynamic potentials – internal energy, enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations – partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams.

UNIT V
Thermodynamic aspects of compression, expansion processes and duct flow of compressible fluids, steam power plant, internal combustion engines, jet and rocket engines.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the fundamental concepts of thermodynamics and its related functions
CO2: Relate PVT behaviour of fluids and understand the real gas behavior
CO3: Apply second law and analyse the feasibility of system/devices
CO4: Analyse the thermodynamic property relations and their application to fluid flow
CO5: Develop the significance of thermodynamic potentials and their use in the analysis of processes
CO6: Formulate thermodynamic formulations and the working of compressors and expanders

TEXT BOOKS:

REFERENCES:
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the fundamental concepts of thermodynamics and its related functions</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>Relate PVT behaviour of fluids and understand the real gas behavior</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>Apply second law and analyse the feasibility of system/devices</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyse the thermodynamic property relations and their application to fluid flow</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Develop the significance of thermodynamic potentials and their use in the analysis of processes</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>Formulate thermodynamic formulations and the working of compressors and expanders</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
The course is aimed to

- Make students learn about characterization of solids, size reduction, techniques of solid – fluid separation and mixing

UNIT I
General characteristics of solids, different techniques of size analysis, shape factor, surface area determination, estimation of particle size. Screening methods and equipment, screen efficiency, ideal and actual screens.

UNIT II
Laws of size reduction, energy relationships in size reduction, methods of size reduction, classification of equipments, crushers, grinders, disintegrators for coarse, intermediate and fine grinding, power requirement, work index; size enlargement - principle of granulation, briquetting, pelletisation, and flocculation.

UNIT III
Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jiggling

UNIT IV
Theory of filtration, Batch and continuous filters. Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipments - selection, operation and design of filters and optimum cycle of operation, filter aids.

UNIT V
Mixing and agitation - Mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers, power requirement for mixing. Storage and Conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, conveyer selection, different types of conveyers and their performance characteristics.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to

- CO1: Understand and determine various properties of particulates
- CO2: Gain Preliminary understanding on Size Reduction and Size Enlargement
- CO3: Understand various separation and purification techniques employed in solid particles
- CO4: Enhance their knowledge on Filtration Process
- CO5: Understand Handling, Storage and Transportation of Solids
- CO6: Obtain knowledge on various unit operations and their applications

TEXT BOOKS:

REFERENCES:
Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand and determine various properties of particulates</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Gain Preliminary understanding on Size Reduction and Size Enlargement</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand various separation and purification techniques employed in solid particles</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Enhance their knowledge on Filtration Process</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand Handling, Storage and Transportation of Solids</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Obtain knowledge on various unit operations and their applications</td>
<td>3</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES:
The course is aimed to
- Impart knowledge about unit process and unit operations in various industries
- Develop understanding of manufacturing process flow drawing for the manufacturing chemical processes, its applications and major engineering problems encountered in the process

UNIT I
Introduction to chemical processing; symbolic representation of different unit operations and unit processes to build a flow sheet; Production of pulp and paper, Manufacture of sugar, starch and starch derivatives.

UNIT II
Alkalies and Acids: Chlor - alkali Industries: Manufacture of Soda ash, Manufacture of caustic soda and chlorine - common salt. Sulphur and Sulphuric acid: Mining of sulphur and manufacture of sulphuric acid, Manufacture of hydrochloric acid.

UNIT III
Cement -Types and Manufacture of Portland cement, , Refining of edible oils and fats, fatty acids, Manufacture of Soaps and detergents; Manufacture of paints and Varnishes – Pigments

UNIT IV
Natural and synthetic fibres- Manufacture of nylon 6, 6 and nylon 6 fibres, viscose rayon and polyester fibres; Nature, types, composition and uses of glass -its manufacture, melting, shaping, annealing and finishing operations; Basic principles of polymerization reactions: stepwise and chain polymerization, general polymerization systems: bulk, solution, suspension and emulsion polymerisation.

UNIT V
Fertilizers: Nitrogen Fertilizers; Synthetic ammonia, nitric acid, Urea, Phosphorous Fertilizers: Phosphate rock, phosphoric acid, super phosphate and Triple Super phosphate

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the various unit operations and processes with their symbols.
CO2: Understand the various chemical reactions involved in the process
CO3: Understand the manufacturing process involved
CO4: Know to draw the process Flow sheet and understand the major engineering problems encountered in the processes
CO5: Learn manufacturing processes of organic and Inorganic Chemicals and its applications.
CO6: Understand the role of chemical Engineering in the production

TEXT BOOKS:
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the various unit operations and processes with their symbols.</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the various chemical reactions involved in the process</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the manufacturing process involved</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Students will know to draw the process Flow sheet and understand the major engineering problems encountered in the processes</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>To learn manufacturing processes of organic and Inorganic Chemicals and its applications.</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Students will understand the role of chemical Engineering in the production</td>
<td>2</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
The course is aimed to
- Learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

LIST OF EXPERIMENTS*
1. Viscosity measurement of non-Newtonian fluids
2. Calibration of constant and variable head meters
3. Calibration of weirs and notches
4. Open drum orifice and draining time
5. Flow through straight pipe
6. Flow through annular pipe
7. Flow through helical coil and spiral coil
8. Losses in pipe fittings and valves
9. Characteristic curves of pumps
10. Pressure drop studies in packed column
11. Hydrodynamics of fluidized bed
12. Drag coefficient of solid particle
13. Friction in straight pipes

EQUIPMENTS REQUIRED
1. Viscometer
2. Venturi meter
3. Orifice meter
4. Rotameter
5. Weir
6. Open drum with orifice
7. Pipes and fittings
8. Helical and spiral coils
9. Centrifugal pump
10. Packed column
11. Fluidized bed
*Minimum 10 experiments shall be offered

OUTCOMES:
On the completion of the course students are expected to
CO1: Identify and characterize of flow patterns and regimes
CO2: Calibrate flow measurement devices
CO3: Correlate the difference between fixed and fluidized bed columns and its application.
CO4: Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties
CO5: Compare the results of theoretical analytical models to the actual behavior of real fluid flows and draw sustainable conclusions
CO6: Work effectively as a team with commitment to the professional ethics among the peer group involved.
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Identify and characterize of flow patterns and regimes</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Calibrate flow measurement devices</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Correlate the difference between fixed and fluidized bed columns and its application.</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>Compare the results of theoretical analytical models to the actual behavior of real fluid flows and draw sustainable conclusions</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Work effectively as a team with commitment to the professional ethics among the peer group involved.</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
The course is aimed to

- Develop sound practical knowledge for students on different types of mechanical operations equipments.

**LIST OF EXPERIMENTS**

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher
6. Reduction ratio in Ball mill
7. Separation characteristics of Cyclone separator
8. Reduction ratio of Roll Crusher
9. Separation characteristics of Elutriator
10. Reduction ratio of Drop weight crusher
11. Size separation using Sub-Sieving

**EQUIPMENTS REQUIRED**

1. Sieve shaker
2. Leaf filter
3. Plate and Frame Filter Press
4. Sedimentation Jar
5. Jaw Crusher
6. Ball Mill
7. Cyclone Separator
8. Roll Crusher
9. Elutriator
10. Drop Weight Crusher
11. Sieves.

*Minimum 10 experiments shall be offered

**OUTCOMES:**

On the completion of the course students are expected to

**CO1:** Determine the size analysis in solid-solid separation systems

**CO2:** Capability to select different solid-fluid separation equipments.

**CO3:** Evaluate the size reduction and various crushing parameters

**CO4:** Estimate the separation characteristics

**CO5:** Understand the technical methods related to unit operations in process plant

**CO6:** Apply and understand fluid particle systems and equipment
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcome(s)</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO1</th>
<th>PO1</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Determine the size analysis in solid- solid separation systems</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>Capability to select different solid - fluid separation equipments.</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Evaluate the size reduction and various crushing parameters</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>Estimate the separation characteristics</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the technical methods related to unit operations in process plant</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Apply and understand fluid particle systems and equipment</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
SEMESTER V

MG5451  PRINCIPLES OF MANAGEMENT  L  T  P  C  3 0  0  3

OBJECTIVES:
- Sketch the Evolution of Management.
- Extract the functions and principles of management.
- Learn the application of the principles in an organization.
- Study the various HR related activities.
- Analyze the position of self and company goals towards business.

UNIT I  INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS  9

UNIT II  PLANNING  9

UNIT III  ORGANISING  9

UNIT IV  DIRECTING  9

UNIT IV  CONTROLLING  9
System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

TOTAL: 45 PERIODS

OUTCOMES:
CO1: Upon completion of the course, students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.
CO2: Have same basic knowledge on international aspect of management.
CO3: Ability to understand management concept of organizing.
CO4: Ability to understand management concept of directing.
CO5: Ability to understand management concept of controlling.

<table>
<thead>
<tr>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td></td>
<td></td>
<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>✓</td>
<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>✓</td>
<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></td>
<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></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOKS:

REFERENCES:
The course is aimed to
- Understand the phase Behavior of fluids under different PVT conditions and apply them for practical purposes. The course will render a comprehensive understanding of theory and application of solution thermodynamics.

UNIT I SOLUTION THERMODYNAMICS 6
Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, excess properties of mixtures, pure species and liquids.

UNIT II PHASE EQUILIBRIA 12
Phase equilibrium in ideal solution, excess Gibbs free energy models, Henry’s law, fugacity, Phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid-liquid equilibrium.

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 12
Vapor-Liquid Equilibrium at low, moderate and high pressures; bubble and dew point calculation, thermodynamic consistency test of VLE data

UNIT IV CHEMICAL REACTION EQUILIBRIA 9
Chemical Reaction Equilibrium of single and multiple reactions, Standard Gibbs free change, equilibrium constant-effect of temperature; homogeneous gas and liquid phase reactions.

UNIT V REFRIGERATION 6

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the systematic development of new class of properties to describe real mixtures
CO2: Develop the idea of chemical potential to derive the idea of phase equilibria
CO3: Understand the relationship connecting T, P and composition originating from the concept of chemical potential and fugacity coefficient
CO4: Understand the principle of chemical reaction thermodynamics for the prediction of equilibrium conversion.
CO5: Understand the concept of equilibrium between combination of two co-existing phases other than liquid and vapor
CO6: Derive the relationship that connects the composition of two co-existing phases as function of temperature and pressure.
CO7: Analyze the ideal and actual vapor-compression refrigeration cycle and Evaluate the performance of innovative vapor compression refrigeration systems

TEXT BOOKS:

REFERENCES
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the systematic development of new class of properties to describe real mixtures</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Develop the idea of chemical potential to derive the idea of phase equilibria</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the relationship connecting T, P and composition originating from the concept of chemical potential and fugacity coefficient</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the principle of chemical reaction thermodynamics for the prediction of equilibrium conversion.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the concept of equilibrium between combination of two co existing phases other than liquid and vapor</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO6</td>
<td>Derive the relationship that connect the composition of two co existing phases as function of temperature and pressure.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO7</td>
<td>Analyze the ideal and actual vapor-compression refrigeration cycle and Evaluate the performance of innovative vapor compression refrigeration systems</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
The course is aimed to
- Learn and determine mass transfer rates under laminar and turbulent conditions and apply these concepts in the design of humidification columns, dryers and crystallisers.

UNIT I  MOLECULAR DIFFUSION  9
Introduction to mass transfer operations. Molecular diffusion in gases, liquids and solids. Diffusivity measurement and prediction; multi-component diffusion.

UNIT II  CONVECTIVE TRANSFER AND INTERPHASE MASS TRANSFER  9
Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients. NTU and NTP concepts, Stage-wise and differential contractors.

UNIT III  HUMIDIFICATION OPERATIONS  9
Humidification – Equilibrium, humidity chart, adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers, dehumidifiers and humidifiers using enthalpy transfer unit concept.

UNIT IV  DRYING  9
Drying – Equilibrium. Classification of dryers, batch drying – Mechanism and time of cross through circulation drying, theoretical estimation of drying rate and time. Continuous dryers – material and energy balance. Advance drying techniques such as freeze drying, microwave drying

UNIT V  CRYSTALLIZATION  9
Crystal geometry. Equilibrium, yield and purity of products, theory of super saturation, nucleation and crystal growth, classification of crystallizers, design of batch crystallizers and continuous crystallizers.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the fundamentals, types and mechanism of mass transfer operations
CO2: Understand the theories of mass transfer and the concept of inter-phase mass transfer
CO3: Understand the basics of humidification process and its application
CO4: Understand the concept and mechanism of drying operations
CO5: Understand the concept of crystallization process and identification of suitable crystallizer
CO6: Formulate and solve material balances for unit operations such as humidification, drying and crystallization operations.

TEXT BOOKS:

REFERENCES:
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the fundamentals, types and mechanism of mass transfer operations</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the theories of mass transfer and the concept of inter-phase mass transfer</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the basics of humidification process and its application</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the concept and mechanism of drying operations</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the concept of crystallization process and identification of suitable crystallizer</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>Formulate and solve material balances for unit operations such as humidification, drying and crystallization operations.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CH5503 CHEMICAL REACTION ENGINEERING I

OBJECTIVE:

The course is aimed to
- Learn reaction kinetics, types of reactors, design of reactors, understand the isothermal, non-
  isothermal operation of reactors and gain knowledge about non ideal reactors.

UNIT I

Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction;
Design equation for constant and variable volume batch reactors, analysis of experimental kinetics
data, integral and differential analysis. Half-life calculation.

UNIT II

Ideal reactor classification. Design of continuous reactors - stirred tank and tubular flow reactor,
recycle reactors, combination of reactors, and size comparison of reactors.

UNIT III

Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting
choice, optimum yield and conversion, selectivity, reactivity and yield.

