I. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

| I. | The program aims to produce proficient engineers in Robotics and Automation field to serve the various technological needs of Industry and Society. |
| II. | To impart graduates with multidisciplinary engineering knowledge in Robotics and Automation system |
| III. | The program shall create graduates to continuously uplift the knowledge, skill, attitude, self-learning, and teamwork, constantly able to practice the ethical values and protect the environmental eco systems. |

II. PROGRAM OUTCOMES (POs)

<table>
<thead>
<tr>
<th>PO</th>
<th>Graduate Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Engineering knowledge</strong>: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.</td>
</tr>
<tr>
<td>2</td>
<td><strong>Problem analysis</strong>: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.</td>
</tr>
<tr>
<td>3</td>
<td><strong>Design/development of solutions</strong>: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.</td>
</tr>
<tr>
<td>4</td>
<td><strong>Conduct investigations of complex problems</strong>: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.</td>
</tr>
<tr>
<td>5</td>
<td><strong>Modern tool usage</strong>: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.</td>
</tr>
<tr>
<td>6</td>
<td><strong>The engineer and society</strong>: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.</td>
</tr>
<tr>
<td>7</td>
<td><strong>Environment and sustainability</strong>: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.</td>
</tr>
<tr>
<td>8</td>
<td><strong>Ethics</strong>: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.</td>
</tr>
<tr>
<td>9</td>
<td><strong>Individual and team work</strong>: Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.</td>
</tr>
<tr>
<td>10</td>
<td><strong>Communication</strong>: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.</td>
</tr>
<tr>
<td>11</td>
<td><strong>Project management and finance</strong>: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.</td>
</tr>
<tr>
<td>12</td>
<td><strong>Life-long learning</strong>: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.</td>
</tr>
</tbody>
</table>
III. PROGRAM SPECIFIC OUTCOMES (PSOs)

| (1) | Multi-disciplinary Engineering in Robotics: Analyse the real world needs and design the robot and Automation solutions using the competency in multi domain engineering elements and integrated software tools. |
| (2) | Enhancement and upgradation of existing systems: Analyse conventional functions and process of various engineering elements and propose robots and automation solutions for enhanced performance of conventional systems. |
| (3) | Robotic system integration and automated Solution and connectivity: Recommend the sensing, interfacing, controlling, actuating, communicating technologies and analysing the data through various subsystems and build the robots. |

PEO's – PO's & PSO's MAPPING:

<table>
<thead>
<tr>
<th>PEO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>II.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>III.</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>II.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>III.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
### SEMESTER 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></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>THEORY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>HS5151</td>
<td>Technical English</td>
<td>HSMC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>MA5158</td>
<td>Engineering Mathematics-I</td>
<td>BSC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>PH5151</td>
<td>Engineering Physics</td>
<td>BSC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>CY5151</td>
<td>Engineering Chemistry</td>
<td>BSC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>GE5151</td>
<td>Engineering Graphics</td>
<td>ESC</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>GE5154</td>
<td>தமிழரும் ததொழில்நுட்பமும்</td>
<td>HSMC</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PRACTICAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>BS5161</td>
<td>Basic Sciences Laboratory</td>
<td>BSC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>8.</td>
<td>GE5162</td>
<td>Workshop Practices Laboratory</td>
<td>ESC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>GE5163</td>
<td>English Laboratory</td>
<td>EEC</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td>2</td>
<td>14</td>
</tr>
</tbody>
</table>

### SEMESTER 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></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>THEORY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>HS5251</td>
<td>Professional Communication</td>
<td>HSMC</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>MA5252</td>
<td>Engineering Mathematics - II</td>
<td>BSC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>GE5153</td>
<td>Problem Solving and Python Programming</td>
<td>ESC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>EE5202</td>
<td>Basic Electrical, Electronics Engineering and Measurements</td>
<td>ESC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>GE5152</td>
<td>Engineering Mechanics</td>
<td>ESC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>PH5252</td>
<td>Physics for Electronic Sciences</td>
<td>BSC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7.</td>
<td>GE5252</td>
<td>தமிழரும் ததொழில்நுட்பமும் / Tamils and Technology</td>
<td>HSMC</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PRACTICAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>GE5161</td>
<td>Problem Solving and Python Programming Laboratory</td>
<td>ESC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>EE5212</td>
<td>Basic Electrical, Electronics Engineering and Measurements Laboratory</td>
<td>ESC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>10.</td>
<td>GE5262</td>
<td>Communication Laboratory / Foreign Language</td>
<td>EEC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>

*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><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>MA5355</td>
<td>Transforms Techniques and Partial</td>
<td>BSC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Differential Equations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>PR5451</td>
<td>Kinematics and Dynamics of Machines</td>
<td>ESC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>RO5301</td>
<td>Digital Electronics and Microprocessor</td>
<td>ESC</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>4.</td>
<td>RO5302</td>
<td>Electrical Drives and Actuators</td>
<td>PCC</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>5.</td>
<td>AU5352</td>
<td>Mechanics of Solids</td>
<td>PCC</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>7.</td>
<td>RO5311</td>
<td>Electrical Drives and Actuators</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>RO5312</td>
<td>Mechanics of Solids and Machines</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>GE5361</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><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td>2</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><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>GE5251</td>
<td>Environmental Sciences</td>
<td>BSC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>PR5301</td>
<td>Thermodynamics and Fluid Mechanics</td>
<td>ESC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>RO5401</td>
<td>Manufacturing Technology</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>RO5402</td>
<td>Robot Kinematics</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>RO5403</td>
<td>Materials for Robots</td>
<td>PCC</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>7.</td>
<td>Audit Course- I*</td>
<td></td>
<td>AC</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>RO5411</td>
<td>Thermal and Fluid Mechanics Laboratory</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>ME5461</td>
<td>Manufacturing Technology Laboratory</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

