ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
REGULATIONS 2021
B. TECH. PETROCHEMICAL ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)

PROGRAM EDUCATIONAL OBJECTIVES:

After 3 years of graduation, our graduates will be

1. Successful in their careers in the diversified sectors of the Petrochemical Technology.
2. A successful entrepreneur, manager or occupy higher positions.
3. Pursuing higher studies and research programmes in India and abroad.

PROGRAM OUTCOMES:

1. The graduates of the petrochemical technology will be able to apply knowledge of science and engineering to analyze petrochemical technology problems.
2. The graduates of the petrochemical technology will be able to Understand and interpret the problems in petrochemical processes.
3. The graduates of the petrochemical technology will be able to Design and develop appropriate solutions for the petrochemical systems.
4. The graduates of the petrochemical technology will be able to Identify, formulate and solve complex petrochemical technology problems.
5. The graduates of the petrochemical technology will be able to Use the modern engineering skills and software tools to analyze petrochemical technology problems.
6. The graduates of the petrochemical technology will be able to understand the global and societal impact of Petrochemical engineering practice.
7. The graduates of the petrochemical technology will be able to understand the impact of petrochemical technology solutions in environmental context and adopt suitable methods for sustainable development.

8. The graduates of the petrochemical technology will be able to meet the professional and ethical duties.

9. The graduates of the petrochemical technology will function effectively as an individual and in multidisciplinary teams.

10. The graduates of the petrochemical technology will be able to communicate effectively both in verbal and written forms.

11. The graduates of the petrochemical technology will be able to apply principles of management and economics for the effective functioning of Petrochemical and allied Industries.

12. The graduates of the petrochemical technology will engage in lifelong learning.

**PROGRAM SPECIFIC OUTCOMES:**

Graduates of Petrochemical Technology will:

PSO1: Strong foundation in Chemical, Petroleum & Petrochemical processes and effectively describe various units of modern petroleum refining and petrochemical industries.

PSO2: Effectively describe, analyze, develop appropriate solutions for Chemical, Petroleum & Petrochemical industrial problems using innovative research & development skills with continuous learning efforts.

<table>
<thead>
<tr>
<th>PEOs</th>
<th>PROGRAMME OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>I</td>
<td>3</td>
</tr>
<tr>
<td>II</td>
<td>2</td>
</tr>
<tr>
<td>III</td>
<td>3</td>
</tr>
</tbody>
</table>

**PROGRAMME OUTCOMES:**

<table>
<thead>
<tr>
<th>PEOs</th>
<th>PROGRAMME OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>I</td>
<td>3</td>
</tr>
<tr>
<td>II</td>
<td>2</td>
</tr>
<tr>
<td>III</td>
<td>3</td>
</tr>
</tbody>
</table>
### B.E. PETROCHEMICAL ENGINEERING

**CURRICULUM FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS I AND IV**

#### SEMESTER I

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</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>IP3151</td>
<td>Induction Programme</td>
<td></td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>HS3151</td>
<td>Professional English – I</td>
<td>HSMC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>MA3151</td>
<td>Matrices and Calculus</td>
<td>BSC</td>
<td>3 1 0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>PH3151</td>
<td>Engineering Physics</td>
<td>BSC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>CY3151</td>
<td>Engineering Chemistry</td>
<td>BSC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>GE3151</td>
<td>Problem Solving and Python Programming</td>
<td>ESC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>GE3152</td>
<td>தமிழர் மரபு /Heritage of Tamils</td>
<td>HSMC</td>
<td>1 0 0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**THEORY**

**PRACTICALS**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</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>8.</td>
<td>GE3171</td>
<td>Problem Solving and Python Programming Laboratory</td>
<td>ESC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>BS3171</td>
<td>Physics and Chemistry Laboratory</td>
<td>BSC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>GE3172</td>
<td>English Laboratory $^$</td>
<td>EEC</td>
<td>0 0 2</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

**TOTAL**

16 1 10 27 22

$^\$ Skill Based Course
<table>
<thead>
<tr>
<th>S. No.</th>
<th>COURSE CODE</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><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>HS3251</td>
<td>Professional English – II</td>
<td>HSMC</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>MA3251</td>
<td>Statistic and Numerical Methods</td>
<td>BSC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>PH3253</td>
<td>Materials Science for Technologists</td>
<td>BSC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>BE3252</td>
<td>Basic Electrical, Electronics and Instrumentation Engineering</td>
<td>BSC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>CY3251</td>
<td>Chemistry for Technologists</td>
<td>BSC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>GE3251</td>
<td>Engineering Graphics</td>
<td>ESC</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>7.</td>
<td>GE3252</td>
<td>கற்பினை வேதாய்மை / Tamil Language / Tamil and Technology</td>
<td>HSMC</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td>NCC Credit Course Level 1*</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>GE3271</td>
<td>Engineering Practices Laboratory</td>
<td>ESC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>10.</td>
<td>BE3272</td>
<td>Basic Electrical, Electronics and Instrumentation Engineering Laboratory</td>
<td>ESC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>11.</td>
<td>GE3272</td>
<td>Communication Laboratory / Foreign Language</td>
<td>EEC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td>1</td>
<td>16</td>
</tr>
</tbody>
</table>

# NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

$ Skill Based Course
# SEMESTER III

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>COURSE CODE</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></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>MA3351</td>
<td>Transforms and Partial Differential Equations</td>
<td>BSC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>PE3351</td>
<td>Process Calculations</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>PC3351</td>
<td>Fluid Mechanics for Petrochemical Technologists</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>PC3353</td>
<td>Petroleum Primary Processing Technology</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>CH3491</td>
<td>Heat Transfer</td>
<td>PCC</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>PC3352</td>
<td>Mechanical Operations</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>PE3481</td>
<td>Heat Transfer Laboratory</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>8.</td>
<td>PE3361</td>
<td>Fluid Mechanics and Solid Operations laboratory</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>GE3361</td>
<td>Professional Development*</td>
<td>EEC</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>TOTAL</td>
<td></td>
<td>17</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

$ Skill Based Course

# SEMESTER IV

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>COURSE CODE</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></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>PE3451</td>
<td>Chemical Engineering Thermodynamics</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>PC3451</td>
<td>Petroleum Secondary Processing Technology</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>EL3491</td>
<td>Mass Transfer</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>CPE339</td>
<td>Natural Gas and LNG Processing</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>CPE331</td>
<td>Chemical Reaction Engineering</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>GE3451</td>
<td>Environmental Sciences and Sustainability</td>
<td>BSC</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>NCC Credit Course Level 2#</td>
<td></td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>PC3461</td>
<td>Petrochemical and Polymer Analysis Laboratory</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>PC3462</td>
<td>Petroleum Product Testing Laboratory</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>10.</td>
<td>PM3511</td>
<td>Industrial Training/Internship I*</td>
<td>EEC</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td></td>
<td>17</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

# NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.
*Four weeks industrial training/internship carries two credits. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester.

### SEMESTER V

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>COURSE CODE</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><strong>THEORY</strong></td>
<td></td>
<td>Save content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>PM3501</td>
<td>Equilibrium Staged Operations</td>
<td>PCC</td>
<td>2 1 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>PC3551</td>
<td>Catalytic Reaction Engineering</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</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>4.</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>5.</td>
<td></td>
<td>Professional Elective III</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Mandatory Course- I*</td>
<td>MC</td>
<td>3 0 0</td>
<td>3</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>7.</td>
<td>PM3511</td>
<td>Industrial Training/Internship I**</td>
<td>EEC</td>
<td>0 0 0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>CH3561</td>
<td>Mass Transfer Laboratory</td>
<td>PCC</td>
<td>0 0 3</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td>14 1 3</td>
<td>19.5</td>
<td>18.5</td>
</tr>
</tbody>
</table>

* Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC-I)

**Four weeks industrial training/internship carries two credits. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester.

### SEMESTER VI

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>COURSE CODE</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><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>PC3652</td>
<td>Process Instrumentation Dynamics and Control</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>PM3601</td>
<td>Refinery Process Design</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Open Elective – I*</td>
<td>OEC</td>
<td>3 0 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></td>
<td>Mandatory Course-II*</td>
<td>MC</td>
<td>3 0 0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>NCC Credit Course Level 3#</td>
<td></td>
<td>3 0 0</td>
<td>3</td>
<td>3 #</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>PM3611</td>
<td>Chemical Reaction and Process Control Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>PC3651</td>
<td>Computational Petrochemical Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>11.</td>
<td>PM3711</td>
<td>Industrial Training/Internship II**</td>
<td>EEC</td>
<td>- - -</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td>21 0 8</td>
<td>29</td>
<td>22</td>
</tr>
</tbody>
</table>
*Open Elective – I shall be chosen from the emerging technologies.
**Two weeks industrial training/internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester.
* Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MC- II)
* NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

### SEMESTER VII/VIII

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>COURSE CODE</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><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td>L T P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>PC3752</td>
<td>Process Safety in Petrochemical Industries</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>PC3751</td>
<td>Process Equipment Design</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>GE3791</td>
<td>Human values and Ethics</td>
<td>HSMC</td>
<td>2 0 0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>Elective- Management #</td>
<td></td>
<td>HSMC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>Open Elective – II**</td>
<td></td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>Open Elective – III***</td>
<td></td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>Open Elective – IV***</td>
<td></td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td>L T P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>PM3711</td>
<td>Industrial Training/Internship II##</td>
<td>EEC</td>
<td>- - -</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>L T P</td>
<td></td>
<td>20</td>
</tr>
</tbody>
</table>

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

**Open Elective – II shall be chosen from the emerging technologies.
***Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes

# Elective- Management shall be chosen from the Elective Management courses
##Two weeks industrial training/internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

### SEMESTER VIII/VII

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>COURSE CODE</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><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td>L T P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>PM3811</td>
<td>Internship#/Project Work</td>
<td>EEC</td>
<td>0 0 20</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>L T P</td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

#15 weeks of continuous Internship in an organization carries 10 credits.