UNIT IV

Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for
different reactors, design for constant rate input and constant heat transfer coefficient, operation of
batch and continuous reactors, optimum temperature progression.

UNIT V

The residence time distribution for chemical reactors, residence time functions and relationship
between them in reactor; Models for non-ideal reactors, conversion in non-ideal reactors.

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to
CO1: Understand the kinetics of homogenous reaction.
CO2: Develop performance equation and determine the conversion for different reactors.
CO3: Understand the reactor arrangement in series and parallel configuration.
CO4: Understand the design of reactor for multiple reactions.
CO5: Understand the non-isothermal operation of the reactor
CO6: Understand the residence time distribution function and analyze the non-ideality in the
  reactor.

TEXT BOOKS:

   1999
   University Press, 2005

REFERENCES:

1. L.K Doraishwamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC
   Press , 2014
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the kinetics of homogenous reaction.</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Develop performance equation and determine the conversion for different reactors.</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the reactor arrangement in series and parallel configuration.</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the design of reactor for multiple reactions.</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the non-isotherm operation of the reactor</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand the residence time distribution function and analyze the non-ideality in the reactor.</td>
<td>3</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
CH5511 HEAT TRANSFER LABORATORY

OBJECTIVE:
The course is aimed to
- Develop sound practical knowledge for students on different types of heat transfer equipments

LIST OF EXPERIMENTS*
1. Measurement of Thermal Conductivity of metal rod
2. Performance studies on Cooling Tower
3. Batch drying kinetics using Tray Dryer
4. Heat transfer in Open Pan Evaporator
5. Boiling Heat Transfer
6. Heat Transfer through Packed Bed
7. Heat Transfer in a Double Pipe Heat Exchanger
8. Heat Transfer in a Bare and Finned Tube Heat Exchanger
9. Heat Transfer in a Vertical and Horizontal Condenser
10. Heat Transfer in Helical Coils
11. Heat Transfer in Agitated Vessels
12. Heat transfer studies in Stefan - Boltzmann apparatus

EQUIPMENTS REQUIRED
1. Thermal Conductivity Apparatus
2. Cooling Tower
3. Tray Dryer
4. Open Pan Evaporator
5. Packed Bed
6. Double Pipe Heat Exchanger
7. Bare and Finned Tube Heat Exchanger
8. Vertical and Horizontal Condenser
9. Agitated Vessels and Helical Coils
10. Stefan - Boltzmann apparatus
*Minimum 10 experiments shall be offered.

TOTAL: 60 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Apply the concepts of heat transfer and fluid dynamics to the operation of heat transfer equipments.
CO2: Estimate the heat transfer rate and heat transfer co-efficient
CO3: To perform heat transfer operation and to compare observed with predicted performance.
CO4: Evaluate the performance/calculate the parameters in heat transfer equipments.
CO5: Collect and analyse the heat transfer data practically.
CO6: Conduct experiments to solve complex engineering problems effectively as an individual as well as team work
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Apply the concepts of heat transfer and fluid dynamics to the operation of heat transfer equipments.</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Estimate the heat transfer rate and heat transfer co-efficient</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>To perform heat transfer operation and to compare observed with predicted performance.</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Evaluate the performance/calculate the parameters in heat transfer equipments.</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Collect and analyse the heat transfer data practically.</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Conduct experiments to solve complex engineering problems effectively as an individual as well as team work</td>
<td>3</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
The course is aimed to
  - Solve chemical engineering problems from core courses using Excel, Matlab, Polymath and process simulation using Aspen Plus.

MICROSOFT EXCEL SOFTWARE
Excel used to solve chemical engineering problems. Use goal seek, regression, solver to solve the problem. Solve differential equation using Runge-Kutta method, matrix methods.

POLYMATH

MATLAB
Solving chemical engineering Problem using Matlab. Simultaneous equation, Differential equation and Partial differential Equation. Simulink tool for chemical process and process control.

ASPN SOFTWARE
Simulation of simple unit operations equipments Distillation, extraction and absorption. Reactors simulation. Simulation of simple process flow sheets.

Evaluation
This Lab course will have two or three online assessment tests and an online end semester examination in Process simulation laboratory and assignments in all the above four units.

TOTAL: 60 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Solving chemical engineering problems using different tools available in the excel software.
CO2: Solving simultaneous equation and differential equation using polymath
CO3: Solving simultaneous equation and differential equation using Matlab
CO4: Simulation of simple chemical process with controller using simulink tool
CO5: Estimation of fluid property and understand the unit operation simulation using Aspen Plus
CO6: Dynamic simulation of chemical process using aspen plus

TEXT BOOKS

REFERENCES
1. Pradeep Ahuja Introduction to Numerical Methods in Chemical Engineering PHI New delhi, 2010
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Solving chemical engineering problems using different tools available in the excel software.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>Solving simultaneous equation and differential equation using polymath</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>Solving simultaneous equation and differential equation using Matlab</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>Simulation of simple chemical process with controller using Simulink tool</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>Estimation of fluid property and understand the unit operation simulation using Aspen Plus</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>Dynamic simulation of chemical process using Aspen plus</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE:
The course is aimed to
- Learn gas solid non catalytic, gas solid catalytic and fluid- fluid reaction and apply the knowledge for the reactor design.

UNIT I
Gas solid non catalytic reaction. Reaction kinetics, Shrinking Core Model and Progressive conversion model, Controlling resistances (diffusion through gas film, ash layer and chemical reaction controlling), rate controlling steps; time for Complete Conversion for Single and Mixed Sizes, design of fluid –particle reactors.

UNIT II

UNIT III
Gas solid catalytic reaction: steps in catalytic reaction, Single site, dual site mechanisms, Langmuir Hinshelwood, EleyRideal, Rate controlling steps. Experimental methods for determining rate, differential, integral reactor and reactor design.

UNIT IV
Diffusion Within Catalyst Particle, Mass and Heat Transfer Within Catalyst Pellets, Effectiveness Factor, Thiele Modulus, Effectiveness factor for non isothermal condition.

UNIT V
Fluid Fluid reaction. Kinetics and design of Fluid- Fluid Reactions. Rate equation, Kinetic regimes for absorption combined with chemical reaction. Various cases of mass transfer with chemical reaction, Factors to select the contactor, Tower Reactor Design.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the gas solid non catalytic reaction and different models for non catalytic reaction.
CO2: Understand catalyst, catalyst preparation, property estimation and isotherm study.
CO3: Understand the gas solid catalytic reaction and their mechanism
CO4: Design of catalytic reactor for gas solid reaction.
CO5: Understand the concepts of effectiveness factor, Thiele modulus.
CO6: Understand the concept of Mass Transfer and Mass transfer with reaction for fluid fluid reaction and tower design.

TEXT BOOKS:

REFERENCES:
2. L.K Doraiswamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC Press, 2014
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the gas solid non catalytic reaction and different models for non catalytic reaction.</td>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand catalyst, catalyst preparation, property estimation and isotherm study.</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the gas solid catalytic reaction and their mechanism.</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Design of catalytic reactor for gas solid reaction.</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the concepts of effectiveness factor, Thiele modulus.</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand the concept of Mass Transfer and Mass transfer with reaction for fluid fluid reaction and tower design.</td>
<td>3</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
The course is aimed to
- Impart knowledge on how certain substances undergo the change in composition, change in phases and exhibit their properties according to the changed environment. Also, to design absorber and stripper, distillation column, extraction and leaching equipment and adsorber.

UNIT I  ABSORPTION
Equilibrium and operating line concept in absorption calculations; types of contactors, design of packed and plate type absorbers; Operating characteristics of stage wise and differential contactors, concepts of NTU, HTU and overall volumetric mass transfer coefficients; multicomponent absorption; mechanism and model of absorption with chemical reaction; thermal effects in absorption process.

UNIT II  DISTILLATION
Vapour liquid equilibria - Raoul't law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by McCabe - Thiele method and Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and extractive distillation.

UNIT III  LIQUID-LIQUID EXTRACTION
Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction.

UNIT IV  LEACHING
Solid-liquid equilibria- leaching equipment for batch and continuous operations, calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank’s system), equipments for leaching operation, multi stage continuous cross current and countercurrent leaching, stage calculations, stage efficiency.

UNIT V  ADSORPTION, ION EXCHANGE AND MEMBRANE SEPARATION PROCESSES
Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

OUTCOMES:
On the completion of the course students are expected to
CO1:  Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process
CO2:  Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower.
CO3:  Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction process.
CO4:  Describe core principles of leaching, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation.
CO5:  Understand the concept of adsorption techniques, various isotherms and ion exchange process.

TOTAL: 45 PERIODS
CO6: Formulate and solve mass and energy balances for unit operations such as absorption, distillation, extraction, leaching, adsorption and other separation processes.

**TEXT BOOKS:**

**REFERENCES:**
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process</td>
<td>PO1  2  2  1  1  1  1  1  3  3  2  2</td>
</tr>
<tr>
<td>CO2</td>
<td>Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower.</td>
<td>PO1  3  3  1  1  1  1  1  3  3  2  2</td>
</tr>
<tr>
<td>CO3</td>
<td>Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction process.</td>
<td>PO1  3  3  3  1  1  1  1  3  3  2  2</td>
</tr>
<tr>
<td>CO4</td>
<td>Describe core principles of leaching, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation.</td>
<td>PO1  3  3  3  1  1  1  1  3  3  2  2</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the concept of adsorption techniques, various isotherms and ion exchange process.</td>
<td>PO1  3  2  2  1  1  1  1  3  3  2  2</td>
</tr>
<tr>
<td>CO6</td>
<td>Formulate and solve mass and energy balances for unit operations such as absorption, distillation, extraction, leaching, adsorption and other separation processes.</td>
<td>PO1  3  3  1  1  1  1  1  3  3  2  2</td>
</tr>
</tbody>
</table>

**Overall CO**

| PO1 2 3 1 1 1 1 1 3 3 2 2 |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
CH5603  PROCESS DYNAMICS AND CONTROL

OBJECTIVE:

The course is aimed to

- Determine possible control objectives, input variables (manipulated variables and disturbances), model the dynamic behavior of a process, design PID controllers, frequency response and analyze stability of closed loop and open loop systems.

UNIT I


UNIT II

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, FOPDT Model, Skogestad’s rule for FOPDT and SOPDT, Lead-Lag systems

UNIT III

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, control valves, transient response of closed-loop control systems and their stability, Root locus diagram.

UNIT IV

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings, Nyquist Stability Criterion

UNIT V

Introduction to advanced control systems, cascade control, feed forward control, Controllers for Inverse response Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the need to develop mathematical description of a chemical process as a prerequisite to process design and to control the process.

CO2: Develop transient models for chemical processes using material and/or energy balance equations by incorporating constitutive relationships and seek their solution using Laplace Transforms.

CO3: Represent a physical system using FOPDT model and estimate parameters in FOPDT model.

CO4: Convert a process and instrumentation diagram to a control block diagram

CO5: Understand Frequency response of control systems and tune the PID controllers

CO6: Appreciate the performance augmentation of PID controllers by using advanced control strategies such as Cascade, Feed forward, Dead time compensation.

TEXT BOOKS:

REFERENCES:
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the need to develop mathematical description of a chemical process as a prerequisite to process design and to control the process.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Develop transient models for chemical processes using material and/or energy balance equations by incorporating constitutive relationships and seek their solution using Laplace Transforms.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>Represent a physical system using FOPDT model and estimate parameters in FOPDT model.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Convert a process and instrumentation diagram to a control block diagram.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>Understand Frequency response of control systems and tune the PID controllers.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CO6</td>
<td>Appreciate the performance augmentation of PID controllers by using advanced control strategies such as Cascade, Feed forward, Dead time compensation.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
The course is aimed to
  • Gain the hands-on training about the control systems

LIST OF EXPERIMENTS*
1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level System
4. Response of Interacting level System
5. Open loop study on a level system
6. Open loop study on a flow system
7. Open loop study on a thermal system
8. Closed loop study on a level system
9. Closed loop study on a flow system
10. Closed loop study on a thermal system
11. Tuning of a level system
12. Tuning of a flow system
13. Tuning of a thermal system
14. Flow co-efficient of control valves
15. Characteristics of different types of control valves

EQUIPMENTS REQUIRED
1. Thermometer and Thermo well setup
2. U tube manometer (mercury and water) setup
3. Non-interacting System
4. Interacting System
5. Closed loop Level system
6. Closed loop flow system
7. Closed loop thermal system
8. Control valve setup

*Minimum 10 experiments shall be offered.

TOTAL: 60 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1:  Able to determine the response of a first order and second order system for various input
CO2:  Able to determine the response of an interacting and non-interacting system for various input
CO3:  Understand the difference between an open loop and closed loop system
CO4:  Understand the concept of three classical controller P, PI, PID controller
CO5:  Understand the concept of stability and tuning of a system
CO6:  Understand about the different type of control valves
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Able to determine the response of a first order and second order system for various input</td>
<td>PO1 3 PO2 3 PO3 2 PO4 3 PO5 2 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 3 PSO2 1 PSO3 1</td>
</tr>
<tr>
<td>CO2</td>
<td>Able to determine the response of a interacting and non-interacting system for various input</td>
<td>PO1 3 PO2 3 PO3 2 PO4 3 PO5 2 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 3 PSO2 1 PSO3 1</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the difference between an open loop and closed loop system</td>
<td>PO1 3 PO2 3 PO3 2 PO4 3 PO5 2 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 3 PSO2 1 PSO3 1</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the concept of three classical controller P, PI, PID controller</td>
<td>PO1 3 PO2 3 PO3 2 PO4 3 PO5 2 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 3 PSO2 1 PSO3 1</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the concept of stability and tuning of a system</td>
<td>PO1 3 PO2 3 PO3 2 PO4 3 PO5 2 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 3 PSO2 1 PSO3 1</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand about the different type of control valves</td>
<td>PO1 2 PO2 2 PO3 3 PO4 2 PO5 2 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 3 PSO2 1 PSO3 1</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>PO1 3 PO2 3 PO3 2 PO4 3 PO5 2 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 3 PSO2 1 PSO3 1</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
CH5612 MASS TRANSFER LABORATORY

OBJECTIVE:
The course is aimed to
- Develop sound practical knowledge for students on different types of mass transfer equipments

LIST OF EXPERIMENTS*
1. Separation of binary mixture using Simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of forced draft dryer
7. Adsorption studies
8. Cross current leaching studies
9. Surface evaporation
10. Wetted wall column
11. Solid Liquid mass transfer studies
12. Water purification using ion exchange columns
13. Mass transfer characteristics of Rotating disc contactor
14. Estimation of mass/heat transfer coefficient for cooling tower
15. Demonstration of Gas – Liquid absorption

EQUIPMENTS REQUIRED
1. Simple distillation setup
2. Steam distillation setup
3. Packed column
4. Liquid-liquid extractor
5. Forced draft dryer
6. Wetted wall column
7. Rotating disc contactor
8. Cooling tower
9. Absorption column

*Minimum 10 experiments shall be offered.
TOTAL: 60 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Determine the diffusivity practically and compare the results with the empirical correlations.
CO2: Estimate the mass transfer rate and mass transfer co-efficient
CO3: Evaluate the performance/calculate the parameters in different distillation processes
CO4: Evaluate the performance/calculate the parameters in leaching and extraction operations
CO5: Estimate the drying characteristics
CO6: Collect and analyse the mass transfer data practically
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Determine the diffusivity practically and compare the results with the empirical correlations.</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>Estimate the mass transfer rate and mass transfer co-efficient</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>Evaluate the performance/calculate the parameters in different distillation processes</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>Evaluate the performance/calculate the parameters in leaching and extraction operations</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>Estimate the drying characteristics</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>Collect and analyse the mass transfer data practically</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
SEMESTER VII

CH5715 TRANSPORT PHENOMENA

OBJECTIVE:
The course is aimed to
- Describe mass, momentum and energy transport at molecular, microscopic and macroscopic level to determine velocity, temperature and concentration profiles.

UNIT I MOMENTUM TRANSPORT 12
Viscosity, temperature and pressure effect on viscosity of gases and liquids, Newton’s law, mechanism of momentum transport, shell momentum balance method, Shear stress and velocity distributions in falling film, circular tube, annulus, slit.

UNIT II ENERGY TRANSPORT 12
Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier’s law, mechanism of energy transport, shell energy balance method, Energy flux and temperature distribution in solids and laminar flow with electrical, nuclear, viscous, chemical heat source, heat conduction through composite walls, cylinders, spheres, fins, slits.

UNIT III MASS TRANSPORT 12
Diffusivity, temperature and pressure effect on diffusivity, Fick’s law, mechanism of mass transport, shell mass balance method, Mass flux and concentration distribution in solids and in laminar flow: stagnant gas film, heterogeneous and homogeneous chemical reaction systems, falling film, porous catalyst.

UNIT IV EQUATIONS OF CHANGE AND THEIR APPLICATIONS 12

UNIT V TRANSPORT IN TURBULENT FLOWS AND ANALOGIES 12
Comparison of laminar and turbulent flows, time-smoothed equations of change, empirical expressions. Comparison of laminar and turbulent hydrodynamics, thermal and concentration boundary layer and their thicknesses. Development and applications of analogies between momentum, heat and mass transfer.

TOTAL: 60 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the mechanisms of momentum, heat and mass transfer each at molecular, micro and macro levels.
CO2: Develop mathematical models to determine transfer fluxes and velocity, temperature and concentration distribution for flow channels, heat sources and systems involving diffusion and reactions.
CO3: Determine the interrelationship between the molecular, microscopic and macroscopic descriptions of transport processes and compare the various coordinate systems to formulate equations of change.
CO4: Apply the equation of change for different coordinate systems and solve of momentum, mass and heat transport problems.
CO5: Apply the concepts of dimensional analysis and scale factors for equation of change for
different coordinate systems.

CO6: Analyze the analogy between the transports and understand the turbulence and boundary layer concept in heat and mass transport.

TEXT BOOKS:

REFERENCES:
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the mechanisms of momentum, heat and mass transfer each at molecular, micro and macro levels.</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Develop mathematical models to determine transfer fluxes and velocity, temperature and concentration distribution for flow channels, heat sources and systems involving diffusion and reactions.</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Determine the interrelationship between the molecular, microscopic and macroscopic descriptions of transport processes and compare the various coordinate systems to formulate equations of change.</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Apply the equation of change for different coordinate systems and solve of momentum, mass and heat transport problems.</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Apply the concepts of dimensional analysis and scale factors for equation of change for different coordinate systems.</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Analyze the analogy between the transports and understand the turbulence and boundary layer concept in heat and mass transport.</td>
<td>3</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
The course is aimed to
- Obtain process and equipment design of the equipments that are used in process industries and to select appropriate equipment for the process and to adhere to standard specifications like BIS and ASTM.

UNIT I
Double Pipe Heat Exchangers, Shell and Tube Heat Exchangers, Reboilers and Condensors.

UNIT II
Cooling Towers, Dryers, Evaporators, Crystallizers

UNIT III
Absorption Column, Distillation column, Extraction Column.

UNIT IV
Packed Bed Reactors, Vertical and Horizontal Pressure Vessels, Storage vessels for solids, liquids and gases, Horton spheres.

UNIT V
Design of Plant Layout, Process physical properties data and their sources (nomographs), BIS and ASTM standards & Codes, P & ID, Pipe Line design and piping layout, Pumps and their performance curves and selection, Materials of construction and selection of process equipments.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Design double pipe and shell and tube heat exchangers according to standards such as BIS, TEMA
CO2: Design Cooling towers and evaporators and design evaporators and crystallizers
CO3: Process and Equipment Design of separation equipments such as absorbers, distillation column, extractors
CO4: Calculate the design specifications of packed bed reactor and storage vessels, bins and silos
CO5: Determine sizes, materials, and capital and operating costs of equipment commonly used in the chemical processing industries
CO6: Design the essential elements of a chemical engineering process (equipment sizes, material & energy balances, economics, environmental, safety)

TEXT BOOKS:

REFERENCES:
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Design double pipe and shell and tube heat exchangers according to standards such as BIS, TEMA</td>
</tr>
<tr>
<td></td>
<td>3 3 3 2 2 3 3 - 2 2 2 3 3 2</td>
</tr>
<tr>
<td>CO2</td>
<td>Design Cooling towers and evaporators and design evaporators and crystallizer</td>
</tr>
<tr>
<td></td>
<td>3 3 3 2 2 2 3 3 - - 2 2 3 3 -</td>
</tr>
<tr>
<td>CO3</td>
<td>Process and Equipment Design of separation equipments such as absorbers, distillation column, extractors</td>
</tr>
<tr>
<td></td>
<td>3 3 3 2 2 - - - - 2 2 3 3 -</td>
</tr>
<tr>
<td>CO4</td>
<td>Calculate the design specifications of packed bed reactor and storage vessels, bins and silos</td>
</tr>
<tr>
<td></td>
<td>3 3 3 2 2 - - - - 2 2 3 3 -</td>
</tr>
<tr>
<td>CO5</td>
<td>Determine sizes, materials, and capital and operating costs of equipment commonly used in the chemical processing industries</td>
</tr>
<tr>
<td></td>
<td>3 3 3 2 2 3 3 - 2 2 2 2 3 3 2</td>
</tr>
<tr>
<td>CO6</td>
<td>Design the essential elements of a chemical engineering process (equipment sizes, material &amp; energy balances, economics, environmental, safety)</td>
</tr>
<tr>
<td></td>
<td>3 3 3 2 2 3 3 - 2 2 2 2 3 3 2</td>
</tr>
</tbody>
</table>

| Overall CO      |                                                                 |
|                 | 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
GE5451 TOTAL QUALITY MANAGEMENT

OBJECTIVES:
- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.

UNIT I INTRODUCTION 9
Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM —Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

UNIT II TQM PRINCIPLES 9

UNIT III TQM TOOLS & TECHNIQUES I 9

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

UNIT V QUALITY MANAGEMENT SYSTEM 9

TOTAL: 45 PERIODS

OUTCOMES:
CO1: Ability to apply TQM concepts in a selected enterprise.
CO2: Ability to apply TQM principles in a selected enterprise.
CO3: Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
CO4: Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
CO5: Ability to apply QMS and EMS in any organization.
TEXT BOOK:

REFERENCES:
The course is aimed to
   • Develop sound practical knowledge for students on different types of reactors.

LIST OF EXPERIMENTS*
  1. Kinetic studies in a Batch reactor
  2. Kinetic studies in a Plug flow reactor
  3. Kinetic studies in a CSTR
  4. Kinetic studies in a Packed bed reactor
  5. Kinetic studies in a PFR followed by a CSTR
  6. RTD studies in a PFR
  7. RTD studies in a Packed bed reactor
  8. RTD studies in a CSTR
  9. Studies on micellar catalysis
 10. Study of temperature dependence of rate constant using CSTR.
 11. Kinetic studies in Sono chemical reactor
 12. Studies on Cascade CSTR
 13. Kinetics of photochemical reaction
 14. Demonstration of heterogeneous catalytic reaction
 15. Demonstration of gas-liquid reaction
 16. Kinetics study in Adiabatic reactor
 17. Determination of Activation Energy of a reaction
 18. Kinetic study in semi batch reactor

EQUIPMENTS REQUIRED
  1. Batch reactor
  2. Plug flow reactor
  3. Continuous Stirred Tank Reactor
  4. Sono chemical reactor
  5. Photo chemical reactor
  6. Packed bed reactor

*Minimum 10 experiments shall be offered.

OUTCOMES:
On the completion of the course students are expected to
CO1:  Determine the rate constant experimentally in a batch reactor.
CO2:  Determine the conversion of a reaction in different reactors (batch, CSTR, PFR)
CO3:  Study of temperature dependence of rate constant.
CO4:  Determine the non-ideal behaviour and residence time distribution in PFR and CSTR.
CO5:  Determine the conversion of reactor arranged in series.
CO6:  Determine the rate constant using sono and photo chemical reactors.
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PS01</th>
<th>PS02</th>
<th>PS03</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Determine the rate constant experimentally in a batch reactor.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Determine the conversion of a reaction in different reactors (batch, CSTR, PFR)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Study of temperature dependence of rate constant.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Determine the non-ideal behaviour and residence time distribution in PFR and CSTR.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Determine the conversion of reactor arranged in series.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Determine the rate constant using sono and photo chemical reactors.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CH5712  COMPREHENSION

OBJECTIVE:
The course is aimed to
- Evaluate a student’s competency and mastery of concepts in the field of Chemical Engineering.

The students will be evaluated in the following area of subjects
- Process Calculation – Fluid Mechanics – Heat Transfer – Chemical Engineering Thermodynamics

TOTAL: 60 PERIODS

OUTCOMES:
On the completion of the course students are expected to
- CO1: Understand various unit operations and unit processes and their role in a engineering industry
- CO2: Acquire knowledge on fluid properties and performance characteristics of fluid machineries
- CO3: Understand the fundamental concepts of heat and mass transfer and their applications.
- CO4: Learn about thermodynamic property relations and their application to fluid flow.
- CO5: Learn reaction kinetics, design and operation of reactors
- CO6: Make an original contribution in their area of research in the dissertation phase.
**Course Articulation Matrix:**

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand various unit operations and unit processes and their role in a engineering industry</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>Acquire knowledge on fluid properties and performance characteristics of fluid machineries</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the fundamental concepts of heat and mass transfer and their applications.</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>Learn about thermodynamic property relations and their application to fluid flow.</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>Learn reaction kinetics, design and operation of reactors</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Make an original contribution in their area of research in the dissertation phase.</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

**Overall CO**

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
Ch5713            Internship/ Industrial Training

Objective:
The course is aimed to
- Make use of the knowledge gained by the student at various stages of the degree course in industries to acquire the practical knowledge and experience.

Outcomes:
On the completion of the course students are expected to
CO1: Provides real work experience
CO2: Opportunity to explore students’ interest
CO3: Students will be able to integrate classroom knowledge and theory with practical application
CO4: Provides a nice learning curve for students with little experience
CO5: Develops professional skills and competencies
CO6: Assists in building up the career of students
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Provides real work experience</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>Opportunity to explore students’ interest</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Students will be able to integrate classroom knowledge and theory with practical application</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>Provides a nice learning curve for students with little experience</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>Develops professional skills and competencies</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>Assists in building up the career of students</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CH5714  PROJECT – I

OBJECTIVE:
The course is aimed to
- Make use of the knowledge gained by the student at various stages of the degree course.

OUTCOMES:
On the completion of the course students are expected to
CO1:  Apply the fundamental concept learnt during the theory courses to solve industrial problems
CO2:  Review the current status based on the information available in the literature or data obtained in the laboratory/ industry
CO3:  Carry out material and energy balance for process calculations
CO4:  Design equipment for chemical process industries
CO5:  Evaluate the economics of a process through cost estimation
CO6:  Identify industrial problem, design process to carry out the process in an economically feasible way

TOTAL: 90 PERIODS
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Apply the fundamental concept learnt during the theory courses to solve industrial problems</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Review the current status based on the information available in the literature or data obtained in the laboratory/ industry</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Carry out material and energy balance for process calculations</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Design equipment for chemical process industries</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>Evaluate the economics of a process through cost estimation</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CO6</td>
<td>Identify industrial problem, design process to carry out the process in an economically feasible way</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
The course is aimed to

- Make use of the knowledge gained by the student at various stages of the degree course.