**TOTAL CREDITS : 165.5**
### ELECTIVE – MANAGEMENT COURSES

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>GE3751</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>GE3752</td>
<td>Total Quality Management</td>
<td>HSMC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>GE3753</td>
<td>Engineering Economics and Financial Accounting</td>
<td>HSMC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>GE3754</td>
<td>Human Resource Management</td>
<td>HSMC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>GE3755</td>
<td>Knowledge Management</td>
<td>HSMC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>GE3792</td>
<td>Industrial Management</td>
<td>HSMC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

### MANDATORY COURSES I

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>MX3081</td>
<td>Introduction to Women and Gender Studies</td>
<td>MC</td>
<td>3 0 0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>MX3082</td>
<td>Elements of Literature</td>
<td>MC</td>
<td>3 0 0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>MX3083</td>
<td>Film Appreciation</td>
<td>MC</td>
<td>3 0 0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>MX3084</td>
<td>Disaster Management</td>
<td>MC</td>
<td>3 0 0</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

### MANDATORY COURSES II

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>MX3085</td>
<td>Well Being with traditional practices (Yoga, Ayurveda and Siddha)</td>
<td>MC</td>
<td>3 0 0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>MX3086</td>
<td>History of Science and Technology in India</td>
<td>MC</td>
<td>3 0 0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>MX3087</td>
<td>Political and Economic Thought for a Humane Society</td>
<td>MC</td>
<td>3 0 0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>MX3088</td>
<td>State, Nation Building and Politics in India</td>
<td>MC</td>
<td>3 0 0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>MX3089</td>
<td>Industrial Safety</td>
<td>MC</td>
<td>3 0 0</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
## PROFESSIONAL ELECTIVE COURSES: VERTICALS

<table>
<thead>
<tr>
<th>Vertical I</th>
<th>Vertical II</th>
<th>Vertical III</th>
<th>Vertical IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Engineering</td>
<td>Hydrocarbon Transportation and Storage</td>
<td>Health, Safety and Environment</td>
<td>Process Intensification</td>
</tr>
<tr>
<td>Renewable and Non-renewable Energy</td>
<td>Storage Transportation of Crude Oil and Natural Gas</td>
<td>Fire and Explosion Control</td>
<td>Transport phenomena</td>
</tr>
<tr>
<td>Energy Conservation and Management</td>
<td>Petroleum Economics</td>
<td>Industrial Hygiene</td>
<td>Process modeling and simulation</td>
</tr>
<tr>
<td>Energy Auditing &amp; Demand Side Management</td>
<td>Piping Engineering</td>
<td>Transportation Safety</td>
<td>Polymer Technology</td>
</tr>
<tr>
<td>Hydrogen and Microbial fuel cells</td>
<td>Design of Pressure Vessels and storage Vessels</td>
<td>Process Hazard Analysis Studies</td>
<td>Fluidization Engineering</td>
</tr>
<tr>
<td>Biofuels</td>
<td>Petroleum Corrosion Technology</td>
<td>Health Safety and Environmental Management</td>
<td>Water Treatment and Management</td>
</tr>
<tr>
<td>Unconventional Hydrocarbon Sources</td>
<td>Product Design and Development for Petrochemical Engineers</td>
<td>Plant Safety and Risk Management</td>
<td>Process Instrumentation</td>
</tr>
</tbody>
</table>

### Registration of Professional Elective Courses from Verticals:
Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation. Students are permitted to choose all Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in Semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to Regulations 2021 Clause 4.10.
# PROFESSIONAL ELECTIVE COURSES: VERTICALS

## VERTICAL I: ENERGY ENGINEERING

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>PM3001</td>
<td>Renewable and Non-renewable Energy</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CPE334</td>
<td>Energy Conservation and Management</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CPE333</td>
<td>Energy Auditing &amp; Demand Side Management</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>CPE337</td>
<td>Hydrogen and Microbial fuel cells</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>PM3002</td>
<td>Biofuels</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>CPE347</td>
<td>Unconventional Hydrocarbon Sources</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

## VERTICAL II: HYDROCARBON TRANSPORTATION AND STORAGE

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>CPE345</td>
<td>Storage Transportation of Crude Oil and Natural Gas</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CPE342</td>
<td>Petroleum Economics</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CPE343</td>
<td>Piping Engineering</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>CPE332</td>
<td>Design of Pressure Vessels and storage Vessels</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>CPE341</td>
<td>Petroleum Corrosion Technology</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>CPE340</td>
<td>Product Design and Development for Petrochemical Engineers</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
### VERTICAL III: HEALTH, SAFETY AND ENVIRONMENT

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>CPC331</td>
<td>Fire and Explosion Control</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CPE338</td>
<td>Industrial Hygiene</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CPE346</td>
<td>Transportation Safety</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>CPC333</td>
<td>Process Hazard Analysis Studies</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>CPE336</td>
<td>Health Safety and Environmental Management</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>CPE344</td>
<td>Plant Safety and Risk Management</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

### VERTICAL IV: PROCESS INTENSIFICATION

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>PM3003</td>
<td>Transport phenomena</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CCH331</td>
<td>Process modeling and simulation</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CPC332</td>
<td>Polymer Technology</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>CPE335</td>
<td>Fluidization Engineering</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>PM3004</td>
<td>Water Treatment and Management</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>CPC334</td>
<td>Process Instrumentation</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories.

### OPEN ELECTIVE I AND II
**EMERGING TECHNOLOGIES**

To be offered other than Faculty of Information and Communication Engineering

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>OCS351</td>
<td>Artificial Intelligence and Machine Learning Fundamentals</td>
<td>OEC</td>
<td>2 0 2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>OCS352</td>
<td>IoT Concepts and Applications</td>
<td>OEC</td>
<td>2 0 2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>OCS353</td>
<td>Data Science Fundamentals</td>
<td>OEC</td>
<td>2 0 2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>OCS354</td>
<td>Augmented and Virtual Reality</td>
<td>OEC</td>
<td>2 0 2</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

### OPEN ELECTIVES – III

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>OHS351</td>
<td>English for Competitive Examinations</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>OCE353</td>
<td>Lean Concepts, Tools And Practices</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>OMG352</td>
<td>NGOs and Sustainable Development</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>OMG353</td>
<td>Democracy and Good Governance</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>OME353</td>
<td>Renewable Energy Technologies</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>OME354</td>
<td>Applied Design Thinking</td>
<td>OEC</td>
<td>2 0 2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>OMF351</td>
<td>Reverse Engineering</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>OMF353</td>
<td>Sustainable Manufacturing</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>9.</td>
<td>OAU351</td>
<td>Electric and Hybrid Vehicle</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>10.</td>
<td>OAS352</td>
<td>Space Engineering</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>11.</td>
<td>OIM351</td>
<td>Industrial Management</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>OIE354</td>
<td>Quality Engineering</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Type</td>
<td>Credits</td>
<td>Hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------------</td>
<td>------</td>
<td>---------</td>
<td>-------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSF351</td>
<td>Fire Safety Engineering</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OML351</td>
<td>Introduction to non-destructive testing</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OMR351</td>
<td>Mechatronics</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORA351</td>
<td>Foundation of Robotics</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAE352</td>
<td>Fundamentals of Aeronautical engineering</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OGI351</td>
<td>Remote Sensing Concepts</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAI351</td>
<td>Urban Agriculture</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OEE352</td>
<td>Electric Vehicle technology</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OEI353</td>
<td>Introduction to PLC Programming</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OBT352</td>
<td>Biomedical Instrumentation</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OFD352</td>
<td>Traditional Indian Foods</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OFD353</td>
<td>Introduction to food processing</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPY352</td>
<td>IPR for Pharma Industry</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTT351</td>
<td>Basics of Textile Finishing</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTT352</td>
<td>Industrial Engineering for Garment Industry</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTT353</td>
<td>Basics of Textile Manufacture</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OCH353</td>
<td>Energy Technology</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OCH354</td>
<td>Surface Science</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPT351</td>
<td>Basics of Plastics Processing</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OEC351</td>
<td>Signals and Systems</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OEC352</td>
<td>Fundamentals of Electronic Devices and Circuits</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OBM351</td>
<td>Foundation Skills in integrated product Development</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OBM352</td>
<td>Assistive Technology</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OMA352</td>
<td>Operations Research</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OMA353</td>
<td>Algebra and Number Theory</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OMA354</td>
<td>Linear Algebra</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SL. NO.</td>
<td>COURSE CODE</td>
<td>COURSE TITLE</td>
<td>CATEGORY</td>
<td>PERIODS PER WEEK</td>
<td>TOTAL CONTACT PERIODS</td>
<td>CREDITS</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>--------------------------------------------------------------------</td>
<td>----------</td>
<td>------------------</td>
<td>------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>1.</td>
<td>OHS352</td>
<td>Project Report Writing</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>OCE354</td>
<td>Basics of Integrated Water Resources Management</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>OMA355</td>
<td>Advanced Numerical Methods</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>OMA356</td>
<td>Random Processes</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>OMA357</td>
<td>Queuing and Reliability Modelling</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>OMG354</td>
<td>Production and Operations Management for Entrepreneurs</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>OMG355</td>
<td>Multivariate Data Analysis</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>OME352</td>
<td>Additive Manufacturing</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>9.</td>
<td>OME353</td>
<td>New Product Development</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>10.</td>
<td>OME355</td>
<td>Industrial Design &amp; Rapid Prototyping Techniques</td>
<td>OEC</td>
<td>2 0 2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>11.</td>
<td>OMF352</td>
<td>Micro and Precision Engineering</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>OMF354</td>
<td>Cost Management of Engineering Projects</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>13.</td>
<td>OAU352</td>
<td>Batteries and Management system</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>14.</td>
<td>OAU353</td>
<td>Sensors and Actuators</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>15.</td>
<td>OAS353</td>
<td>Space Vehicles</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>16.</td>
<td>OIM352</td>
<td>Management Science</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>17.</td>
<td>OIM353</td>
<td>Production and Control</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>18.</td>
<td>OIE353</td>
<td>Operations Management</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>19.</td>
<td>OSF352</td>
<td>Industrial Hygiene</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>20.</td>
<td>OML352</td>
<td>Electrical, Electronic and Magnetic materials</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>21.</td>
<td>OML353</td>
<td>Nanomaterials and applications</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>22.</td>
<td>OMR353</td>
<td>Sensors</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>23.</td>
<td>ORA352</td>
<td>Foundation of Automation</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>24.</td>
<td>ORA353</td>
<td>Concepts in Mobile Robotics</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>25.</td>
<td>OMV351</td>
<td>Marine Propulsion</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Department</td>
<td>Credits</td>
<td>Lecture</td>
<td>Lab</td>
<td>Project</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------</td>
<td>------------</td>
<td>---------</td>
<td>---------</td>
<td>-----</td>
<td>---------</td>
</tr>
<tr>
<td>OMV352</td>
<td>Marine Merchant Vehicles</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OMV353</td>
<td>Elements of Marine Engineering</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OAE353</td>
<td>Drone Technologies</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OGI352</td>
<td>Geographical Information System</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OAI352</td>
<td>Agriculture Entrepreneurship Development</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OEN352</td>
<td>Biodiversity Conservation</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OEE353</td>
<td>Introduction to control systems</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OEI354</td>
<td>Introduction to Industrial Automation Systems</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OBT353</td>
<td>Environment and Agriculture</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OFD354</td>
<td>Fundamentals of Food Engineering</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OFD355</td>
<td>Food safety and Quality Regulations</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OPY353</td>
<td>Nutraceuticals</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OTT354</td>
<td>Basics of Dyeing and Printing</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OTT355</td>
<td>Fibre Science</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OTT356</td>
<td>Garment Manufacturing Technology</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OCH353</td>
<td>Energy Technology</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OCH354</td>
<td>Surface Science</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OPT352</td>
<td>Plastic Materials for Engineers</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OPT353</td>
<td>Properties and Testing of Plastics</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OEC353</td>
<td>VLSI Design</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OEC354</td>
<td>Industrial IoT and Industry 4.0</td>
<td>OEC</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>OBM353</td>
<td>Wearable devices</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>OBM354</td>
<td>Medical Informatics</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
Enrollment for B.E. / B. Tech. (Honours) / Minor degree (Optional)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech. (Honours) Minor degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes. Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 of Regulations 2021.