**OUTCOMES:**

On the completion of the course students are expected to

CO1: Apply the fundamental concept learnt during the theory courses to solve industrial problems
CO2: Review the current status based on the information available in the literature or data obtained in the laboratory/industry
CO3: Carry out material and energy balance for process calculations
CO4: Design equipment for chemical process industries
CO5: Evaluate the economics of a process through cost estimation
CO6: Identify industrial problem, design process to carry out the process in an economically feasible way

**TOTAL: 240 PERIODS**
## Course Articulation Matrix:

| Course Outcomes | Statement                                                                 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO12 | PSO1 | PSO2 | PSO3 |
|-----------------|---------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO7             | Apply the fundamental concept learnt during the theory courses to solve industrial problems | 3   | 3   | 2   | 2   | 3   | 3   | 3   | 3   | 3   | 2   | 2   | 2    |      |      |      |
| CO8             | Review the current status based on the information available in the literature or data obtained in the laboratory/industry | 2   | 2   | 3   | 3   | 3   | 2   | 3   | 2   | 3   | 3   | 3   | 2    | 2    | 3    |     |
| CO9             | Carry out material and energy balance for process calculations            | 3   | 3   | 3   | 2   | 3   | 3   | 2   | 3   | 3   | 2   | 3   | 3    | 3    | 3    |     |
| CO10            | Design equipment for chemical process industries                         | 3   | 3   | 3   | 3   | 2   | 2   | 3   | 3   | 3   | 2   | 2   | 3    | 3    | 3    |     |
| CO11            | Evaluate the economics of a process through cost estimation              | 3   | 3   | 3   | 3   | 3   | 3   | 2   | 2   | 3   | 3   | 2   | 2    | 3    | 3    |     |
| CO12            | Identify industrial problem, design process to carry out the process in an economically feasible way | 2   | 2   | 3   | 2   | 2   | 2   | 2   | 3   | 3   | 2   | 3   | 3    |      |      |      |
| Overall CO      |                                                                          | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3    |      |      |      |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
The course is aimed to
- Gain fundamental knowledge about drugs and pharmaceutical and their manufacturing process

UNIT I  INTRODUCTION
Development of drugs and pharmaceutical industry; organic therapeutic agents’ uses and economics.

UNIT II  DRUG ACTION, METABOLISM AND PHARMACOKINETICS
Mechanism of drug action; physico-chemical principles of drug metabolism; radioactivity; Pharmacokinetics, Pharmacodynamics, Factors modifying drug action, adverse drug reaction, drug interactions, Bioassay of drugs, drug discovery and development

UNIT III  MANUFACTURE OF DRUGS, PROCESS AND APPLICATIONS
Types of reaction process and special requirements for bulk drug manufacture

UNIT IV  PRINCIPLES OF DRUG MANUFACTURE
Compressed tablets; dry and wet granulation; slugging or direct compression; tablet presses; coating of tablets; capsule preparation; oval liquids, parental solutions, oral liquids; injections; ointments

UNIT V  PHARMACEUTICAL ANALYSIS AND QUALITY CONTROL
Analytical methods and other tests used in drug manufacture; packing techniques; quality management.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to

CO1:  Understanding the drug metabolism, pharmaco-dynamic and pharmaco-kinetic principles
CO2:  Understanding knowledge of various drugs on different disease
CO3:  Demonstrate statistical quality control procedure and quality assurance programmes in various stages of pharmaceutical process
CO4:  Understand and learn the strategies to improve the same during dosage from development
CO5:  Understanding analytical methods to develop new process and product formulations.
CO6:  Apply the knowledge on choosing active ingredients for finished product

TEXT BOOKS

REFERENCES
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understanding the drug metabolism, pharmaco-dynamic and pharmaco-kinetic principles</td>
</tr>
<tr>
<td>CO2</td>
<td>Understanding knowledge of various drugs on different disease</td>
</tr>
<tr>
<td>CO3</td>
<td>Demonstrate statistical quality control procedure and quality assurance programmes in various stages of pharmaceutical process</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand and learn the strategies to improve the same during dosage from development</td>
</tr>
<tr>
<td>CO5</td>
<td>Understanding analytical methods to develop new process and product formulations.</td>
</tr>
<tr>
<td>CO6</td>
<td>Apply the knowledge on choosing active ingredients for finished product</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td>- - 3 2 - 1 2 1 - 2 - 1 2 1 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
The course is aimed to
- Gain knowledge about electrochemical process and its application

UNIT I

UNIT II
Mass transfer in electrochemical systems: diffusion controlled electrochemical reaction – the importance of convention and the concept of limiting current. over potential, primary-secondary current distribution – rotating disc electrode

UNIT III

UNIT IV

UNIT V
Electrodes used in different electrochemical industries: Metals-Graphite – Lead dioxide – Titanium substrate insoluble electrodes – Iron oxide – semi conducting type etc. Metal finishing-cell design. types of electrochemical reactors, batch cell, fluidized bed electrochemical reactor, filter press cell, Swiss roll cell, plug flow cell, design equation, figures of merits of different type of electrochemical reactors.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to

CO1: Understanding on aspects of electrochemistry -
CO2: Understanding on the electrochemical kinetics,
CO3: Understanding on electrochemical reaction, concept of limiting current. Over potential
CO4: Understanding the causes of and the mechanisms of various types of corrosion,
CO5: Apply the concepts involved in electro process and design of batteries, fuel cell and electrochemical reactors
CO6: Understanding on the mechanism of corrosion.

TEXT BOOKS

REFERENCES
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understanding on aspects of electrochemistry -</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>Understanding on the electrochemical kinetics,</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Understanding on electrochemical reaction, concept of limiting current.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Understanding the causes of and the mechanisms of various types of corrosion,</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Apply the concepts involved in electro process and design of batteries, fuel cell and electrochemical reactors</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Understanding on the mechanism of corrosion</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CH5003 ENERGY TECHNOLOGY

OBJECTIVE:
The course is aimed to
- Provide a survey of the most important renewable energy resources, and the technologies for harnessing these energies from simple to advanced energy systems

UNIT I
Introduction to energy – Global energy scene – Indian energy scene - Units of energy, conversion factors, general classification of energy, energy crisis, energy alternatives

UNIT II
Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

UNIT III
Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

UNIT IV
Biomass origin - Resources – Biomass estimation. Thermochemical conversion – Biological conversion, Chemical conversion – Hydrolysis & hydrogenation, solvolysis, biocrude, biodiesel power generation gasifier, biogas, integrated gasification.

UNIT V
Energy conservation - Act; Energy management importance, duties and responsibilities; Energy audit – Types methodology, reports, instruments. Benchmarking and energy performance, material and energy balance, thermal energy management.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.
CO2: Students will excel as professionals in the various fields of energy engineering
CO3: Compare different renewable energy technologies and choose the most appropriate based on local conditions.
CO4: Explain the technological basis for harnessing renewable energy sources.
CO5: Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies
CO6: To develop in-depth technical understanding of energy problems at an advanced level.

TEXT BOOKS

REFERENCES
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO1</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Students will excel as professionals in the various fields of energy engineering</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>Compare different renewable energy technologies and choose the most appropriate based on local conditions.</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>Explain the technological basis for harnessing renewable energy sources.</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>To develop in-depth technical understanding of energy problems at an advanced level.</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
The course is aimed to
  • Know the latest trends to be followed in the process industries

UNIT I    PROCESS INTENSIFICATION      9
Novel reactor configurations; combination of reaction and separation; use of different energy fields, lab on a chip.

UNIT II   CHEMICAL PRODUCT DESIGN      9
Scope and importance; identification of needs and specifications; sources of ideas and screening ideas; selection of product idea; process development for product manufacture; specialty chemical manufacture; economic aspects.

UNIT III   RENEWABLE ENERGY             9
Hydrogen production, Hydrogen economy, Fuel Cell Technology, biofuel cells and biohydrogen, solar energy

UNIT IV    MATERIALS ENGINEERING        9
Polymers and composites, ceramics and glasses, colloidal dispersions and nanoparticles, thin films and electronic materials

UNIT V     BIOENGINEERING               9
Biomechanics, biotransport and biomaterials, biomolecular and cellular engineering, drug discovery and development.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understanding on the Chemical Engineering concepts,
CO2: Understanding on the renewable energy, energy economy
CO3: Understanding on Fuel Cell, biohydrogen
CO4: Understanding on the Polymers and composites, colloid particles
CO5: Understanding on the solar energy, biohydrogen
CO6: Understanding on cellular engineering, drug discovery

REFERENCES:
| Course Outcomes | Statement                                                                 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO12 | PSO1 | PSO2 | PSO3 |
|-----------------|---------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1             | Understanding on the Chemical Engineering concepts,                       | 3   | 3   | 2   | 2   | 1   | 1   | -   | -   | -   | -   | 1   | -   | 3    | 3    | 3    | 2    |
| CO2             | Understanding on the renewable energy, energy economy                     | 3   | 3   | 2   | 2   | 1   | 1   | 1   | 1   | -   | -   | -   | -   | 3    | 3    | 3    | 2    |
| CO3             | Understanding on Fuel Cell, biohydrogen                                  | 3   | 3   | 2   | 2   | 1   | 1   | 1   | 1   | -   | -   | -   | -   | 3    | 3    | 3    | 2    |
| CO4             | Understanding on the Polymers and composites, colloid particles            | 3   | 3   | 2   | 2   | 1   | 1   | 1   | 1   | -   | -   | -   | -   | 3    | 3    | 3    | 2    |
| CO5             | Understanding on the solar energy, biohydrogen                           | 3   | 3   | 2   | 2   | 1   | 1   | 1   | 1   | -   | -   | -   | -   | 3    | 3    | 3    | 2    |
| CO6             | Understanding on cellular engineering, drug discovery                     | 3   | 3   | 2   | 2   | 1   | 2   | 1   | 1   | -   | -   | -   | -   | 3    | 3    | 3    | 2    |
| Overall CO      |                                                                           | 3   | 3   | 2   | 2   | 1   | 2   | 1   | 1   | -   | -   | -   | -   | 3    | 3    | 3    | 2    |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
The course is aimed to
- Gain knowledge about advanced separation process. Also, to learn conceptual design of separation processes and design of equipment involved

UNIT I  BASICS OF SEPARATION PROCESS  9
Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.

UNIT II  MEMBRANE SEPARATIONS  9
Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollowfiber Membrane Reactors and their relative merits, commercial, Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nano-filtration, Ultra filtration and Micro filtration, Ceramic membranes, Hybrid process and Biological Membranes.

UNIT III  SEPARATION BY ADSORPTION TECHNIQUES  9
Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption.

UNIT IV  INORGANIC SEPARATIONS  9
Controlling factors, Applications, Types of Equipment employed for Electrophoresis, Dielectrophoresis, Ion Exchange Chromatography and Electrodialysis, EDR, Bipolar Membranes.

UNIT V  OTHER TECHNIQUES  9
Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to

CO1: Understand the key concepts of conventional and advanced aspects of separation processes, and the selection of separation processes.

CO2: Understand the concepts and develop design equations for membrane separation processes.

CO3: Understand the principles and processes of adsorption and chromatographic techniques and to design an absorber to achieve specific separation.

CO4: Analyze the separation system for multi-component mixtures, design separation process based on electrical properties.

CO5: Apply the latest concepts like super critical fluid extraction, pervaporation, lyophilisation etc., also to understand Innovative techniques for controlling and managing oil spills in Chemical process industries.

CO6: Understand and select appropriate separation technique for intended problem.

TEXT BOOK:
REFERENCES:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the key concepts of conventional and advanced aspects of separation processes, and the selection of separation processes.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the concepts and develop design equations for membrane separation processes.</td>
<td>2    -    3    -    1    -    1    -    -    -    1    2    2    2    -</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the principles and processes of adsorption and chromatographic techniques and to design an absorber to achieve specific separation.</td>
<td>2    2    3    1    -    1    -    -    -    2    2    3    2    -</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyze the separation system for multi-component mixtures, design separation process based on electrical properties.</td>
<td>1    1    3    2    3    2    1    -    -    -    1    2    3    2    1</td>
</tr>
<tr>
<td>CO5</td>
<td>Apply the latest concepts like super critical fluid extraction, pervaporation, lyophilisation etc., also to understand Innovative techniques for controlling and managing oil spills in Chemical process industries.</td>
<td>3    3    1    3    1    2    2    2    -    -    1    3    2    2    2</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand and select appropriate separation technique for intended problem.</td>
<td>1    1    1    1    -    1    1    1    -    -    1    1    2    2    -</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>2    2    2    2    2    2    2    2    1    -    -    1    2    3    3    1</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CH5006  

OPTIMIZATION OF CHEMICAL PROCESSES

OBJECTIVE:

The course is aimed to
- Develop objective functions and use linear programming, geometric, dynamic and integer programming and genetic algorithms for solution to chemical engineering problems.

UNIT I
Introduction to optimization; applications of optimization in chemical engineering; classification of optimization problems; Developing models for optimization

UNIT II
Continuity of Functions; NLP Problem Statement Convexity and Its Applications Interpretation of the Objective Function in Terms of its Quadratic Approximation Necessary and Sufficient Conditions for an Extremum of an Unconstrained Function; region elimination methods; interpolation methods; direct root methods.

UNIT III

UNIT IV
Introduction to geometric, dynamic and integer programming and genetic algorithms. Linear Programming – Solution of Problems using Excel SOLVER

UNIT V
Formulation of objective functions; fitting models to data; applications in fluid mechanics, heat transfer, mass transfer, reaction engineering, equipment design, reaction engineering, resource allocation and inventory control.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to

CO1: Frame mathematical models and formulate optimization models for chemical processes / equipment.

CO2: Understand the concept of optimum and extremum and the necessary and sufficient conditions for extremum and solve single and multivariable optimization problems through various techniques.

CO3: Apply various search methods to solve unconstrained single variable optimization and unconstrained multi variable optimization

CO4: Apply higher order techniques like geometric programming, dynamic and integer programming and genetic algorithms

CO5: Able to use the principles of engineering and in particular chemical engineering to develop equality and inequality constraints for an optimization problem

CO6: Apply optimization techniques for real world problems and be knowledgeable to use software packages for their solution

TEXT BOOKS:
REFERENCES:
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Frame mathematical models and formulate optimization models for chemical processes / equipment.</td>
<td>PO 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the concept of optimum and extremum and the necessary and sufficient conditions for extremum and solve single and multivariable optimization problems through various techniques.</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Apply various search methods to solve unconstrained single variable optimization and unconstrained multi variable optimization</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Apply higher order techniques like geometric programming, dynamic and integer programming and genetic algorithms</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Able to use the principles of engineering and in particular chemical engineering to develop equality and inequality constraints for an optimization problem</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Apply optimization techniques for real world problems and be knowledgeable to use software packages for their solution</td>
<td>3</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
The course is aimed to
  • Gain knowledge about petroleum refining process and production of petrochemical products.

UNIT I

UNIT II
Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen

UNIT III

UNIT IV
Petrochemicals - Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, and Extraction of Aromatics.

UNIT V
Production of Petrochemicals like Dimethyl Terephthalate(DMT), Ethylene Glycol, Synthetic glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol, Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and production of Carbon Black.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to

CO1: Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.

CO2: Understand the insights of primary treatment processes to produce the precursors.

CO3: Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.

CO4: Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.

CO5: Understand the societal impact of petrochemicals and learn their manufacturing processes.

CO6: Learn the importance of optimization of process parameters for the high yield of petroleum products.

TEXT BOOKS

REFERENCES
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO 10</th>
<th>PO 11</th>
<th>PO12</th>
<th>PSO 1</th>
<th>PSO 2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the insights of primary treatment processes to produce the precursors.</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the societal impact of petrochemicals and learn their manufacturing processes.</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CO6</td>
<td>Learn the importance of optimization of process parameters for the high yield of petroleum products.</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CH5008 POLYMER TECHNOLOGY

OBJECTIVE:
The course is aimed to
- Gain knowledge about mechanism of polymer process and its application

UNIT I GENERAL ASPECTS OF POLYMERS
Classification of polymers- natural and synthetic, thermoplastic and thermosetting. Types and mechanism of polymerization: addition (free radical, cationic, anionic and living); condensation and copolymerization, Functionality-degree of polymerization. Techniques of polymerization: Bulk, emulsion, solution and suspension.

UNIT II MIXING AND MOULDING DEVICES

UNIT III ELASTOMERS AND APPLICATION ORIENTED POLYMERS

UNIT IV PROPERTIES OF POLYMER MATERIALS
Molecular weight-weight average, mechanical properties, thermal properties, electrical properties, rheological properties, and optical properties.

UNIT V POLYMER COMPOSITES

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the fundamentals of polymers and mechanism of polymerization techniques.
CO2: Apply the mechanism and effectiveness of polymerization in making finished materials.
CO3: Understand the knowledge of developing new formulations and products from elastomers
CO4: Understand the knowledge of polymer stability and unique definition of the product by evaluating molecular weight
CO5: Understand the manufacture and properties of application oriented industrial polymers.
CO6: Acquire knowledge on different tests for characterization of polymer for applications in R & D work

TEXT BOOKS:
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the fundamentals of polymers and mechanism of polymerization techniques.</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Apply the mechanism and effectiveness of polymerization in making finished materials.</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the knowledge of developing new formulations and products from elastomers.</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the knowledge of polymer stability and unique definition of the product by evaluating molecular weight</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the manufacture and properties of application oriented industrial polymers.</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Acquire knowledge on different tests for characterization of polymer for applications in R &amp; D work</td>
<td>3</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1. 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CH5009 PROCESS MODELING AND SIMULATION

OBJECTIVE:
The course is aimed to
- Develop steady state and transient models for processes and unit operations and to understand lumped and distributed parameter models and to seek solution of models using analytic and numerical techniques and to construct data driven models and estimate the parameters.

UNIT I
Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

UNIT II
Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flow sheeting — sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations using Matrices and Numerical techniques. Error estimates.

UNIT III
Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems – Solution of ODE using Eigen values – Jordan Canonical Form – Stiff equations – Gear’s algorithm - Perturbation Methods

UNIT IV
Analysis of compressible flow, heat exchanger, packed columns, Monolith Reactor Modeling – Pseudo-homogeneous and Heterogeneous models for catalytic reactors – plug flow reactor, solution of ODE boundary value problems – shooting Method

UNIT V
Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, - hierarchy in model development, classification and solution of partial differential equations – Characteristic curves for parabolic, Elliptic and Hyperbolic equations - Empirical modeling, parameter estimation, population balance and stochastic modelling - Principal Component Analysis

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to

CO1: Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics

CO2: Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods

CO3: Create the mathematical models for different unit operations equipments such as stirred tank heaters, Heat exchangers, Evaporators, Reactors, distillation columns

CO4: Analyze the principles of steady state/unsteady state lumped systems and steady state/ unsteady state distributed systems

CO5: Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions

CO6: Appreciate the applicability of stochastic, population balance model and data driven models
TEXT BOOKS

REFERENCES:
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Create the mathematical models for different unit operations equipments such as stirred tank heaters, Heat exchangers, Evaporators, Reactors, distillation columns</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyze the principles of steady state/unsteady state lumped systems and steady state/ unsteady state distributed systems</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions</td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Appreciate the applicability of stochastic, population balance model and data driven models</td>
<td>3</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE:
The course is aimed to
- Enable the students to gain knowledge about various process plant utilities essentially required for the working of any chemical or related industry plants

UNIT I  INDUSTRIAL WATER  9
Hard and Soft water, Requisites of Industrial Water and its uses. Methods of Water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening, Reverse Osmosis.

UNIT II  STEAM GENERATION  9
Properties of Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Corrosion in boiler and Trouble Shooting. Steam Traps and Accessories

UNIT III  REFRIGERATION  9
Refrigeration Cycles, Methods of Refrigeration used in Industry, Old and Modern refrigerants, Refrigerating Effects and Liquefaction Processes.

UNIT IV  COMPRESSED AIR  9

UNIT V  FUEL AND PUMPS  9
Types of Fuel used in Chemical Process Industries for Power Generation, Internal Combustion Engine, Petrol and Diesel Engine. Combustion calculations, various types of pumps used in industries

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the importance of process plant utilities
CO2: Understand the Requisites of Industrial Water and treatment methodologies
CO3: Understand various types of steam generators and boiler corrosion
CO4: Understand the concept of refrigeration used in industries
CO5: Understand the classification of compressors and humidification equipments
CO6: Understand the types of engines and fuels used for power generation and pumps used in chemical industries.

TEXT BOOKS:
1. Industrial Chemistry by Shashi Chawla, Dhanpat Rai and Sons Publication
2. P. L. Ballaney, "Thermal Engineering", Khanna Publisher New Delhi, 1986
3. Heat Transfer by D.S. Kumar
4. Fuel Furances and Refractories by O.P. Gupta, Khanna Publishers

REFERENCES:
2. Plant Utilities by D.B. Dhone, NiraliPrakshan Publication
### Course Articulation Matrix:

| Course Outcomes | Statement                                                                 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-----------------|---------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1             | Understand the importance of process plant utilities                     | 3   | 1   | 1   | -   | 1   | 3   | 3   | 2   | -   | -   | 3   | 2   | 3   | 2   | 1   |
| CO2             | Understand the Requisites of Industrial Water and treatment methodologies | 3   | 3   | 1   | 1   | 2   | -   | 1   | 1   | -   | -   | 2   | 2   | 3   | 1   | 1   |
| CO3             | Understand various types of steam generators and boiler corrosion         | 3   | 2   | 1   | 1   | 2   | -   | 1   | -   | -   | -   | 1   | 2   | 3   | 3   | 1   |
| CO4             | Understand the concept of refrigeration used in industries                | 3   | 2   | 1   | 1   | 2   | -   | -   | -   | -   | -   | 1   | 2   | 3   | 3   | 1   |
| CO5             | Understand the classification of compressors and humidification equipments| 3   | 2   | 1   | 1   | 2   | -   | -   | -   | -   | -   | 1   | 1   | 3   | 3   | 1   |
| CO6             | Understand the types of engines and fuels used for power generation and pumps used in chemical industries. | 3   | 2   | 1   | 1   | 2   | -   | -   | -   | -   | -   | 1   | 3   | 3   | 3   | 1   |

**Overall CO**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CH5010  CHEMICAL PROCESS DESIGN  

OBJECTIVE:

The course is aimed to

- Design and sequence chemical processes based on hierarchical modeling and be able to critically choose reactors, separation trains and heat exchanger networks for optimal performance.

UNIT I  
Process Design and Development: General Design Considerations; The Hierarchy of Chemical Process Design; The Nature of Process Synthesis and Analysis  

UNIT II  
Choice of reactor based on reactor performance, reactor conditions and reactor configuration. Reactor networks in process flow sheets  

UNIT III  
Choice of separation of heterogeneous and homogeneous mixtures – Attainable region Separation systems in process flowsheets: multicomponent distillation for ideal and non-ideal systems, distillation column sequences  

UNIT IV  
Heat exchange networks synthesis and utilities: Energy targets, Integration in distillation columns  

UNIT V  
Introduction to optimization approaches to optimal design, role of simulations in process design, Design under uncertainty and failure tolerance, Engineering around variations, Introduction to process integration  

TOTAL: 45 PERIODS  

OUTCOMES:

On the completion of the course students are expected to

CO1: Understand different codes, standards, design factors and system of units used in design process.

CO2: Understand the importance of process diagrams, design of reactors

CO3: Evaluate the choice of reactors and configure reactors for process design

CO4: Map attainable regions in separation systems

CO5: Apply the skill in thermal design of heat transfer equipment and assessing thermal efficiency of the above equipment in practice.

CO6: Apply optimization techniques for chemical engineering processes and use software packages for their solution

TEXT BOOKS:


REFERENCES:


<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand different codes, standards, design factors and system of units used in design process.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the importance of process diagrams, design of reactors</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>Evaluate the choice of reactors and configure reactors for process design</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>Map attainable regions in separation systems</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>Apply the skill in thermal design of heat transfer equipment and assessing thermal efficiency of the above equipment in practice.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>Apply optimization techniques for chemical engineering processes and use software packages for their solution</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
The course is aimed to

- Understand various material and its properties and manufacturing methods

UNIT I  INTRODUCTION

UNIT II  MECHANICAL BEHAVIOUR

UNIT III  PHASE DIAGRAMS AND PHASE TRANSFORMATIONS

UNIT IV  FERROUS, NON-FERROUS METALS AND COMPOSITES

UNIT V  NANOMATERIALS

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to

CO1: Understand the basics knowledge such as internal structure, properties and processing of metals.

CO2: Understand basic and the mechanical behavior of the metals.

CO3: Understand phase diagrams and phase transformations of metals.

CO4: Understand the manufacturing process of ferrous, non-ferrous metals and composites.

CO5: Understand the basic concepts of nano materials.

CO6: Apply knowledge of various materials properties and processing methods in chemical industry.
TEXT BOOKS:
2. V. Raghavan, Materials Science and Engineering, Prentice Hall

REFERENCES:
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CO1</strong></td>
<td>Understand the basics knowledge such as internal structure, properties and processing of metals.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3   3   -   -   -   2   3   3   2   3   2   3   3   3   2</td>
</tr>
<tr>
<td><strong>CO2</strong></td>
<td>Understand basic and the mechanical behavior of the metals.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3   3   3   2   2   3   2   3   -   -   3   3   3   3   3</td>
</tr>
<tr>
<td><strong>CO3</strong></td>
<td>Understand phase diagrams and phase transformations of metals.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3   3   3   2   3   3   2   2   -   -   2   3   3   3   2</td>
</tr>
<tr>
<td><strong>CO4</strong></td>
<td>Understand the manufacturing process of ferrous, non-ferrous metals and composites.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3   3   3   2   2   3   2   2   -   -   3   3   3   3   2</td>
</tr>
<tr>
<td><strong>CO5</strong></td>
<td>Understand the basic concepts of nano materials.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3   3   3   2   3   3   3   2   -   -   2   3   3   3   2</td>
</tr>
<tr>
<td><strong>CO6</strong></td>
<td>Apply knowledge of various materials properties and processing methods in chemical industry.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3   3   3   2   3   2   2   2   3   2   2   3   3   3   2</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3   3   3   2   3   3   2   2   2   2   2   3   3   3   2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
CH5012  BIOCHEMICAL ENGINEERING  

OBJECTIVE: 
The course is aimed to 
- Introduce fundamental concept of Bioprocesses to Chemical Engineers to deal with the design and construction of unit processes that involve biological organisms or molecules

| UNIT I  | INTRODUCTION TO BIOPROCESS | 9 |
|-----------------------------------|---------------------------|
| Overview of traditional and modern application of bioprocesses, unit operations in bioprocesses, Microbiology overview- microbial taxonomy, prokaryotic cell, eukaryotic cell; Introduction to biochemistry- fats, lipids, proteins, carbohydrates, nucleic acids, vitamins.

| UNIT II | ENZYME TECHNOLOGY | 9 |
|-----------------------------------|---------------------------|
| Classification of enzymes, Kinetics of enzyme catalyzed reaction: enzyme substrate complex and enzyme action, types of inhibition, Immobilization-methods, properties, Diffusional limitations, enzyme reactors.