### Name of the Programme

<table>
<thead>
<tr>
<th>S.No</th>
<th>Subject Area</th>
<th>Credits per Semester</th>
<th>Total Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>1</td>
<td>HSMC</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>BSC</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>ESC</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>PCC</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>5</td>
<td>PEC</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>OEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>EEC</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Non-Credit  / (Mandatory)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>22</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### VERTICALS FOR MINOR DEGREE (IN ADDITIONS TO ALL THE VERTICALS OF OTHER PROGRAMMES)

<table>
<thead>
<tr>
<th>Vertical I</th>
<th>Vertical II</th>
<th>Vertical III</th>
<th>Vertical IV</th>
<th>Vertical V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fintech and Block Chain</td>
<td>Entrepreneurship</td>
<td>Public Administration</td>
<td>Business Data Analytics</td>
<td>Environment and Sustainability</td>
</tr>
<tr>
<td>Financial Management</td>
<td>Foundations of Entrepreneurship</td>
<td>Principles of Public Administration</td>
<td>Statistics For Management</td>
<td>Sustainable Infrastructure Development</td>
</tr>
<tr>
<td>Fundamentals of Investment</td>
<td>Team Building &amp; Leadership Management for Business</td>
<td>Constitution of India</td>
<td>Datamining For Business Intelligence</td>
<td>Sustainable Agriculture and Environmental Management</td>
</tr>
<tr>
<td>Banking, Financial Services and Insurance</td>
<td>Creativity &amp; Innovation in Entrepreneurship</td>
<td>Public Personnel Administration</td>
<td>Human Resource Analytics</td>
<td>Sustainable Bio Materials</td>
</tr>
<tr>
<td>Introduction to Blockchain and its Applications</td>
<td>Principles of Marketing Management For Business</td>
<td>Administrative Theories</td>
<td>Marketing And Social Media Web Analytics</td>
<td>Materials for Energy Sustainability</td>
</tr>
<tr>
<td>Fintech Personal Finance and Payments</td>
<td>Human Resource Management for Entrepreneurs</td>
<td>Indian Administrative System</td>
<td>Operation And Supply Chain Analytics</td>
<td>Green Technology</td>
</tr>
<tr>
<td>Introduction to Fintech</td>
<td>Financing New Business Ventures</td>
<td>Public Policy Administration</td>
<td>Financial Analytics</td>
<td>Environmental Quality Monitoring and Analysis</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Integrated Energy Planning for Sustainable Development</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Energy Efficiency for Sustainable Development</td>
</tr>
</tbody>
</table>
(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

**VERTICAL 1: FINTECH AND BLOCK CHAIN**

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>CMG331</td>
<td>Financial Management</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CMG332</td>
<td>Fundamentals of Investment</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CMG333</td>
<td>Banking, Financial Services and Insurance</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>CMG334</td>
<td>Introduction to Blockchain and its Applications</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>CMG335</td>
<td>Fintech Personal Finance and Payments</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>CMG336</td>
<td>Introduction to Fintech</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

**VERTICAL 2: ENTREPRENEURSHIP**

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>CMG337</td>
<td>Foundations of Entrepreneurship</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CMG338</td>
<td>Team Building &amp; Leadership Management for Business</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CMG339</td>
<td>Creativity &amp; Innovation in Entrepreneurship</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>CMG340</td>
<td>Principles of Marketing Management For Business</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>CMG341</td>
<td>Human Resource Management for Entrepreneurs</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>CMG342</td>
<td>Financing New Business Ventures</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
# VERTICAL 3: PUBLIC ADMINISTRATION

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>CMG343</td>
<td>Principles of Public Administration</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CMG344</td>
<td>Constitution of India</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CMG345</td>
<td>Public Personnel Administration</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>CMG346</td>
<td>Administrative Theories</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>CMG347</td>
<td>Indian Administrative System</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>CMG348</td>
<td>Public Policy Administration</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

# VERTICAL 4: BUSINESS DATA ANALYTICS

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>CMG349</td>
<td>Statistics For Management</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CMG350</td>
<td>Data Mining For Business Intelligence</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CMG351</td>
<td>Human Resource Analytics</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>CMG352</td>
<td>Marketing And Social Media Web Analytics</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>CMG353</td>
<td>Operation And Supply Chain Analytics</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>CMG354</td>
<td>Financial Analytics</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
**VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY**

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</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>CES331</td>
<td>Sustainable infrastructure Development</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CES332</td>
<td>Sustainable Agriculture and Environmental Management</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CES333</td>
<td>Sustainable Bio Materials</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>CES334</td>
<td>Materials for Energy Sustainability</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>CES335</td>
<td>Green Technology</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>CES336</td>
<td>Environmental Quality Monitoring and Analysis</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>CES337</td>
<td>Integrated Energy Planning for Sustainable Development</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>CES338</td>
<td>Energy Efficiency for Sustainable Development</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”

“One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character."

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity
This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts
Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values
This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity
Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules
This would address some lacunas that students might have, for example, English, computer
familiarity etc.

(vi) Lectures by Eminent People
Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area
A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations
They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities
About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering / Technology / Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

REFERENCES:
Guide to Induction program from AICTE

HS3151 PROFESSIONAL ENGLISH I L T P C 3 0 0 3

OBJECTIVES:
- To improve the communicative competence of learners
- To learn to use basic grammatical structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text
- To help learners use language effectively in professional contexts
- To develop learners’ ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.

UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 1
What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C’s of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?
UNIT 1 INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION  8
Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Wh/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

UNIT II NARRATION AND SUMMATION  9
Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes & suffixes); Synonyms and Antonyms. Phrasal verbs.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT  9
Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product/Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).

UNIT IV CLASSIFICATION AND RECOMMENDATIONS  9
Reading – Newspaper articles; Journal reports –and Non Verbal Communication ( tables, pie charts etc., ). Writing – Note-making / Note-taking ("Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal (chart, graph etc, to verbal mode) Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.

UNIT V EXPRESSION  9
Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.

TOTAL : 45 PERIODS

LEARNING OUTCOMES :
At the end of the course, learners will be able
- To use appropriate words in a professional context
- To gain understanding of basic grammatic structures and use them in right context.
- To read and infer the denotative and connotative meanings of technical texts
- To write definitions, descriptions, narrations and essays on various topics

TEXT BOOKS :
1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)
2. English for Science & Technology Cambridge University Press, 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:
ASSESSMENT PATTERN
Two internal assessments and an end semester examination to test students’ reading and writing skills along with their grammatical and lexical competence.

MA3151 MATRICES AND CALCULUS L T P C
3 1 0 4

COURSE 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 9+3

UNIT II DIFFERENTIAL CALCULUS 9+3

UNIT III FUNCTIONS OF SEVERAL VARIABLES 9+3

UNIT IV INTEGRAL CALCULUS 9+3
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 - Applications : Hydrostatic force and pressure, moments and centres of mass.

UNIT V MULTIPLE INTEGRALS 9+3

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course the students will be able to
- CO1 :Use the matrix algebra methods for solving practical problems.
- CO2 :Apply differential calculus tools in solving various application problems.
- CO3 :Able to use differential calculus ideas on several variable functions.
CO4 : Apply different methods of integration in solving practical problems.
CO5 : Apply multiple integral ideas in solving areas, volumes and other practical problems.

TEXT BOOKS:
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCES:

PH3151 ENGINEERING PHYSICS

COURSE OBJECTIVES
- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to be successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

UNIT I MECHANICS

UNIT II ELECTROMAGNETIC WAVES
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 – Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization – Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

UNIT V  APPLIED QUANTUM MECHANICS
The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch’s theorem for particles in a periodic potential – Basics of Kronig-Penney model and origin of energy bands.

COURSE OUTCOMES
After completion of this course, the students should be able to
CO1: Understand the importance of mechanics.
CO2: Express their knowledge in electromagnetic waves.
CO3: Demonstrate a strong foundational knowledge in oscillations, optics and lasers.
CO4: Understand the importance of quantum physics.
CO5: Comprehend and apply quantum mechanical principles towards the formation of energy bands.

TEXT BOOKS:
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.

REFERENCES:
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag,
COURSE OBJECTIVES:

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

UNIT I WATER AND ITS TREATMENT


UNIT II NANO CHEMISTRY

Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of nanomaterials: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III PHASE RULE AND COMPOSITES

Phase rule: Introduction, definition of terms with examples. One component system: water system; Reduced phase rule: Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.

Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

UNIT IV FUELS AND COMBUSTION

Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO\textsubscript{2} emission and carbon foot print.

UNIT V ENERGY SOURCES AND STORAGE DEVICES

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; Electric vehicles: working principles Fuel cells: H\textsubscript{2}-O\textsubscript{2} fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

TOTAL: 45 PERIODS
COURSE OUTCOMES
At the end of the course, the students will be able:

CO1 : To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
CO2 : To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
CO3 : To apply the knowledge of phase rule and composites for material selection requirements.
CO4 : To recommend suitable fuels for engineering processes and applications.
CO5 : To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

TEXT BOOKS:

REFERENCES:

GE3151 PROBLEM SOLVING AND PYTHON PROGRAMMING

OBJECTIVES:
- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING
UNIT II     DATA TYPES, EXPRESSIONS, STATEMENTS
Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

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

UNIT IV     LISTS, TUPLES, DICTIONARIES
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNIT V     FILES, MODULES, PACKAGES
Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

TOTAL : 45 PERIODS

OUTCOMES:
Upon completion of the course, students will be able to
CO1: Develop algorithmic solutions to simple computational problems.
CO2: Develop and execute simple Python programs.
CO3: Write simple Python programs using conditionals and looping for solving problems.
CO4: Decompose a Python program into functions.
CO5: Represent compound data using Python lists, tuples, dictionaries etc.
CO6: Read and write data from/to files in Python programs.

TEXT BOOKS:

REFERENCES:
5. https://www.python.org/
TEXT-CUM-REFERENCE BOOKS

3. Social Life of the Tamils - Dr.K.K.Pillai (Published by: TNTB & ESC and RMRL).
4. Social Life of the Tamils - Dr.S.Singaravelu.
5. Social Life of the Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by:...
International Institute of Tamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9. Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)

11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)


GE3171 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY L T P C

OBJECTIVES:
- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

EXPERIMENTS:
Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here.

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)

2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).

3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)

4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)

5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)

6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)

7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)

8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy, Matplotlib, scipy)

9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)

10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter’s age validity, student mark range validation)


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:
CO1: Develop algorithmic solutions to simple computational problems
CO2: Develop and execute simple Python programs.
CO3: Implement programs in Python using conditionals and loops for solving problems.
CO4: Deploy functions to decompose a Python program.
CO5: Process compound data using Python data structures.
CO6: Utilize Python packages in developing software applications.

TEXT BOOKS:

REFERENCES:
5. https://www.python.org/

BS3171 PHYSICS AND CHEMISTRY LABORATORY

PHYSICS LABORATORY: (Any Seven Experiments)

COURSE OBJECTIVES:
- To learn the proper use of various kinds of physics laboratory equipment.
- To learn how data can be collected, presented and interpreted in a clear and concise manner.
- To learn problem solving skills related to physics principles and interpretation of experimental data.
- To determine error in experimental measurements and techniques used to minimize such error.
- To make the student as an active participant in each part of all lab exercises.

LIST OF EXPERIMENTS
1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
2. Simple harmonic oscillations of cantilever.
3. Non-uniform bending - Determination of Young’s modulus
4. Uniform bending – Determination of Young’s modulus
5. Laser- Determination of the wave length of the laser using grating
6. Air wedge - Determination of thickness of a thin sheet/wire
7. a) Optical fibre - Determination of Numerical Aperture and acceptance angle
b) Compact disc- Determination of width of the groove using laser.
8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
11. Photoelectric effect
12. Michelson Interferometer.
13. Melde’s string experiment
14. Experiment with lattice dynamics kit.

TOTAL: 30 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students should be able to
CO1: Understand the functioning of various physics laboratory equipment.
CO2: Use graphical models to analyze laboratory data.
CO3: Use mathematical models as a medium for quantitative reasoning and describing physical reality.
CO4: Access, process and analyze scientific information.
CO5: Solve problems individually and collaboratively.

CHEMISTRY LABORATORY: (Any seven experiments)

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 alloys.
- To demonstrate the synthesis of nanoparticles

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)
1. Preparation of Na₂CO₃ as a primary standard and estimation of acidity of a water sample using the primary standard
2. Determination of types and amount of alkalinity in water sample.
   - Split the first experiment into two
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler’s method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Estimation of TDS of a water sample by gravimetry.
8. Determination of strength of given hydrochloric acid using pH meter.
9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
13. Preparation of nanoparticles (TiO₂/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

TOTAL: 30 PERIODS

OUT COMES :
- 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 analyse and determine the composition of alloys.
- To learn simple method of synthesis of nanoparticles
- To quantitatively analyse the impurities in solution by electroanalytical techniques
TEXT BOOKS:

GE3172 ENGLISH LABORATORY

OBJECTIVES:
- To improve the communicative competence of learners
- To help learners use language effectively in academic/work contexts
- To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
- To build on students’ English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION
Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; - politeness strategies- making polite requests, making polite offers, replying to polite requests and offers- understanding basic instructions( filling out a bank application for example).

UNIT II NARRATION AND SUMMATION
Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities. Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations* - describing experiences and feelings- engaging in small talk- describing requirements and abilities.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT
Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking – Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.

UNIT IV CLASSIFICATION AND RECOMMENDATIONS
Listening – Listening to TED Talks; Listening to lectures - and educational videos. Speaking – Small Talk; discussing and making plans-talking about tasks-talking about progress- talking about positions and directions of movement-talking about travel preparations- talking about transportation-

UNIT V EXPRESSION
Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions. Speaking –making predictions- talking about a given topic-giving opinions-understanding a website-describing processes

TOTAL : 30 PERIODS

LEARNING OUTCOMES:
At the end of the course, learners will be able
- To listen and comprehend complex academic texts
- To speak fluently and accurately in formal and informal communicative contexts
- To express their opinions effectively in both oral and written medium of communication
ASSESSMENT PATTERN
- One online / app based assessment to test listening /speaking
- End Semester ONLY listening and speaking will be conducted online.
- Proficiency certification is given on successful completion of listening and speaking internal test and end semester exam.

HS3251 PROFESSIONAL ENGLISH -II
L T P C 2 0 0 2

OBJECTIVES:
- To engage learners in meaningful language activities to improve their reading and writing skills
- To learn various reading strategies and apply in comprehending documents in professional context.
- To help learners understand the purpose, audience, contexts of different types of writing
- To develop analytical thinking skills for problem solving in communicative contexts
- To demonstrate an understanding of job applications and interviews for internship and placements

UNIT I  MAKING COMPARISONS  6
Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases

UNIT II  EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING  6
Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds

UNIT III  PROBLEM SOLVING  6
Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences

UNIT IV  REPORTING OF EVENTS AND RESEARCH  6

UNIT V  THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY  6
Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.

TOTAL : 30 PERIODS

OUTCOMES:
At the end of the course, learners will be able
- To compare and contrast products and ideas in technical texts.
- To identify cause and effects in events, industrial processes through technical texts
- To analyse problems in order to arrive at feasible solutions and communicate them orally and in the written format.
- To report events and the processes of technical and industrial nature.
- To present their opinions in a planned and logical manner, and draft effective resumes in context of job search.
TEXT BOOKS:
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:

ASSESSMENT PATTERN
Two internal assessments and an end semester examination to test students’ reading and writing skills along with their grammatical and lexical competence.

MA3251 STATISTICS AND NUMERICAL METHODS

OBJECTIVES:
- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I TESTING OF HYPOTHESIS 9+3
Sampling distributions - Tests for single mean, proportion and 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.

UNIT II DESIGN OF EXPERIMENTS 9+3
One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - 2^2 factorial design.

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3
UNIT IV  INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION

Lagrange’s and Newton’s divided difference interpolations – Newton’s forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson’s 1/3 rules.

UNIT V  NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS


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

- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture.
- Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

TEXT BOOKS:

REFERENCES:
• To learn about iron-carbon system, and about various ferrous and non-ferrous alloys.
• To introduce the preparation, properties and applications of ceramics, composites and nanomaterials.

UNIT I  CRYSTALLOGRAPHY  

UNIT II  MECHANICAL PROPERTIES  

UNIT III  PHASE DIAGRAMS  
Basic concepts - Gibbs phase rule – Unary phase diagram (iron) - Binary phase diagrams: isomorphous systems (Cu-Ni) – determination of phase composition and phase amounts – tieline and lever rule - binary eutectic diagram with no solid solution and limited solid solution (Pb-Sn) – eutectoid and peritectic reactions - other invariant reactions – microstructural development during the slow cooling: eutectic, hypereutectic and hypoeutectic compositions.

UNIT IV  FERROUS AND NONFERROUS ALLOYS  

UNIT V  CERAMICS, COMPOSITES AND NANO MATERIALS  

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Upon completion of this course, the students should be able to
CO2: Understand the basics of crystallography and its importance in materials properties
CO3: Understand the significance of dislocations, strengthening mechanisms, and tensile, creep, hardness and fracture behavior of materials
CO4: Gain knowledge on binary phase diagrams, and also will be able to determine the phase composition and phase amount.
CO5: Understand about the Fe-C system and various microstructures in it, and also about various ferrous and non-ferrous alloys.
CO6: Get adequate understanding on the preparation, properties and applications of ceramics, composites and nanomaterials.

TEXT BOOKS:
1. R.Balasubramaniam, Callister's Materials Science and Engineering, Wiley (Indian Edition),

38

REFERENCES:

BE3252 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION

ENGINEERING

OBJECTIVES:
- To introduce the basics of electric circuits and analysis
- To impart knowledge in domestic wiring
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To introduce the functional elements and working of sensors and transducers.

UNIT I ELECTRICAL CIRCUITS
DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm’s Law – Kirchhoff’s Laws – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)
Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only), Three phase supply – star and delta connection – power in three-phase systems

UNIT II MAGNETIC CIRCUITS AND ELECTRICAL INSTALLATIONS
Magnetic circuits definitions- MMF, flux, reluctance, magnetic field intensity, flux density, fringing, self and mutual inductances-simple problems.
Domestic wiring, types of wires and cables, earthing, protective devices- switch fuse unit-
Miniature circuit breaker-moulded case circuit breaker- earth leakage circuit breaker, safety precautions and First Aid

UNIT III ELECTRICAL MACHINES
UNIT III  ANALOG ELECTRONICS

UNIT V  SENSORS AND TRANSDUCERS
Sensors, solenoids, pneumatic controls with electrical actuator, mechatronics, types of valves and its applications, electro-pneumatic systems, proximity sensors, limit switches, piezoelectric, hall effect, photo sensors,Strain gauge, LVDT, differential pressure transducer,optical and digital transducers, Smart sensors, Thermal Imagers.

COURSE OUTCOMES:
After completing this course, the students will be able to
CO1: Compute the electric circuit parameters for simple problems
CO2: Explain the concepts of domestics wiring and protective devices
CO3: Explain the working principle and applications of electrical machines
CO4: Analyze the characteristics of analog electronic devices
CO5: Explain the types and operating principles of sensors and transducers

TEXT BOOKS:
3. S.K. Bhattacharya, Basic Electrical Engineering, Pearson Education, 2019
4. James A Svoboda, Richard C. Dorf, Dorf’s Introduction to Electric Circuits, Wiley,2018

REFERENCES:

CY3251  CHEMISTRY FOR TECHNOLOGISTS
L T P C
3 0 0 3

OBJECTIVES:
The course aims to
• Provide conceptual understanding on spectroscopic and surface analytical techniques.
• Impart knowledge to students on the chemistry of surface and interfaces.
• make students well versed on the chemical analysis of oils, fats, soaps & lubricants.
• Provide deep knowledge to students about various classification and properties of hydrocarbon.
• familiarize students with the identification and characteristics of dyes and their applications.

UNIT I  SPECTROSCOPIC TECHNIQUES
spectroscopy, UV-Vis, IR spectroscopy, Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM) - principles, instrumentation (Block diagram) and applications.