| UNIT III | KINETICS OF MICROBIAL GROWTH | 9 |
|-----------------------------------|---------------------------|
| Stoichiometry of microbial growth and product formation, Medium formulation, operating conditions of suspended and immobilized cells in bioreactors-Batch, fed batch; operation and control of bioreactors.

| UNIT IV | MASS TRANSFER IN BIOPROCESSES | 9 |
|-----------------------------------|---------------------------|
| Stoichiometry of microbial growth and product formation, Medium formulation, operating conditions of suspended and immobilized cells in bioreactors-Batch, fed batch; operation and control of bioreactors.

| UNIT V  | DOWN STREAM PROCESSING | 9 |
|-----------------------------------|---------------------------|
| Product recovery: Filtration, sedimentation, centrifugation, cell disruption, extraction, crystallization, drying, Design and analysis of bioreactors.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
- CO1: Understand basics of microbiology to engineer them
- CO2: To apply the reaction kinetics to enzyme catalyzed reactions
- CO3: Understand basics of cell growth and apply to scale up reactors
- CO4: Understand mass transport mechanisms in bioprocesses
- CO5: Understand the downstream processing and industrial bioreactors
- CO6: Application of chemical concepts in bio-based industries

TEXT BOOKS

REFERENCES
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Course Articulation Matrix:</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand basics of microbiology to engineer them</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>To apply the reaction kinetics to enzyme catalyzed reactions</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand basics of cell growth and apply to scale up reactors</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand mass transport mechanisms in bioprocesses</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the downstream processing and industrial bioreactors</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>Application of chemical concepts in bio-based industries</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Overall CO</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
GE5071 DISASTER MANAGEMENT

OBJECTIVE:
The course is aimed to
- Educate students about the basic knowledge on various types of Disasters and Disaster Management

UNIT I  INTRODUCTION TO DISASTERS  9

UNIT II  APPROACHES TO DISASTER RISK REDUCTION (DRR)  9
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  9
Factors Affecting Vulnerabilities, Differential Impacts, Impact of Development Projects such as Dams, Embankments, and 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  9

UNIT V  DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS  9
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.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand foundations of hazards, disasters and associated natural/social phenomena and to provide knowledge on response during different types of Disasters
CO2: Gain Preliminary understanding of DRR approaches
CO3: Manage the Public Health aspects and Humanitarian Assistance of the disasters and Capacity to describe analyse various aspects influencing vulnerabilities and capacities.
CO4: Understand the Technological innovations and their usage during various phases of Disaster
CO5: To enhance awareness of institutional process, vulnerability profile, Policies, Law, and methods of assessment in the country
Gain the capacity to obtain, analyse, and communicate information on risks, relief needs and lessons learned from earlier disasters in order to formulate strategies for mitigation in future scenarios.

**TEXT BOOKS:**

**REFERENCES:**
1. Govt. of India: Disaster Management Act , Government of India, 2005
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand foundations of hazards, disasters and associated natural/social phenomena and to provide knowledge on response during different types of Disasters</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Gain Preliminary understanding of DRR approaches</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Manage the Public Health aspects and Humanitarian Assistance of the disasters and Capacity to describe analyse various aspects influencing vulnerabilities and capacities.</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the Technological innovations and their usage during various phases of Disaster</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>To enhance awareness of institutional process, vulnerability profile, Policies, Law, and methods of assessment in the country</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO6</td>
<td>Gain the capacity to obtain, analyse, and communicate information on risks, relief needs and lessons learned from earlier disasters in order to formulate strategies for mitigation in future scenarios</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
INDUSTRIAL PROCESS PLANT SAFETY

OBJECTIVE:

The course is aimed to
- Educate Students about implementation of safety procedures, risk analysis and assessment, hazard identification

UNIT I
Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling.

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

UNIT III
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
Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras-VizagBopali analysis

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

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understanding the chemical process safety, plant layout, safety codes
CO2: Plant inspection, safe handling of chemicals
CO3: Understanding on risk management iso 14000, ems
CO4: Hazard identification safety audits, checklist, what if analysis
CO5: Vulnerability models event tree analysis fault tree analysis, hazan, hazop
CO6: Past accident analysis fixborough-mexico-madras-vizagbopali analysis

TEXT BOOKS:

REFERENCES:
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understanding the chemical process safety, plant layout, safety codes</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>Plant inspection, safe handling of chemicals</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Understanding on risk management iso 14000, ems</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Hazard identification safety audits, checklist, what if analysis</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Vulnerability models event tree analysis fault tree analysis, hazan, hazop</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Past accident analysis fixborough-mexico-madras-vizagbopal analysis</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
The course is aimed to
- Know the principle and importance of various analytical instruments used for the characterization of various materials.

UNIT I   INTRODUCTION TO SPECTROSCOPICAL METHODS OF ANALYSIS  9
Electromagnetic radiation: Various ranges, Dual properties, Various energy levels, Interaction of photons with matter, absorbance & transmittance and their relationship, Color and complementary colours-Orbital overlap- MO diagrams of O₂, N₂ and H₂. Permitted energy levels for the electrons of an atom and simple molecules, HOMO and LUMO levels of simple organic compounds and polyenes-Various electronic transitions in organic and inorganic compounds effected by UV, and Visible radiations, Various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and Visible radiations, Choice of solvents, cut off wavelengths for solvents

UNIT II   QUALITATIVE ANALYSIS BY UV AND VISIBLE SPECTROCOPY  9
Lamda max and epsilon max rules, Woodward -Fieser rules for the calculation of absorption maxima (Lamda max) for dienes and carbonyl compounds, Fieser and Kuhn rules, Effects of auxo chromes and effects of conjugation on the absorption maxima, Different shifts of absorption peaks (Bathochromic, hypsochromic, hypochromic), Difference in the absorption spectra of organic and inorganic compounds and complexes, Instrumentation for single beam and double beam UV and VISIBLE spectrophotometers (source, optical parts and detectors), Applications of UV and VISIBLE spectroscopies.

UNIT III   QUANTITATIVE ANALYSIS BY UV AND VISIBLE SPECTROCOPY  9
Beer -Lambert's law, Limitations, Deviations (Real, Chemical, Instrumental), problems based on Beer- Lambert's Equation-Estimation of inorganic ions such as Fe²⁺, Fe³⁺, Ni²⁺ ions and estimation of Nitrite (NO₂⁻) using Beer -Lambert's Law, Multicomponent analysis (no overlap, single way overlap and two-way overlap), Photometric titration (Experimental set -up and various types of titrations and their corresponding curves).

UNIT IV   IR SPECTROSCOPY  9
Theory of IR spectroscopy, Various stretching and vibration modes for diatomic and triatomic molecules (both linear and nonlinear), various ranges of IR (Near, Mid, Finger print and Far) and their usefulness, Instrumentation (Only the sources and detectors used in different regions), sample preparation techniques (Gas, Liquid and solid), Qualitative analysis of alkanes, alkenes and carbonyl compounds

UNIT V   CHROMATOGRAPHIC METHODS  9
Classification of chromatographic methods, Column, Thin layer, Paper, Gas, High Performance Liquid Chromatographical methods (Principle, mode of separation, Technique and applications).

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the fundamentals, concepts and mechanisms involved in spectral analysis.
CO2: Understand the purpose and theories in qualitative analysis.
CO3: Understand the purpose and theories in quantitative analysis.
CO4: Understand the purpose and theories in IR spectral analysis.
CO5: Understand the purpose and theories of chromatographic methods.
CO6: Understand the importance of analytical instrumentation during the purification, compounding and formulating the finished product.
TEXT BOOKS:

REFERENCES:
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the fundamentals, concepts and mechanisms involved in spectral analysis.</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the purpose and theories in qualitative analysis.</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the purpose and theories in quantitative analysis.</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the purpose and theories in IR spectral analysis.</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the purpose and theories of chromatographic methods.</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand the importance of analytical instrumentation during the purification, compounding and formulating the finished product.</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CH5015  PROCESS ENGINEERING ECONOMICS

OBJECTIVE:
The course is aimed to
- Understand the various concepts of economics, process development, design consideration and cost estimation in chemical industry.

UNIT I  INTEREST AND PLANT COST
Economics-Engineering economics-Financial efficiency, human factors, capital, accounting. Time value of money – Interest, present worth, annuities, Depreciation-methods, capital investment, estimation of capital cost, elements of cost, break even analysis (BEA)

UNIT II  PROFITABILITY AND FINANCIAL RATIOS
Profitability - methods to estimate profitability, Alternative investments, Balance sheet-Preparation, Income statement (Profit and loss account) and financial ratio analysis.

UNIT III  ECONOMIC BALANCE IN EQUIPMENTS
Essentials of economic balance, economic balance in batch operations, cyclic operations, economic balance for insulation, evaporation, heat transfer equipment.

UNIT IV  PRINCIPLES OF MANAGEMENT
Principles of management, planning and organizing, staffing, process of directing-communication and types of communication, coordinating and controlling, Types of organizations, Management information systems (MIS).

UNIT V  PRODUCTION PLANNING CONTROL
Work measurement techniques, motion study(Work sampling)-procedure and application, time study-procedure-performance rating-types of performance rating, learning curve, elements of production control, forecasting, planning, routing, scheduling, dispatching, inventory and control, role of control charts in quality control.

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the concept of economics in a process plant, time value of money and cost indices
CO2: Able to integrate knowledge about financial statements, Depreciation and Accounting.
CO3: Able develop economic balance for chemical engineering equipment’s and determine the optimum cost for operation
CO4: Understand the basics of principles of management, types of organization and MIS
CO5: Understand the theory behind Work measurement technique, Production planning and elements of production control
CO6: Understand the concept of inventory control and the role of control charts in quality control

TEXT BOOKS

REFERENCES
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO 10</th>
<th>PO 11</th>
<th>PO 12</th>
<th>PSO 1</th>
<th>PSO 2</th>
<th>PSO 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the fundamentals, concepts and mechanisms involved in spectral analysis.</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the purpose and theories in qualitative analysis.</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the purpose and theories in quantitative analysis.</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the purpose and theories in IR spectral analysis.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the purpose and theories of chromatographic methods.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand the importance of analytical instrumentation during the purification, compounding and formulating the finished product.</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>

**Overall CO**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
AUDIT COURSE (AC)

AD5091 CONSTITUTION OF INDIA L T P C

3 0 0 0

OBJECTIVES:
- Teach history and philosophy of Indian Constitution.
- Describe the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- Summarize powers and functions of Indian government.
- Explain emergency rule.
- Explain structure and functions of local administration.

UNIT I INTRODUCTION
History of Making of the Indian Constitution-Drafting Committee- (Composition & Working) - Philosophy of the Indian Constitution-Preamble-Salient Features

UNIT II CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES

UNIT III ORGANS OF GOVERNANCE
Parliament-Composition-Qualifications and Disqualifications-Powers and Functions-Executive President-Governor-Council of Ministers-Judiciary, Appointment and Transfer of Judges, Qualifications Powers and Functions

UNIT IV EMERGENCY PROVISIONS

UNIT V LOCAL ADMINISTRATION
District's Administration head- Role and Importance-Municipalities- Introduction- Mayor and role of Elected Representative-CEO of Municipal Corporation-Pachayati raj- Introduction- PRI- Zila Pachayat-Elected officials and their roles- CEO ZilaPachayat- Position and role-Block level-Organizational Hierarchy (Different departments)-Village level- Role of Elected and Appointed officials-Importance of grass root democracy

TOTAL: 45 PERIODS

OUTCOMES:
CO1: Able to understand history and philosophy of Indian Constitution.
CO2: Able to understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
CO3: Able to understand powers and functions of Indian government.
CO4: Able to understand emergency rule.
CO5: Able to understand structure and functions of local administration.

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>CO3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>CO4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>CO5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>

TEXTBOOKS:
4. The Constitution of India (Bare Act), Government Publication, 1950
OBJECTIVES:
- Develop knowledge of self-development
- Explain the importance of Human values
- Develop the overall personality through value education
- Overcome the self destructive habits with value education
- Interpret social empowerment with value education

UNIT I INTRODUCTION TO VALUE EDUCATION 9
Values and self-development – Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non-moral valuation, Standards and principles, Value judgements

UNIT II IMPORTANCE OF VALUES 9
Importance of cultivation of values, Sense of duty, Devotion, Self-reliance, Confidence, Concentration, Truthfulness, Cleanliness. Honesty, Humanity, Power of faith, National Unity, Patriotism, Love for nature, Discipline

UNIT III INFLUENCE OF VALUE EDUCATION 9
Personality and Behaviour development - Soul and Scientific attitude. Positive Thinking, Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship. Happiness Vs suffering, love for truth.

UNIT IV REINCARNATION THROUGH VALUE EDUCATION 9

UNIT V VALUE EDUCATION IN SOCIAL EMPOWERMENT 9
Equality, Non violence, Humility, Role of Women, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively

TOTAL: 45 PERIODS

OUTCOMES:
CO1 – Gain knowledge of self-development
CO2 – Learn the importance of Human values
CO3 – Develop the overall personality through value education
CO4 – Overcome the self destructive habits with value education
CO5 – Interpret social empowerment with value education

<table>
<thead>
<tr>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔️</td>
<td>✔️</td>
<td></td>
<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>✔️</td>
<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>✔️</td>
<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>✔️</td>
<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>✔️</td>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔️</td>
</tr>
</tbody>
</table>

REFERENCES:
OBJECTIVES:
- Understand the methodology of pedagogy.
- Compare pedagogical practices used by teachers in formal and informal classrooms in developing countries.
- Infer how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.
- Illustrate the factors necessary for professional development.
- Identify the Research gaps in pedagogy.

UNIT I INTRODUCTION AND METHODOLOGY:
Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES
Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers’ attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT
Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes.

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS
Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 45 PERIODS

OUTCOMES:
- Understand the methodology of pedagogy.
- Understand Pedagogical practices used by teachers in formal and informal classrooms in developing countries.
- Find how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.
- Know the factors necessary for professional development.
- Identify the Research gaps in pedagogy.

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
REFERENCES:
OBJECTIVES:
- Develop healthy mind in a healthy body thus improving social health also improve efficiency
- Invent Do’s and Don’t’s in life through Yam
- Categorize Do’s and Don’t’s in life through Niyam
- Develop a healthy mind and body through Yog Asans
- Invent breathing techniques through Pranayam

UNIT I INTRODUCTION TO YOGA
Definitions of Eight parts of yog.( Ashtanga )

UNIT II YAM
Do’s and Don’t’s in life.
Shaucha, santosh, tapa, swadhyay, ishwarpnanidhan

UNIT III NIYAM
Do’s and Don’t’s in life.
Ahinsa, satya, astheya, bramhacharya and aparigraha

UNIT IV ASAN
Various yog poses and their benefits for mind & body

UNIT V PRANAYAM
Regularization of breathing techniques and its effects-Types of pranayam

OUTCOMES:
CO1 – Develop healthy mind in a healthy body thus improving social health also improve efficiency
CO2 – Learn Do’s and Don’t’s in life through Yam
CO3 – Learn Do’s and Don’t’s in life through Niyam
CO4 – Develop a healthy mind and body through Yog Asans
CO5 – Learn breathing techniques through Pranayam

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES:
1. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
2. ‘Yogic Asanas for Group Tarining-Part-I” : Janardan Swami Yogabhysi Mandal, Nagpur
OBJECTIVES:
- Develop basic personality skills holistically
- Develop deep personality skills holistically to achieve happy goals
- Rewrite the responsibilities
- Reframe a person with stable mind, pleasing personality and determination
- Discover wisdom in students

UNIT I  NEETISATAKAM-HOLISTIC DEVELOPMENT OF PERSONALITY - I  9
Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue)

UNIT II  NEETISATAKAM-HOLISTIC DEVELOPMENT OF PERSONALITY - II  9
Verses- 52,53,59 (don’t’s) - Verses- 71,73,75,78 (do’s)

UNIT III  APPROACH TO DAY TO DAY WORK AND DUTIES  9
Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48

UNIT IV  STATEMENTS OF BASIC KNOWLEDGE – I  9
Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18

UNIT V  PERSONALITY OF ROLE MODEL - SHRIMAD BHAGWADGEETA  9
Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 45PERIODS

OUTCOMES:
CO1: To develop basic personality skills holistically
CO2: To develop deep personality skills holistically to achieve happy goals
CO3: To rewrite the responsibilities
CO4: To reframe a person with stable mind, pleasing personality and determination
CO5: To awaken wisdom in students

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES:
1. Gopinath,Rashtriya Sanskrit Sansthanam P, Bhartrihari’s ThreeSatakam , Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram,Publication Department, Kolkata,2016
COURSE OBJECTIVES
The course will introduce the students to
- get a knowledge about Indian Culture
- Know Indian Languages and Literature religion and philosophy and the fine arts in India
- Explore the Science and Scientists of Ancient, Medieval and Modern India
- Understand education systems in India

UNIT I INTRODUCTION TO CULTURE 9
Culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian Culture, Ancient India, Medieval India, Modern India.

UNIT II INDIAN LANGUAGES AND LITERATURE 9
Indian Languages and Literature – I: Languages and Literature of South India, – Indian Languages and Literature – II: Northern Indian Languages & Literature

UNIT III RELIGION AND PHILOSOPHY 9
Major religions practiced in India and Understanding their Philosophy – religious movements in Modern India (Selected movements only)

UNIT IV FINE ARTS IN INDIA (ART, TECHNOLOGY & ENGINEERING) 9
Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in India, development of science in ancient, medieval and modern India

UNIT V EDUCATION SYSTEM IN INDIA 9
Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Science and Scientists of Medieval India, Scientists of Modern India

TOTAL: 45 PERIODS

COURSE OUTCOMES
After successful completion of the course the students will be able to
- Understand philosophy of Indian culture.
- Distinguish the Indian languages and literature.
- Learn the philosophy of ancient, medieval and modern India.
- Acquire the information about the fine arts in India.
- Know the contribution of scientists of different eras.
- Understand education systems in India

REFERENCES:
5. Satya Prakash, “Founders of Sciences in Ancient India”, Vijay Kumar Publisher, 1989
Course Objectives: The main learning objective of this course is to make the students an appreciation for:

1. Introduction to Sanga Tamil Literature.
2. ‘Agathinai’ and ‘Purathinai’ in SangaTamil Literature.
3. ‘Attruppadai’ in SangaTamil Literature.
4. ‘Puranaanuru’ in SangaTamil Literature.
5. ‘Pathitrupaththu’ in SangaTamil Literature.

UNIT I  SANGA TAMIL LITERATUREANINTRODUCTION  9

UNIT II  ‘AGATHINAI’AND’PURATHINAI’  9

UNIT III  ‘ATTRUPPADAI’.  9
AttruppadaiLiterature–Attruppadaiin'Puranaanuru'-Attruppadaiin'Pathitrupaththu'-Attruppadai in ‘Pathitrupaattu’.

UNIT IV  ‘PURANAANURU’  9
Puranaanuru on Good Administration, Rulerand Subjects–Emotion & its Effectin Puranaanuru.

UNIT V  ‘PATHITRUPATHTHU’  9
Pathitrupaththuin‘Etuthogai’–Pathitrupaththu’sParables–Tamildynasty:Valor, Administration, Charity in Pathitrupaththu- Mesage to Society from Pathitrupaththu.

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

1. Appreciate and apply the messages in Sanga Tamil Literature in their life.
2. Differentiate ‘Agathinai’ and ‘Purathinai’in their personal and societal life.
3. Appreciate and apply the messages in ‘Attruppadai’ in their personal and societal life.
4. Appreciate and apply the messages in ‘Puranaanuru’ in their personal and societal life.
5. Appreciate and apply the messages in ‘Pathitrupaththu’in their personal and societal life.

REFERENCES:

<table>
<thead>
<tr>
<th>CO</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>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total (L:45) = 45 PERIODS
COURSE DESCRIPTION

This course offers an introduction to language and communication. The primary goal of this course is to familiarize students with key ideas related to communication using language as well as non-verbal means. Ideas related to the use of language and the underlying power structures are also examined. The course also examines the role of media in communication and in the dissemination of ideas as well as opinions.

Objectives

- To familiarize students with the concept of communication using linguistic and non-linguistic resources.
- To help students ask critical questions regarding facts and opinions.
- To provide students with the material to discuss issues such as language and power structures.
- To help students think critically about false propaganda and fake news.

Learning Outcomes

- Students will be able to use linguistic and non-linguistic resources of language in an integrated manner for communication.
- Students will be able to analyse communication in terms of facts and opinions.
- Students will be able to discuss, analyse and argue about issues related to language and power.

UNIT I LINGUISTIC AND NON-LINGUISTIC RESOURCE OF COMMUNICATION: 9

a) Writing and Speech
b) Distinction between language structure and language use, form and function, acceptability and grammaticality
c) Gestures and Body language, pictures and symbols, cultural appropriacy
d) Communicative Competency, context and situation, combination of linguistic and non-linguistic elements of communication

UNIT II STRUCTURE OF WRITING/CONVERSATION: 9

a) Language skills and the communication cycle; speaking and listening, writing and reading
b) Initiating and closing conversations, intervention, turn taking
c) Writing for target reader, rhetorical devices and strategies
d) Coherence and Cohesion in speech and writing

UNIT III POWER STRUCTURE AND LANGUAGE USE: 9

a) Gender and language use
b) Politeness expressions and their use
c) Ethical dimensions of language use  
d) Language rights as part of human rights

UNIT IV MEDIA COMMUNICATION:  
a) Print media, electronic media, social media  
b) Power of media  
c) Manufacturing of opinion, fake news and hidden agendas

UNIT V PERSUASIVE COMMUNICATION AND MISCOMMUNICATION:  
a) Fundamentals of persuasive communication  
b) Persuasive strategies  
c) Communication barriers

TOTAL : 45 PERIODS

TEXT BOOKS:

OBJECTIVES:

- Teach definition and classification of values.
- Explain Purusartha.
- Describe Sarvodaya idea.
- Summarize sustenance of life.
- Conclude views of hierarchy of values.

UNIT I  DEFINITION AND CLASSIFICATION OF VALUES  9
Extrinsic values- Universal and Situational values- Physical- Environmental-Sensuous- Economic- Social-Aesthetic-Moral and Religious values

UNIT II  CONCEPTS RELATED TO VALUES  9
Purusartha-Virtue- Right- duty- justice- Equality- Love and Good

UNIT III  IDEOLOGY OF SARVODAYA  9
Egoism- Altruism and universalism- The Ideal of Sarvodaya and Vasudhaiva Kutumbakam

UNIT IV  SUSTENANCE OF LIFE  9
The Problem of Sustenance of value in the process of Social, Political and Technological Changes

UNIT V  VIEWS ON HIERARCHY OF VALUES  9
The Problem of hierarchy of values and their choice, The views of Pt. Madan Mohan Malviya and Mahatma Gandhi

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Able to understand definition and classification of values.
CO2: Able to understand purusartha.
CO3: Able to understand sarvodaya idea.
CO4: Able to understand sustenance of life.
CO5: Able to understand views of hierarchy of values.

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO2</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXTBOOKS:

2. Little, William, : An Introduction of Ethics (Allied Publisher, Indian Reprint 1955)
OBJECTIVES:

- Illustrate human relations at work its relationship with self.
- Explain the importance of interacting with people at work to develop teamwork.
- Infer the importance of physical health in maintaining human relations at work.
- Describe the importance of staying psychologically healthy.
- Identify the essential qualities for progressing in career.

UNIT I  UNDERSTANDING AND MANAGING YOURSELF  9
Human Relations and You: Self-Esteem and Self-Confidence: Self-Motivation and Goal Setting; Emotional Intelligence, Attitudes, and Happiness; Values and Ethics and Problem Solving and Creativity.

UNIT II  DEALING EFFECTIVELY WITH PEOPLE  9
Communication in the Workplace; Specialized Tactics for Getting Along with Others in the Workplace; Managing Conflict; Becoming an Effective Leader; Motivating Others and Developing Teamwork; Diversity and Cross-Cultural Competence.

UNIT III  STAYING PHYSICALLY HEALTHY  9
Yoga, Pranayam and Exercise: Aerobic and anaerobic.

UNIT IV  STAYING PSYCHOLOGICALLY HEALTHY  9
Managing Stress and Personal Problems, Meditation.

UNIT V  DEVELOPING CAREER THRUST  9

TOTAL: 45 PERIODS

OUTCOMES:
Students will be able to:
CO1: Understand the importance of self-management.
CO2: Know how to deal with people to develop teamwork.
CO3: Know the importance of staying healthy.
CO4: Know how to manage stress and personal problems.
CO5: Develop the personal qualities essential for career growth.

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOK:

REFERENCES:
COURSE DESCRIPTION

Psychological Processes course is designed for students to be aware of the basic principles of psychology for the better understanding of people's psyche and behaviour around them. This course enables learners to use the optimal use of different forms of thinking skills and thereby results in effective communication in diverse situations. Every unit of the syllabus highlights the psychological process of people, the most powerful and constructive use of perceptions.

OBJECTIVES

The major objectives of this course is

- To develop students’ awareness – on psychology, learning behavior and usage of perception effectively.
- To learn to use the various kinds of thinking in a formal context.
- To critically evaluate content and comprehend the message on the bases of perception, personality and intelligence.

UNIT 1: INTRODUCTION


UNIT 2: SENSORY & PERCEPTUAL PROCESSES

Some general properties of Senses: Visual system – the eye, colour vision – Auditory system – Hearing, listening, Sounds - Other senses - Selective attention; physiological correlates of attention; Internal influences on perception learning – set - motivation & emotion - cognitive styles; External influences on perception figure and ground separation – movement – organization – illusion; Internal-external interactions: Constancy - Depth Perception- Binocular & Monocular Perception; Perceptual defense & Perceptual vigilance; Sensory deprivation -Sensory bombardment; ESP - Social Perception.

UNIT 3: COGNITION & AFFECT


UNIT 4: THINKING, PROBLEM-SOLVING & DECISION MAKING

UNIT 5: PERSONALITY & INTELLIGENCE

Psychological phenomena & Attributes of humans - cognition, motivation, and behavior - thoughts, feelings, perceptions, and actions – personality dimensions, traits, patterns - Specialized knowledge, performance accomplishments, automaticity or ease of functioning, skilled performance under challenge - generative flexibility, and speed of learning or behavior change.

References
UNIT II LEARNING THEORIES

UNIT III TECHNOLOGICAL ADVANCEMENTS
Web tools – Social media in education – elearning – MOOCs – Mobile assisted learning – Learning Apps – Blended learning - Self-directed learning

UNIT IV EDUCATIONAL TECHNOLOGY
Technological implications on Education – Teaching, Learning & Testing with Technology - Advantages and drawbacks – Critical analysis on the use of technology

UNIT V ETHICAL IMPLICATIONS
Plagiarism – Online Copyright issues – Ethical and value implications of education and technology on individual and society.

TOTAL: 45 PERIODS

TEACHING METHODS
Teaching modes include guest lectures, discussion groups, presentations, visual media, and a practicum style of learning.

EVALUATION
As this is course is not a content based course, it focuses more on the ethical use of technology in education and society, and so, evaluation can be based on assignments and discussions. So there is no need for an end semester examination. Internals marks can be taken for the total marks.