UNIT II CHEMISTRY OF INTERFACES 9

UNIT III OILS, FATS, SOAPS & LUBRICANTS 9
Chemical constitution, Chemical analysis of oils and fats – acid, saponification and iodine values, Definitions, determinations and significance. Definition, mechanism of lubrication, preparation of petrolubes, desirable characteristics – viscosity, viscosity index, carbon residue, oxidation stability, flash and fire points, cloud and pour points, aniline point. Semisolid lubricant – greases, preparation of sodium, lithium, calcium and axle greases and uses, consistency test and drop point test.Solid lubricants – graphite and molybdenum disulphide.

UNIT IV HYDROCARBON 9

UNIT V COLORANTS 9
Theory of colour and constitution : chromophore and auxochrome, bathochromic and hypsochromic shift, classification of dyes based on application and composition. Chemistry of azo dye – synthesis of Methyl red, Methyl orange, Congo red, phenolphthalein, fluorescein and eosin.

TOTAL: 45 PERIODS

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

- Understand and apply spectroscopic techniques for the analysis of engineering materials for their applications.
- Make use of the applications of adsorption in detergency, wetting, spreading, foaming, de-foaming, and water repellence and separation processes.
- Analyse and estimate oils, fats, lubricants and soap for their intended applications.
- Distinguish and demonstrate the role of different types of hydrocarbon.
- Realize the chemical structures, properties and relationships of different types of dyes and their applications.

TEXT BOOKS :

REFERENCES :
GE3251 ENGINEERING GRAPHICS

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Drawing engineering curves.
2. Drawing freehand sketch of simple objects.
3. Drawing orthographic projection of solids and section of solids.
4. Drawing development of solids
5. Drawing isometric and perspective projections of simple solids.

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

UNIT I PLANE CURVES
Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE
Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS AND FREEHAND SKETCHING
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.
Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES
Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.
Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)
UNIT V  ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+12

Principles of isometric projection — isometric scale — isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids - Prisms, pyramids and cylinders by visual ray method.

Practicing three dimensional modeling of isometric projection of simple objects by CAD Software (Not for examination)

TOTAL: (L=30+P=60) 90 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Use BIS conventions and specifications for engineering drawing.
- Construct the conic curves, involutes and cycloid.
- Solve practical problems involving projection of lines.
- Draw the orthographic, isometric and perspective projections of simple solids.
- Draw the development of simple solids.

TEXT BOOK:

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. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day.
வரலை மற்றும் பணிகள் தமிழக வரலை மற்றும் பணிகள்:

அலகு I

1. தமிழக வரலை மற்றும் பணிகள் - பலகைசுகை பலகைசுகை - கல்வியியல் கல்வியியல் - பலகைசுகை கல்வியியல்.

அலகு II

2. கல்வியியல் கல்வி கல்வியியல் - கல்வியியல் கல்வியியல் - கல்வியியல் கல்வியியல் - கல்வியியல் கல்வியியல்.

அலகு III

3. கல்வியியல் கல்வி கல்வியியல் - கல்வியியல் கல்வியியல் - கல்வியியல் கல்வியியல்.

அலகு IV

4. கல்வியியல் கல்வி கல்வியியல் - கல்வியியல் கல்வியியல் - கல்வியியல் கல்வியியல்.

அலகு V

5. கல்வியியல் கல்வி கல்வியியல் - கல்வியியல் கல்வியியல் - கல்வியியல் கல்வியியல் - கல்வியியல் கல்வியியல்.

TEXT-CUM-REFERENCE BOOKS

1. தமிழ் வரலை - பணிகள் பலகைசுகை - கல்வியியல் (எழுதியவர்: தமிழக பலகைசுகை கல்வியியல் பலகைசுகை).
2. கல்வியியல் கல்வி - பலகைசுகை பலகைசு. (எழுதியவர்: தமிழக பலகைசுகை).
3. கல்வி - கல்வியியல் கல்வியியல் கல்வி. (எழுதியவர்: தமிழக பலகைசு. 
4. கல்வியியல் - கல்வியியல் பலகைசு. (எழுதியவர்: தமிழக பலகைசு.
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TTNB & ESC and RMRL - (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K. K. Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
## NCC Credit Course Level 1*

**NX3251**  
(ARMY WING)  
NCC Credit Course Level - I  

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>202</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

### NCC GENERAL

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCC 1</td>
<td>Aims, Objectives &amp; Organization of NCC</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>NCC 2</td>
<td>Incentives</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>NCC 3</td>
<td>Duties of NCC Cadet</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>NCC 4</td>
<td>NCC Camps: Types &amp; Conduct</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

### NATIONAL INTEGRATION AND AWARENESS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>NI 1</td>
<td>National Integration: Importance &amp; Necessity</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>NI 2</td>
<td>Factors Affecting National Integration</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>NI 3</td>
<td>Unity in Diversity &amp; Role of NCC in Nation Building</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>NI 4</td>
<td>Threats to National Security</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

### PERSONALITY DEVELOPMENT

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD 1</td>
<td>Self-Awareness, Empathy, Critical &amp; Creative Thinking, Decision Making and Problem Solving</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>PD 2</td>
<td>Communication Skills</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PD 3</td>
<td>Group Discussion: Stress &amp; Emotions</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

### LEADERSHIP

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>L 1</td>
<td>Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>L 2</td>
<td>Case Studies: Shivaji, Jhasi Ki Rani</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

### SOCIAL SERVICE AND COMMUNITY DEVELOPMENT

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS 1</td>
<td>Basics, Rural Development Programmes, NGOs, Contribution of Youth</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>SS 4</td>
<td>Protection of Children and Women Safety</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>SS 5</td>
<td>Road / Rail Travel Safety</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>SS 6</td>
<td>New Initiatives</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>SS 7</td>
<td>Cyber and Mobile Security Awareness</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

TOTAL: 30 PERIODS
NCC Credit Course Level 1*

NX3252  (NAVAL WING) NCC Credit Course Level - I  

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>LT</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Aims, Objectives &amp; Organization of NCC</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Incentives</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Duties of NCC Cadet</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>NCC Camps: Types &amp; Conduct</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NCC GENERAL**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>LT</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>NI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>National Integration: Importance &amp; Necessity</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Factors Affecting National Integration</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Unity in Diversity &amp; Role of NCC in Nation Building</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Threats to National Security</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NATIONAL INTEGRATION AND AWARENESS**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>LT</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Self-Awareness, Empathy, Critical &amp; Creative Thinking, Decision Making and Problem Solving</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Communication Skills</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Group Discussion: Stress &amp; Emotions</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PERSONALITY DEVELOPMENT**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>LT</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Case Studies: Shivaji, Jhasi Ki Rani</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LEADERSHIP**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>LT</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Basics, Rural Development Programmes, NGOs, Contribution of Youth</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Protection of Children and Women Safety</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Road / Rail Travel Safety</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>New Initiatives</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Cyber and Mobile Security Awareness</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SOCIAL SERVICE AND COMMUNITY DEVELOPMENT**

TOTAL : 30 PERIODS
# NCC Credit Course Level 1*

**(AIR FORCE WING)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Code</th>
<th>Name</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>NX3253</td>
<td></td>
<td>NCC Credit Course Level - I</td>
<td>20</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

## NCC GENERAL

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCC 1</td>
<td>Aims, Objectives &amp; Organization of NCC</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCC 2</td>
<td>Incentives</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCC 3</td>
<td>Duties of NCC Cadet</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCC 4</td>
<td>NCC Camps: Types &amp; Conduct</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## NATIONAL INTEGRATION AND AWARENESS

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>NI 1</td>
<td>National Integration: Importance &amp; Necessity</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NI 2</td>
<td>Factors Affecting National Integration</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NI 3</td>
<td>Unity in Diversity &amp; Role of NCC in Nation Building</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NI 4</td>
<td>Threats to National Security</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## PERSONALITY DEVELOPMENT

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD 1</td>
<td>Self-Awareness, Empathy, Critical &amp; Creative Thinking, Decision Making and Problem Solving</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD 2</td>
<td>Communication Skills</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD 3</td>
<td>Group Discussion: Stress &amp; Emotions</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## LEADERSHIP

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>L 1</td>
<td>Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L 2</td>
<td>Case Studies: Shivaji, Jhasi Ki Rani</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## SOCIAL SERVICE AND COMMUNITY DEVELOPMENT

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS 1</td>
<td>Basics, Rural Development Programmes, NGOs, Contribution of Youth</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS 4</td>
<td>Protection of Children and Women Safety</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS 5</td>
<td>Road / Rail Travel Safety</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS 6</td>
<td>New Initiatives</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS 7</td>
<td>Cyber and Mobile Security Awareness</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL : 30 PERIODS**
COURSE OBJECTIVES:

- 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.
- Wiring various electrical joints in common household electrical wire work.
- 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.
- 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) Planing 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

a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
b) Staircase wiring
c) Fluorescent Lamp wiring with introduction to CFL and LED types.
d) Energy meter wiring and related calculations/ calibration
e) Study of Iron Box wiring and assembly
f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadac)
g) Study of emergency lamp wiring/Water heater

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) Study an elements of smart phone.
- b) Assembly and dismantle of LED TV.
- c) Assembly and dismantle of computer/ laptop

**TOTAL : 60 PERIODS**

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

**CO1:** 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.

**CO2:** Wire various electrical joints in common household electrical wire work.

**CO3:** 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.

**CO4:** Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

**BE3272  BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION  L  T  P  C  0 0 4  2**

**ENGINEERING LABORATORY**

**COURSE OBJECTIVES:**
- To train the students in conducting load tests electrical machines
- To gain practical experience in experimentally obtaining the characteristics of electronic devices and rectifiers
- To train the students to measure three phase power and displacement

**List of Experiments**
1. Verification of ohms and Kirchhoff’s Laws.
2. Three Phase Power Measurement
3. Load test on DC Shunt Motor.
4. Load test on Self Excited DC Generator
5. Load test on Single phase Transformer
6. Load Test on Induction Motor
7. Characteristics of PN and Zener Diodes
8. Characteristics of BJT, SCR and MOSFET
9. Design and analysis of Half wave and Full Wave rectifiers
10. Measurement of displacement of LVDT

TOTAL: 60 PERIODS

COURSE OUTCOMES:
After completing this course, the students will be able to

CO1: Use experimental methods to verify the Ohm’s law and Kirchhoff’s Law and to measure three phase power

CO2: Analyze experimentally the load characteristics of electrical machines

CO3: Analyze the characteristics of basic electronic devices

CO4: Use LVDT to measure displacement

GE327 COMMUNICATION LABORATORY (Second Semester)

OBJECTIVES
- To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
- To be able to communicate effectively through writing.

UNIT I
Speaking: Role Play Exercises Based on Workplace Contexts, - talking about competition-discussing progress toward goals-talking about experiences- talking about events in life-discussing past events-Writing: writing emails ( formal & semi-formal).