INTERNAL (100 % WEIGHTAGE)
(a) Written Test (40 marks)
(b) Assignment: Write a real time report of the technology use in any school / college (15 marks)
(c) Presentation: Students choose any one of the technological tools and present its relevance to education and society (15 marks)
(d) Group discussion: Students discuss in groups on case studies relating to various challenges in education and technology use in society (20 marks)
(e) Blog entry: Making weekly blog posts in Class Blog on the topics related to the course posted by the instructor and commenting on others’ posts. (10 marks)

REFERENCES
1) Education and Social order by Bertrand Russel
2) Theories of learning by Bower and Hilgard
3) Technology and Society by Jan L Harrington
OBJECTIVES

- To create a new understanding by teaching philosophy through a comparison of Indian and Western traditions.
- To foster critical thinking and imagination by dealing with inter-related concepts in literature and science.
- To bridge the gap between the sciences and humanities through introspective analyses.
- To nurture an understanding of the self and elucidates ways to progress towards a higher understanding of one’s self and others.

UNIT I  KNOWLEDGE

UNIT II  ORIGIN

UNIT III  WORD

UNIT IV  KNOWLEDGE AS POWER/OPPRESSION

UNIT V  SELF KNOWLEDGE/BRAHMAN

TOTAL : 45 PERIODS

OUTCOMES:

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

1. Think sceptically, ask questions and to arrive at deductions.
2. Connect and relate different branches of thought.
3. Comprehends the relation between language, thought and action.
4. Arrive at a better understanding of self and others and forms a new outlook.
REFERENCES:

7. Bacon, Francis: Power as Knowledge

HU5177 APPLICATIONS OF PSYCHOLOGY IN EVERYDAY LIFE

<table>
<thead>
<tr>
<th>UNIT</th>
<th>INTRODUCTION</th>
<th>PSYCHOLOGY IN INDUSTRIES AND ORGANIZATIONS</th>
<th>PSYCHOLOGY AND MENTAL HEALTH</th>
<th>PSYCHOLOGY AND COUNSELING</th>
<th>PSYCHOLOGY AND SOCIAL BEHAVIOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>7</td>
<td>11</td>
</tr>
</tbody>
</table>

TOTAL: 45 PERIODS

TEXTBOOKS

HSMC– ELECTIVES – HUMANITIES II (EVEN SEMESTER)

HU5271 GENDER, CULTURE AND DEVELOPMENT

COURSE DESCRIPTION

This course offers an introduction to Gender Studies that asks critical questions about the meanings of sex and gender in Indian society. The primary goal of this course is to familiarize students with key issues, questions and debates in Gender Studies, both historical and contemporary drawing from Indian literature and media studies, to examine cultural assumptions about sex, gender, and sexuality. This course integrates analysis of current events through student presentations, aiming to increase awareness of contemporary and historical experiences of women, and of the multiple ways that sex and gender interact with class, caste and other social identities. This course also seeks to build an understanding of the concepts of gender, gender-based violence, sexuality, and rights and their impact on development through a number of discussions, exercises and reflective activities.

Objectives

✓ To familiarize students with the concepts of sex and gender through literary and media texts.
✓ To help students ask critical questions regarding gender roles in society.
✓ To provide students with the material to discuss gender issues such as gender based discrimination, violence and development.
✓ To help students think critically about gender based problems and solutions.

Learning Outcomes

➢ Students will be able to critically read literary and media texts and understand the underlying gender perspectives in them.
➢ Students will be able to analyse current social events in the light of gender perspectives.
➢ Students will be able to discuss, analyse and argue about issues related to gender and their impact on society, culture and development.

UNIT I: Introduction to Gender

• Definition of Gender
• Basic Gender Concepts and Terminology
• Exploring Attitudes towards Gender
• Social Construction of Gender

Texts:

1. Sukhu and Dukhu (Amar Chitra Katha)
2. The Cat who Became a Queen (Folk tale, J. Hinton Knowles, Folk-Tales of Kashmir. London: Kegan Paul, Trench, Trübner, and Company, 1893, pp. 8-10.)

UNIT II: Gender Roles and Relations

• Types of Gender Roles
• Gender Roles and Relationships Matrix
• Gender-based Division and Valuation of Labour

Texts:

1. Muniyakka (Short Story, Lakshmi Kannan, Nandanvan and Other Stories, Hyderabad: Orient Blackswan, 2011)
UNIT III: Gender Development Issues

- Identifying Gender Issues
- Gender Sensitive Language
- Gender, Governance and Sustainable Development
- Gender and Human Rights
- Gender and Mainstreaming

Texts:
2. Tell Us Marx (Poem, Mallika Sengupta, Translated by Sanjukta Dasgupta)

UNIT IV: Gender-based Violence

- The concept of violence
- Types of Gender-based violence
- The relationship between gender, development and violence
- Gender-based violence from a human rights perspective

Texts:
1. Lights Out (Play, Manjula Padmanabhan)
2. Lights Out (Video of play enacted)

UNIT V: Gender and Culture

- Gender and Film
- Gender, Media and Advertisement

Texts:
1. Mahanagar (Movie: Satyajit Ray)
2. Beti Bachao Beti Padhao Advertisements

READINGS: Relevant additional texts for readings will be announced in the class. Classes will consist of a combination of activities: dialogue-based lectures, discussions, collaborative learning activities, group work and in-class assignments.

ASSESSMENT AND GRADING:
Discussion & Classroom Participation: 20%
Project/Assignment: 30%
End Term Exam: 50%
OBJECTIVES:

- To emphasize the meaning and nature of ethics, human values and holistic life for leading a good, successful and happy life through continuous examination of thoughts and conduct in day to day life.
- To understand the status and responsible role of individual in abatement of value crisis in contemporary world in order to develop a civilized and human society. Understanding the process of ethical decision making through critical assessment of incidents/cases of ethical dilemmas in personal, professional and social life.
- To view the place of Ethics and Human Values in the development of individual and society through identification and cross examination of life values and world view of his/her role models in society.

UNIT I  HUMAN LIFE, ITS AIM AND SIGNIFICANCE
The concept of a successful life, happy life and a meaningful life, Ethical and decision making capability and its development: Meaning of Ethical dilemma, sharing real life experiences.

UNIT II  CREATIVE AND LEADERSHIP ABILITY AND THEIR DEVELOPMENT
Intellectual, Emotional, Creative, Ethico-spiritual development, Aesthetic sense, Self-dependency, Activeness, Development of positive attitude.

UNIT III  HARMONY IN PERSONAL AND SOCIAL LIFE:
Concept of personal and group Ethics; Balance between - rights and duties-welfare of self and welfare of all, Creating a value based work culture in hostel, classroom and other places in the campus and society.

UNIT IV  CHARACTER, RIGHTEOUSNESS AND VIRTUES FOR A MEANINGFUL LIFE
Egolessness, Humility, Righteousness, Purity, Truthfulness, Integrity, Self-restraint, Self-control, Sense of responsibility, Empathy, Love, Compassion, Maitri / Comradeship, Cooperation, Tolerance.

UNIT V  DILEMMA BETWEEN MATERIALISTIC DEVELOPMENT AND HUMAN WELFARE

TOTAL:45 PERIODS

OUTCOMES:

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

1. Enable students to understand the concept of contemporary ethics at different levels: Individual, local and Global and enable them to cross examine the ethical and social consequences of the decisions of their life-view and world view.
2. Develop the ability of students to create a balance between their individual freedom and social responsibilities and enable them to identify the personal, professional and social values and integrate them in their personality after cross examination.
3. Enable students to cross examine their earlier decisions taken in life and understand the meaning of ethical dilemma to overcome the ethical dilemmas and engage in critical reflection.
4. Develop positive habits of thought and conduct and work cohesively with fellow beings who have variety of strengths, experiences, shortcomings and challenges, hence to enable them to handle diverse type of personalities.
5. Enable students to develop a method for making ethically sound decisions for themselves, within hostels, classrooms, university campus and society.
COURSE DESCRIPTION

This is an intensive course designed to promote comprehensive understanding and insights into the nature of cinema and other related forms and practices. Movies, though at times are used more as escapism, they are also a true art form and expressive tool used by writers, directors and actors. This course will explore the aesthetics of cinema, the concepts behind storytelling and various other elements of a film. It will also explore the impact of movies in our society and in our lives. It also encourages students to use films as a medium to analyse visual texts and read underlying messages.

OBJECTIVES:

- To help learners understand the various movie genres and its types.
- To understand various elements that contributes to film making.
- To make them realize the impact of film in society.
- To analyse the visual media and interpret the underlying messages.
UNIT I  THE COMPONENTS OF FILMS

Story, Screenplay & Script – Actors – Director – Crew Members – Mis En Scene – Structure of A Film – Narrative Elements – Linear & Non-Linear – Types of Movie Genres: Mysteries, Romantic Comedies, Horror Etc.

UNIT II  EVOLUTION OF FILM


UNIT III  FILMS ACROSS THE WORLD


UNIT IV  INDIAN FILMS


UNIT V  INTERPRETING FILMS

Film Criticism & Appreciation – Censorship in Movies – Cultural Representation in Movies – Television – New Media & Online Media – Films Beyond Entertainment.

TOTAL: 45 PERIODS

OUTCOMES

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

- Recognize types of films, their impact on society and their roles in our lives.
- Have an understanding of the concepts of storytelling, Mise en Scene, and other elements of film making.
- Interpret the underlying messages in the movies.

Teaching Methods

- Each unit consists of reading materials, learning activities videos, websites. Students are expected to watch movies sometimes in class and at times at home and discuss in class.

Evaluation

- As this is course is critical appreciation course on films, there is no written end semester examination. The course is more on learning how to critically analyse a movie and appreciate its finer elements. Therefore evaluation can be based on assignments and discussions. Internals marks can be taken for the total marks.

Internal (100 % weightage)

- Assignment 1: Write a movie review with critical analysis (20 marks).
- Assignment2 : Write a script for a scene taken from a short story / novella (20 marks).
- Presentation: Students choose any one topic related to films and present it to the audience. (25 marks)
• Group discussion: Students discuss in groups on the various aspects of movies and its impact on society. (25 marks)
• Blog entry: Making weekly blog posts in Class Blog on the topics related to the course posted by the instructor and commenting on others’ posts. (10 marks)

REFERENCES

1. A Biographical Dictionary of Film by David Thomson, Secker & Warburg, 1975
2. Signs and Meaning in the Cinema by Peter Wollen, Secker & Warburg, 1969
3. The World Viewed by Stanley Cavell 1971
4. Film Style and Technology: History and Analysis by Barry Salt, Starword, 1983

HU5275 FUNDAMENTALS OF LANGUAGE AND LINGUISTICS

OBJECTIVES

• To broadly introduce students to the formal and theoretical aspects of linguistics.
• To enable learners to understand the various practical applications of language and recent findings in the field of applied linguistics.

CONTENTS:

UNIT I LANGUAGE AND LINGUISTICS: AN OVERVIEW

UNIT II MORPHOLOGY - WORDS OF LANGUAGE

UNIT III SYNTAX- THE SENTENCE PATTERNS OF LANGUAGE AND SEMANTICS-THE MEANING OF LANGUAGE

UNIT IV PHONETICS – THE SOUNDS OF LANGUAGE
UNIT V  APPLIED LINGUISTICS - THE PRACTICAL APPLICATIONS OF LANGUAGE

Language learning and teaching (ELT)- lexicography-translation studies-computational linguistics-neurolinguistics (speech pathology and language disorders)- forensic linguistics – sociolinguistics.

TOTAL : 45 PERIODS

Teaching Methods :
Lectures, discussion.

Evaluation Internal and External :
Internal: 2 written tests + assignments, seminars, project (50+15+15+20).
External: A 3 hour written exam (50 marks)

REFERENCES :

HU5276 UNDERSTANDING SOCIETY AND CULTURE THROUGH LITERATURE  L T P C
3 0 0 3

OBJECTIVES

- To internalize the importance of language by understanding its role in the transformation of man.
- To look at language, literature and culture as locus of identity and change.
- To extract meaning from existing literatures and cultures.
- To identify meanings in modern life by reconnecting with lost cultures.

Unit 1 Introduction
Why study literature? Tracing the origin – pictures. Tokens as precursors of writing. Movement from three dimensions to two dimensions- Pictography. From visual to oral -Logography. Reading out literature to young children- Edmund J Farrell.

Unit 2 Reading Culture
Reading culture through language, signs and consumables- Roland Barthes. Culture through poems- Nissim Ezekiel’s ‘The night of the Scorpion’. ‘Nothing’s Changed’- Tatamkhulu Afrika- Apartheid. Ruskin Bond- ‘Night train at Deoli’- How real life is different from movies.

Unit 3 Identifying Meaning
Searching and locating meaning through literature. Looking for order in a chaotic world. The Myth of Sisyphus (Albert Camus) and Adi Shankar’s ‘Jagat Mithya’- the world as an illusion. The Indian version as ‘meaningless meaning’.
Unit 4. **Post Modernism**
‘If on a winter’s night a traveler’- Italo Calvino. The book about the reader- the experience of reading as reading. Metafiction. Selfie Culture. Visual Culture as purpose of modern life.

Unit 5. **Returning to Pictures**

Reading list
1. Bond, Ruskin: ‘Night train at Deoli’
2. Ezekiel, Nissim: ‘The Night of the Scorpion’
3. Afrika, Tatamkhulu: ‘Nothing’s Changed’
4. Barthes, Roland: *Mythologies*
5. Shankaracharya: *Viveka Chudamani*
6. Camus, Albert- *The Myth of Sisyphus*
7. Calvino, Italo: *If on a winter’s night a traveler*

**Outcome**
- Can identify the connections among language, literature and culture.
- Is able to relate between seemingly different aspects of life.
- Understands the fractions in modern life and can assimilate meanings.