UNIT II
Speaking: discussing news stories-talking about frequency-talking about travel problems-discussing travel procedures- talking about travel problems- making arrangements-describing arrangements-discussing plans and decisions- discussing purposes and reasons- understanding common technology terms-Writing: - writing different types of emails.

UNIT III
Speaking: discussing predictions-describing the climate-discussing forecasts and scenarios-talking about purchasing-discussing advantages and disadvantages- making comparisons-discussing likes and dislikes- discussing feelings about experiences-discussing imaginary scenarios Writing: short essays and reports-formal/semi-formal letters.

UNIT IV
Speaking: discussing the natural environment-describing systems-describing position and movement- explaining rules-( example- discussing rental arrangements)- understanding technical instructions-Writing: writing instructions-writing a short article.

UNIT V
Speaking: describing things relatively-describing clothing-discussing safety issues( making recommendations) talking about electrical devices-describing controlling actions- Writing: job application( Cover letter + Curriculum vitae)-writing recommendations.

TOTAL: 60 PERIODS

LEARNING OUTCOMES
- Speak effectively in group discussions held in a formal/semi formal contexts.
- Write emails and effective job applications.
Assessment Pattern
- One online / app based assessment to test speaking and writing skills
- Proficiency certification is given on successful completion of speaking and writing.

MA3351 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

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

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

UNIT - II: FOURIER SERIES
Dirichlet’s conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

UNIT - III: APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS
Classification of PDE – Method of separation of variables – Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

UNIT - IV: FOURIER TRANSFORMS

UNIT - V: Z – TRANSFORMS AND DIFFERENCE EQUATIONS

TOTAL : 60 PERIODS

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

TEXT BOOKS:

REFERENCES:

PE3351 PROCESS CALCULATIONS

OBJECTIVE:
• To teach concept of degree of freedom and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.

UNIT I
Base and derived Units – Composition of Mixture and solutions – calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT II
Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallisation, drying etc., - Material balance with chemical reaction – Limiting and excess reactants – recycle – bypass and purging – Unsteady state material balances.

UNIT III
Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity – Use of humidity in condensation and drying – Humidity chart, dew point.

UNIT IV

UNIT V
Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels – Calculation of excess air from orsat technique, problems on sulphur and sulphur burning compounds – Application of Process simulators in energy and material balance problems.

TOTAL: 45 PERIODS
COURSE OUTCOMES: (Cos)
1. Understand the fundamentals of system of units, apply ideal gas law to solve problems in pure components and mixtures.
2. Apply stoichiometric principles to solve problems and write material balance for different process equipments.
3. Understand and apply basics of humidity to solve problems in humidification and other processes.
4. Understand and apply the basics of energy balance concepts to solve to different chemical processes.
5. Understand the basics of fuels and combustion, to solve problems on combustion of various fuels and also to find excess air.
6. Apply the above knowledge in process flow sheeting calculations.

TEXT BOOKS:

REFERENCES:
2. Venkatramani. V, Anatharaman. N and Meera Shariffa Begam “ Process Calculations” Printice Hall of India, New Delhi,
### Course Articulation Matrix

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PROCESS CALCULATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the fundamentals of system of units, apply ideal gas law to solve problems in pure components and mixtures.</td>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Apply stoichiometric principles to solve problems and write material balance for different process equipments.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand and apply basics of humidity to solve problems in humidification and other processes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand and apply the basics of energy balance concepts to solve to different chemical processes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the basics of fuels and combustion, to solve problems on combustion of various fuels and also to find excess air.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Apply the above knowledge to process flow sheeting in industries.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</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:
- To impart to the student knowledge on fluid properties, fluid statics, dynamic characteristics for through pipes and porous medium.
- To impart flow measurement and fluid machineries.

UNIT I  PROPERTIES OF FLUIDS AND CONCEPT OF PRESSURE  9

UNIT II MOMENTUM BALANCE AND ITS APPLICATIONS  9
Basic equation of fluid flow – Mass balance in a flowing fluid; continuity- Differential momentum balance; Equations of motion - macroscopic momentum balances - Bernoulli’s equation – Correction for fluid friction – Correction for pump work - Velocity potential - Reynolds experiment and significance.

UNIT III DIMENSIONAL ANALYSIS  9
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.

UNIT IV FLOW OF INCOMPRESSIBLE FLUIDS THROUGH DUCTS  9

UNIT V TRANSPORTATION AND METERING  9

OUTCOMES:
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 Bernouli 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 roups 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.
CO6: Understand the impact of technology change and also develop responsibilities to the professional engineering practices.

TEXT BOOKS:

REFERENCES:
## Course Articulation Matrix

<table>
<thead>
<tr>
<th>Course Outcome</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<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>PO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>Apply Bernoulli principle, Navier - Stokes equation and compute pressure variation in static fluid.</td>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<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>PO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the different types of flow conditions in fixed bed and fluidized beds.</td>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<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.</td>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td></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>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>Overall CO</strong></td>
<td></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.
PC3353  PETROLEUM PRIMARY PROCESSING TECHNOLOGY  L T P C  3 0 0 3

OBJECTIVE:
- To make the students to learn the primary refining operation of crude oil and testing of petroleum products and its treatment techniques.

UNIT I  CRUDE OIL COMPOSITION AND CLASSIFICATION  9
Theories behind the Origin of petroleum – Exploration and production of petroleum – Basics of hydrocarbon chemistry – Composition of crude oil – Impurities present in crude oil – Crude oil classification and its characteristics – Crude oil properties, Crude oil assay – Indigenous and imported crudes – Crude availability Vs demands – Refining capacity of India.

UNIT II  TESTING OF PETROLEUM PRODUCTS  9

UNIT III  CRUDE PROCESSING  9

UNIT IV  LUBE DISTILLATE TREATMENT TECHNIQUES  9
Lubricating oil classification and its uses – Production of lubricating oils from vacuum distillates with different treatment techniques: Solvent extraction, Deasphalting, Dewaxing, Catalytic dewaxing and Hydrofining process – Industrial Grease – Manufacture of Calcium Grease.

UNIT V  WAX AND BITUMEN PROCESSING TECHNIQUES  9
Paraffinic wax: Classification and its uses, Petroleum jelly manufacture – Bitumen: Types and their properties – Bitumen Testing: Ductility, Penetration Index and Softening point – Asphalt manufacture: Air blowing technology.

TOTAL: 45 PERIODS

OUTCOME:
CO1. Acquire knowledge on crude composition, types and their characteristics primary refining operations.
CO2. Analyse the suitability of test methods to check the quality of crude oil and its products.
CO3. Understand the concept of separating crude products using fractionating column
CO4. Understand the significance of units present in the lube complex.
CO5. Understand the classification, production and uses of wax and bitumen.
CO6. Identify the role of additives added in the commercial products of petroleum.

TEXT BOOKS:

REFERENCES:
## Course Articulation Matrix: PETROLEUM PRIMARY PROCESSING TECHNOLOGY

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Acquire knowledge on crude composition, types, characteristics and current trends</td>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Analyse the suitability of test methods to check the quality of petroleum products</td>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the concept of separating crude products using fractionating column</td>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the significance of units present in the lube complex and its operation</td>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the classification, production, testing methods and uses of wax and bitumen</td>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO6</td>
<td>Identify the role of additives used in the commercial products of petroleum</td>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td></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.
CH3491 HEAT TRANSFER

OBJECTIVE:
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 Colburn analogy. Dimensional analysis in heat transfer, heat transfer coefficient for flow through a pipe, flow past flat plate.

UNIT III
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

UNIT IV
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 V
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.

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:

PC3352 MECHANICAL OPERATIONS

OBJECTIVE:
- To impact knowledge in the field of particle size reduction and also deals with the detail construction and working of equipment’s used for mechanical operations.

UNIT I PARTICLE CHARACTERIZATION AND MEASUREMENT
General characteristics of solids, different techniques of size analysis- Static – Image analysis and Dynamic analysis – Light scattering techniques, shape factor, surface area determination, estimation of particle size. Advanced particle size analysis techniques. Screening methods and equipment, screen efficiency, ideal and actual screens.

UNIT II PARTICLE SIZE REDUCTION AND SIZE ENLARGEMENT
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; Advanced size reduction techniques – Nano particle fabrication – Top down approach – Bottom-up approach. Size enlargement – Importance of size enlargement, principle of granulation, briquetting, palletization, and flocculation. Fundamentals of particle generation.

UNIT III PARTICLE SEPARATION (GAS-SOLID AND LIQUID-SOLID SYSTEM)
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 FILTRATION AND FILTRATION EQUIPMENTS
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 PARTICLE HANDLING
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, Powder hazards, conveyer selection, different types of conveyers and their performance characteristics.

OUTCOME:
At the end of this course, the students will be able to
1. Determine and Estimate various properties of particulates, particle size using advanced analysis techniques
2. Understand the overview of equipment design used for size reduction, and understand the importance of size enlargement.
3. Examine and identify various separation and purification equipment for solid-solid, solid-liquid and solid-gas system.
4. Categorize various filters and problems associated during the implementation and applications of filtration equipments
5. Analyze and understand the working of various types of impellers, mixers, Handling, Storage and Transportation of Solids.
6. Know the future challenges and obtain knowledge on various unit operations and their applications

TEXT BOOKS:

REFERENCES:
2. Christie J. Geankoplis, Transport processes and unit operations.
<table>
<thead>
<tr>
<th>Course Outcome</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Determine and Estimate various properties of particulates, particle size</td>
<td>PO1</td>
</tr>
<tr>
<td></td>
<td>using advanced analysis techniques</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the overview of equipment design used for size reduction, and</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>understand the importance of size enlargement.</td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Examine and identify various separation and purification equipment for</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>solid-solid, solid-liquid and solid-gas system.</td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Categorize various filters and problems associated during the</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>implementation and applications of filtration equipments</td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>Analyze and understand the working of various types of impellers,</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>mixers, Handling, Storage and Transportation of Solids.</td>
<td></td>
</tr>
<tr>
<td>CO6</td>
<td>Know the future challenges and Obtain knowledge on various unit</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>operations and their applications</td>
<td></td>
</tr>
<tr>
<td>Overall CO</td>
<td></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:
- To enable the students to develop a sound working knowledge on different types of heat transfer equipments.

LIST OF EXPERIMENTS
1. Heat Transfer in a Double Pipe Heat Exchanger
2. Heat transfer in Shell and Tube Heat Exchanger
3. Heat Transfer in a Bare and Finned Tube Heat Exchanger
4. Heat transfer in composite wall
5. Heat transfer by Forced / Natural Convection
6. Heat Transfer by Radiation – Determination of Stefan Bolzmann constant
7. Heat Transfer by Radiation – Emissivity measurement
8. Heat transfer in Open Pan Evaporator
9. Heat transfer by Single effect evaporation / Multiple effect evaporation
10. Boiling Heat Transfer
11. Heat Transfer through Packed Bed
12. Heat Transfer in a Horizontal Condenser / Vertical Condenser
13. Heat Transfer in Helical Coils
14. Heat Transfer in Agitated Vessels

Minimum 10 experiments to be offered

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS
1. Double Pipe Heat Exchanger 1 No.
2. Shell and Tube heat exchanger 1 No.
3. Bare and Finned Tube Heat Exchanger 1 No.
4. Composite wall set up 1 No.
5. Natural convection set up or Forced convection set up 1 No.
6. Stefan Boltzmann Apparatus 1 No.
7. Emissivity measurement set up 1 No.
8. Open Pan Evaporator 1 No.
9. Single effect evaporator or Multiple effect evaporator 1 No.
10. Boiler 1 Compulsory equipment
11. Packed Bed 1 No.
12. Vertical Condenser or Horizontal Condenser 1 No.
13. Helical Coil 1 No.
15. Jacketed vessel 1 No.

Any 10 equipment excluding boiler

OUTCOME:
CO1 : Understand the concepts of heat transfer equipments.
CO2 : Estimate the heat transfer rate and heat transfer co-efficient for heat exchangers.
CO3 : Perform and compare heat transfer operations.
CO4 : Evaluate the parameters in heat transfer equipments.
CO5 : Analyze the heat transfer data from experiments.
CO6 : Solve engineering problems effectively as an individual as well as team work.
## Course Articulation Matrix: HEAT TRANSFER LABORATORY

<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>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the concepts of heat transfer equipments.</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>Estimate the heat transfer rate and heat transfer co-efficient for heat exchangers</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Perform and compare heat transfer operations.</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Evaluate the parameters in heat transfer equipments.</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Analyze the heat transfer data from experiments.</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Solve engineering problems effectively as an individual as well as team work</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</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>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>2</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.
OBJECTIVES:

- To learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.
- Students develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

LIST OF EXPERIMENTS – Phase – I (minimum 5 Experiments to be conducted)
1. Calibration of constant and variable head meters
2. Open drum orifice and draining time
3. Flow through straight pipe
4. Flow through annular pipe
5. Flow through helical coil and spiral coil
6. Characteristic curves of pumps
7. Pressure drop studies in packed column

EQUIPMENT REQUIRED
1. Venturi meter
2. Orifice meter
3. Rotameter
4. Weir
5. Open drum with orifice
6. Pipes and fittings
7. Helical and spiral coils
8. Centrifugal pump
9. Packed column
10. Fluidized bed

LIST OF EXPERIMENTS – Phase- II (minimum 5 Experiments to be conducted)
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. Drop weight crusher
10. Drag on Sphere
11. Effectiveness of screen

EQUIPMENT 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.

TOTAL: 60 PERIODS
OUTCOMES:

- CO1: Correlate the difference between fixed and fluidized bed columns and its application.
- CO2: Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties
- CO3: Compare the results of theoretical analytical models to the actual behavior of real fluid flows and draw sustainable conclusions
- CO4: Determine the size analysis in solid-solid separation systems
- CO5: Evaluate the size reduction and various crushing parameters
- 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 Outcome</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>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Correlate the difference between fixed and fluidized bed columns and its application</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO3</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>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Determine the size analysis in solid- solid separation systems</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</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>CO5</td>
<td>Evaluate the size reduction and various crushing parameters</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td></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>-</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</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.
OBJECTIVES:
To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWERPOINT.

- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize, interlink, and utilizing many more critical features offered.
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

MS WORD:
Create and format a document
Working with tables
Working with Bullets and Lists
Working with styles, shapes, smart art, charts
Inserting objects, charts and importing objects from other office tools
Creating and Using document templates
Inserting equations, symbols and special characters
Working with Table of contents and References, citations
Insert and review comments
Create bookmarks, hyperlinks, endnotes footnote
Viewing document in different modes
Working with document protection and security
Inspect document for accessibility

10 Hours

MS EXCEL:
Create worksheets, insert and format data
Work with different types of data: text, currency, date, numeric etc.
Split, validate, consolidate, Convert data
Sort and filter data
Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.,)
Work with Lookup and reference formulae
Create and Work with different types of charts
Use pivot tables to summarize and analyse data
Perform data analysis using own formulae and functions
Combine data from multiple worksheets using own formulae and built-in functions to generate results
Export data and sheets to other file formats
Working with macros
Protecting data and Securing the workbook

10 Hours

MS POWERPOINT:
Select slide templates, layout and themes
Formatting slide content and using bullets and numbering
Insert and format images, smart art, tables, charts
Using Slide master, notes and handout master
Working with animation and transitions
Organize and Group slides
Import or create and use media objects: audio, video, animation
Perform slideshow recording and Record narration and create presentable videos

10 Hours

TOTAL: 30 PERIODS
OUTCOMES:
On successful completion the students will be able to

- Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements
- Use MS EXCEL to perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding
- Use MS PowerPoint to create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects.

PE3451 CHEMICAL ENGINEERING THERMODYNAMICS L T P C 3 0 0 3

OBJECTIVE:

- Students will learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

UNIT I PVT RELATIONS AND FIRST LAW OF THERMODYNAMICS 9

UNIT II SECOND LAW AND THERMODYNAMIC CORRELATIONS 9

UNIT III SOLUTION THERMODYNAMICS 9
Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, activity and property change of mixing, excess properties of mixtures. Activity coefficient-composition models.

UNIT IV PHASE EQUILIBRIA 9
Phase equilibrium in ideal solution, excess Gibbs free energy models, Henry's law, fugacity, Vapor-Liquid Equilibrium at low, moderate and high pressures; bubble and dew point calculation, thermodynamic consistency test of VLE data, Phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium.

UNIT V 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.

TOTAL: 45 PERIODS

OUTCOME:
1. Understand the fundamentals of system of units, apply ideal gas law to solve problems in pure components and mixtures.
2. Apply stoichiometric principles to solve problems and write material balance for different process equipments.
3. Understand and apply basics of humidity to solve problems in humidification and other processes.
4. Understand and apply the basics of energy balance concepts to solve to different chemical processes.
5. Understand the basics of fuels and combustion, to solve problems on combustion of various fuels and also to find excess air.
6. Apply the above knowledge to process flow sheeting in industries.

TEXT BOOKS:

REFERENCES:
### Course Articulation Matrix

<table>
<thead>
<tr>
<th>Course Outcome(s)</th>
<th>Statement</th>
<th>CHEMICAL ENGINEERING THERMODYNAMICS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the fundamentals concepts of thermodynamics and its related</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>functions, PVT relations and real gas behaviour.</td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Understand and apply basics of second law and analyse the feasibility</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>of devices/system.</td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Understand and analyse thermodynamic property relations, potentials and</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>their applications to fluid flow.</td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Evaluate the molar and partial molar properties of pure components and</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>mixtures.</td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>Understand and apply the concept of equilibrium in phase equilibria &amp;</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>reaction equilibria.</td>
<td></td>
</tr>
<tr>
<td>CO6</td>
<td>Apply the above knowledge to process equipment design as well as its</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>implications.</td>
<td></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:
- Students will learn the process involving to convert one form of hydrocarbon into another form of hydrocarbon to meet the customer requirement using cracking, reforming, alkylation, isomerization and polymerization unit processes.

UNIT I VISBREAKING, THERMAL CRACKING AND COKING
Thermal Cracking: Process flow schemes, Reaction chemistry and free radical mechanisms, Factors influencing thermal cracking process.
Coking : Principle – Types – Advantages - Process flow schemes - Delayed Coking, Fluid Coking and Flexi-Coking processes - Factors influencing coking process

UNIT II CATALYTIC CRAKING AND HYDRO CRACKING
Hydro Cracking: Principle - Advantages - Process flow schemes - Reaction chemistry - Factors influencing hydro cracking process - Commercial Catalyst

UNIT III CATALYTIC REFORMING AND POLYMERIZATION

UNIT IV ALKYLATION AND ISOMERIZATION

UNIT V FINAL TREATMENT TECHNIQUES
Acid gas and Sulphur Removal Techniques: Hydro Desulphurization Processes, Merox process, Metal Oxide process-Iron sponge process, Zinc Oxide process – Chem sweet process, Sulfa Check process, Amine process / Girbotol process and Molecular sieve process. Sulphur recovery using claus process.

OUTCOME:
CO1. Understand the need of different secondary process and demonstrate appropriate technologies available to meet the specified needs of the petroleum products.
CO2. Select appropriate technologies to meet the specified needs of lighter petroleum products from heavier feed
CO3. Select appropriate technologies and different flow sheet to get aromatic and olefin compounds from paraffinic feed and getting heavier products from lighter feed
CO4. Understand different flow sheets, and appropriate technologies to maximize gasoline yield and quality.

CO5. Select appropriate technologies to get cleaner products and demonstrate knowledge on various application of specialty products obtained from crude oil

CO6. Acquiring knowledge on optimization of product blending for quality and quantity improvement.

TEXT BOOKS:

REFERENCES:
## Course Articulation Matrix: PETROLEUM SECONDARY PROCESSING TECHNOLOGY

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the need of different secondary process and demonstrate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>appropriate technologies available to meet the specified needs of the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>petroleum products</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2   3  1  2  1</td>
</tr>
<tr>
<td>CO2</td>
<td>Select appropriate technologies and different flow sheet to get the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>specified needs of lighter petroleum products using thermal catalytic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and hydrocracking</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2   3  2  3  2</td>
</tr>
<tr>
<td>CO3</td>
<td>Select appropriate technologies and different flow sheet to get</td>
<td></td>
</tr>
<tr>
<td></td>
<td>aromatic and olefin compound using reforming process</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2   3  3  3  2</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand different flow sheets, and appropriate technologies to</td>
<td></td>
</tr>
<tr>
<td></td>
<td>maximize gasoline yield and quality by Alkylation and Isomerization.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2   2  3  3  2</td>
</tr>
<tr>
<td>CO5</td>
<td>Select appropriate technologies to get cleaner products of petroleum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and natural gas</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2   3  3  3  2</td>
</tr>
<tr>
<td>CO6</td>
<td>Acquiring knowledge on commercial catalyst used cracking, reforming,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>alkylation, isomerization &amp; polymerization and its recent advancements</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2   2  2  2  1</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2   3  2  2  1</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
UNIT I
Introduction to mass transfer operations; Molecular diffusion in gases, liquids and solids; diffusivity measurement and prediction; multi-component diffusion.

UNIT II
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.

UNIT III ABSORPTION
Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; determination of height of packing using HTU and NTU calculations.

UNIT IV DISTILLATION
Vapour liquid equilibria - Raoult’s law, Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe - Thiele method, Total reflux, minimum reflux ratio, optimum reflux ratio.

UNIT V LEACHING & EXTRACTION
Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for single stage extraction, multi-stage cross current extraction, multi-stage counter current operation. Solid-liquid equilibria- equilibrium diagram for leaching, single stage leaching, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. K Asokan, Mass Transfer concepts, University Press

REFERENCES:

CPE339 NATURAL GAS AND LNG PROCESSING

OBJECTIVE:
- To learn the basic concept and properties, composition of natural Gas.
- To impart estimation and production of natural gas.
- To gain knowledge about production of natural gas from condensate oil fields.
- To learn the acid gas treating of natural gas.
- To gain knowledge about dehydration of natural gas and LNG processes.

UNIT I PROPERTIES AND COMPOSITION OF NATURAL GAS
UNIT II    ESTIMATION AND PRODUCTION OF NATURAL GAS


UNIT III    GAS FROM CONDENSATE OIL FIELDS

Processing of condensate well fluids – Cycling of gas condensate reservoirs – Sweep patterns – Katy cycling plant.

UNIT IV    ACID GAS TREATING OF NATURAL GAS

Acid gas removal: Metal oxide process – Slurry process – Amine process – Carbonate washing process – Methanol based process and other process – Sulphur recovery process.

UNIT V    DEHYDRATION OF NATURAL GAS AND LNG PROCESSES


COURSE OUTCOMES:

On successful completion of this course, the students would be able to
CO1: Understand Natural gas processing.
CO2: Understand Gas Compression, Gas Gathering and Transport Installation.
CO3: Apply knowledge operation and trouble shooting of natural gas pipelines.
CO4: Understand dehydration of natural gas
CO5: Evaluate LNG processes and operations
CO6: Create new process technology for NGE and LNG processes.

TEXT BOOKS:


REFERENCES:

## Course Articulation Matrix: NATURAL GAS AND LNG PROCESSES

<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>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Remembering knowledge about Natural gas processing.</td>
<td>3</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>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>Understanding about Natural gas processing, Gas Compression, Gas Gathering and Transport Installation.</td>
<td>3</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>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Applying knowledge about Operation and trouble shooting of natural gas pipelines.</td>
<td>3</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>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyzing knowledge about dehydration of natural gas</td>
<td>3</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>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Evaluating LNG processes and operations</td>
<td>3</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>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Creating new process technology for NGE and LNG processes.</td>
<td>3</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>1</td>
<td>1</td>
<td>2</td>
<td>2</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>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</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:
- To enable the students to gain knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions

UNIT I  KINETICS OF HOMOGENEOUS REACTIONS  9
Rate equation, elementary, non-elementary reactions, theories of reaction rate - Arrhenius theory, interpretation of kinetic data, integral and differential analysis.

UNIT II  IDEAL REACTORS  9
Design equation for constant and variable volume batch reactors, Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, combination of reactors-Equal sized CSTRs in series and parallel - Equal sized PFRs in series and parallel, size comparison of reactors.

UNIT III  MULTIPLE REACTIONS  9
Design of reactors for multiple reactions – Series, parallel Reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity.

UNIT IV  NON-ISOTHERMAL REACTORS  9
Heats of reaction and equilibrium conversion from thermodynamics, Non-isothermal homogeneous reactor systems, adiabatic reactors, Material and energy balances in batch reactors, Material and energy balances in plug flow and mixed flow reactors.

UNIT V  NON-IDEAL REACTORS  9
Residence time distribution as a factor of performance; residence time functions and relationship between them in reactors; basic models for non-ideal flow-single parameter model, conversion in non-ideal reactors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of course, the students would be able to
1. Apply the principles of reaction kinetics, formulate rate equations and analyze the batch reactor data.
2. Analyze the experimental kinetic data to select a suitable reactor for a particular application and to workout conversion and space time for different types of reactors.
3. Evaluate selectivity, reactivity and yield for parallel and mixed reactions.
4. Design isothermal and non-isothermal reactors for homogeneous reactions.
5. Examine how far real reactors deviate from the ideal reactors.
6. Solve the complex reaction engineering problems.

TEXT BOOKS:

REFERENCE:
# Course Articulation Matrix: CHEMICAL REACTION ENGINEERING

<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>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Apply the principles of reaction kinetics, formulate rate equations and analyze the batch reactor data.</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Analyze the experimental kinetic data to select a suitable reactor.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Evaluate selectivity, reactivity and yield for multiple reactions.</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Design isothermal and non-isothermal reactors for homogeneous reactions.</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Examine how far real reactors deviate from the ideal reactors.</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Solve the complex reaction engineering problems.</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</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.
UNIT - I : ENVIRONMENT AND BIODIVERSITY  

UNIT – II : ENVIRONMENTAL POLLUTION  

UNIT – III : RENEWABLE SOURCES OF ENERGY.  
Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT - IV : SUSTAINABILITY AND MANAGEMENT  
Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT - V : SUSTAINABILITY PRACTICES  

TOTAL: 30 PERIODS

TEXT BOOKS:
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.

REFERENCE BOOKS :

PC3461 PETROCHEMICAL AND POLYMER ANALYSIS LABORATORY L T P C 0 0 4 2

OBJECTIVE:
- To learn basic principles involved in analysis of petrochemical products.

LIST OF EXPERIMENTS (Any 12 Experiments)
1) Refractive index of petrochemicals
2) Flash and Fire point determination using Cleveland Open cup method
3) Flash and Fire point determination using Pensky Martien Closed cup method
4) Kinematic viscosity determination using Redwood
5) Kinematic viscosity determination using Saybolt
6) Determination of moisture content – KF titrator
7) Total acidity determination
8) Solvent Recovery from petrochemical feed stock
9) Elemental analysis of petrochemicals using GC / NMR
10) Functional group analysis of petrochemicals using UV / FTIR
12) Determination of Density, Apparent Density of Polymer
14) Determination of hardness of Polymers
15) Determination of Glass Transition Temperature (Tg) / Melting Point, (Tm) of Polymers
16) Determination of molecular weight by end group analysis (COOH group) / viscosity method.

TOTAL: 60 PERIODS

OUTCOME:
CO1. Perform the testing of various physical properties of the petroleum products in a safe manner.
CO2. Perform the testing of various chemical properties of the petroleum products in a safe manner.
CO3. Differentiate various petroleum products by performing the specific tests.
CO4. Perform the advanced qualitative and quantitative laboratory tasks, including the operation of advanced analytical instrumentation.
CO5. Ability to communicate and perform in the team
CO6. Ability to understand the theoretical knowledge

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS
1. Refractometer
2. Cleveland Open cup Flash and fire point apparatus
3. Pensky Martien Flash and fire point apparatus
4. Redwood Viscometer
5. Saybolt Viscometer
6. KF-Titrator
7. Rotary vacuum evaporator.
8. UV- Visible spectrophotometer/FTIR.
9. Gas Chromatography with MS/NMR with MS
10. Sulphur content determination instrument
11. Orsat apparatus/ Digital flue gas analyzer
12. Durometer
13. Melting point apparatus
## Course Articulation Matrix: PETROCHEMICAL AND POLYMER ANALYSIS LABORATORY

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Perform the testing of various physical properties of the petrochemical / polymer products in a safe manner</td>
<td>PO 1 PO 2 PO 3 PO 4 PO 5 PO 6 PO 7 PO 8 PO 9 PO 10 PO 11 PO 12 PSO 1 PSO 2</td>
</tr>
<tr>
<td>CO2</td>
<td>Perform the testing of various chemical properties of the petrochemical / polymer I products in a safe manner</td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Differentiate various petrochemical / polymer products by performing the specific tests</td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Perform the advanced qualitative and quantitative laboratory tasks, including the operation of advanced analytical instrumentation</td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>Ability to communicate and perform in the team</td>
<td></td>
</tr>
<tr>
<td>CO6</td>
<td>Ability to understand the significance and theoretical principles behind of each test.</td>
<td></td>
</tr>
<tr>
<td><strong>Overall CO</strong></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.
OBJECTIVE:
- On completion of the course, the students should be conversant with the theoretical principles and experimental procedures for quantitative estimation of petroleum products.

LIST OF EXPERIMENTS (Any 12 Experiments)
1. Specific gravity determination using API gravity / Specific gravity bottle method
2. Carbon residue determination Canrodson / Rams bottom method
3. Dynamic viscosity measurement / Kinematic viscosity by U-Tube viscometer
4. Moisture content determination using Dean & Stark / Centrifuge method
5. ASTM Distillation to identify petroleum fractions and find out boiling range
6. Aniline point determination
7. Copper strip corrosion testing of petroleum products
8. Cloud and Pour point determination
9. Smoke point determination
10. Reid-Vapor pressure determination of gasoline
11. BS&W separation using Centrifuge method
12. Drop point determination for industrial grease
13. Softening point determination
14. Ductility of bitumen - Determination
15. Penetration index determination
16. Calorific value of petrochemical product

TOTAL: 45 PERIODS

OUTCOME:
CO1. Perform the testing of various physical properties of the petroleum products in a safe manner.
CO2. Perform the testing of various chemical properties of the petroleum products in a safe manner.
CO3. Differentiate various petroleum products by performing the specific tests.
CO4. Perform the advanced qualitative and quantitative laboratory tasks, including the operation of advanced analytical instrumentation.
CO5. Ability to communicate and perform in the team
CO6. Ability to understand the theoretical knowledge

LIST OF EQUIPMENT
1. Hydrometer
2. Conradson Apparatus / Muffle furnace
3. Brook Field viscometer
4. Dean and Stark apparatus
5. ASTM Distillation apparatus
6. Aniline point apparatus
7. Copper corrosion apparatus
8. Cloud and Pour point apparatus
9. Smoke point apparatus
10. Reid -Vapour pressure apparatus
11. Centrifuge apparatus
12. Drop point apparatus
13. Ring and ball softening point apparatus
14. Ductilometer
15. Penetrometer
16. Bomb calorimeter
## Course Articulation Matrix: PETROLEUM PRODUCT TESTING LABORATORY

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</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>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Perform the testing of various physical properties of the petroleum products in a safe manner</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>Perform the testing of various chemical properties of the petroleum products in a safe manner</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Differentiate various petroleum products by performing the specific tests</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Perform the advanced qualitative and quantitative laboratory tasks, including the operation of advanced analytical instrumentation</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Ability to communicate and perform in the team</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Ability to understand the significance and theoretical principles behind each test</td>
<td>-</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>-</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.