\*Audit Course is optional.
### 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></td>
<td></td>
<td>L    T    P</td>
<td></td>
<td></td>
</tr>
<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>RO5501</td>
<td>Embedded Systems and Programming</td>
<td>PCC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>RO5502</td>
<td>Sensors and Transducers</td>
<td>PCC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>EE5402</td>
<td>Control Systems</td>
<td>PCC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>RO5503</td>
<td>Design of Robot Elements</td>
<td>PCC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</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>6</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>7</td>
<td></td>
<td>Audit Course - II*</td>
<td>AC</td>
<td>3    0    0</td>
<td></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>RO5511</td>
<td>Embedded Systems Laboratory</td>
<td>PCC</td>
<td>0    0    4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>RO5512</td>
<td>Sensors and Control Systems Laboratory</td>
<td>PCC</td>
<td>0    0    4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>RO5513</td>
<td>Modelling and Simulation of Robot Elements Laboratory</td>
<td>PCC</td>
<td>0    0    4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>21   0   12</td>
<td>33</td>
<td>24</td>
</tr>
</tbody>
</table>

*Audit Course is optional.

### 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></td>
<td></td>
<td>L    T    P</td>
<td></td>
<td></td>
</tr>
<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>RO5601</td>
<td>Robot Dynamics and Control</td>
<td>PCC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>RO5602</td>
<td>Robot Path Planning</td>
<td>PCC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>RO5603</td>
<td>Fluid Power Systems and Industrial Automation</td>
<td>PCC</td>
<td>3    0    2</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>4.</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>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>Professional Elective IV</td>
<td>PEC</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>7.</td>
<td>RO5611</td>
<td>Robot Kinematics and Dynamics Laboratory</td>
<td>PCC</td>
<td>0    0    4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>RO5612</td>
<td>Mini Project / Internship*</td>
<td>EEC</td>
<td>0    0    2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>18   0   8</td>
<td>26</td>
<td>22</td>
</tr>
</tbody>
</table>

* minimum of 2 weeks Internship
### SEMESTER 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></td>
<td></td>
<td></td>
<td></td>
<td>L    T  P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THEORY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>RO5701</td>
<td>Robotic Vision and Intelligence</td>
<td>PCC</td>
<td>3    0  0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>RO5702</td>
<td>Autonomous Mobile Robots</td>
<td>PCC</td>
<td>3    0  0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>RO5703</td>
<td>Machine Learning for Intelligent Systems</td>
<td>PCC</td>
<td>3    0  0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>Open Elective – II</td>
<td>OEC</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>PRACTICALS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>RO5711</td>
<td>Robotic Programming, Vision and Intelligence Laboratory</td>
<td>PCC</td>
<td>0    0  4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>RO5712</td>
<td>Project - I</td>
<td>EEC</td>
<td>0    0  6</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>18   0  10</td>
<td>28</td>
<td>23</td>
</tr>
</tbody>
</table>

### SEMESTER 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></td>
<td></td>
<td></td>
<td></td>
<td>L    T  P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRACTICALS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>RO5811</td>
<td>Project - II</td>
<td>EEC</td>
<td>0    0  16</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>0    0  16</td>
<td>16</td>
<td>8</td>
</tr>
</tbody>
</table>

### SUMMARY

**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  II  III  IV  V  VI  VII  VIII</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>HSMC</td>
<td>4  3  3  3  3</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>BSC</td>
<td>12 7 4 3</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>ESC</td>
<td>5 14 7 3</td>
<td>29</td>
</tr>
<tr>
<td>4</td>
<td>PCC</td>
<td>10 13 18 12 11</td>
<td>64</td>
</tr>
<tr>
<td>5</td>
<td>PEC</td>
<td>6 6 6</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>OEC</td>
<td>3 3</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>EEC</td>
<td>1 2 1</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Non-Credit (Mandatory)</td>
<td>√ √</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22 26 25 22 24 22 23 8</td>
<td>172</td>
</tr>
</tbody>
</table>
### Basic Sciences Courses (BSC)

<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>MA5158</td>
<td>Engineering Mathematics-I</td>
<td>BSC</td>
<td>3 1 0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>PH5151</td>
<td>Engineering Physics</td>
<td>BSC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>CY5151</td>
<td>Engineering Chemistry</td>
<td>BSC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>BS5161</td>
<td>Basic Science Laboratory</td>
<td>BSC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>MA5252</td>
<td>Engineering Mathematics - II</td>
<td>BSC</td>
<td>3 1 0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>PH5252</td>
<td>Physics for Electronic Sciences</td>
<td>BSC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>MA5355</td>
<td>Transforms Techniques and Partial Differential Equations</td>
<td>BSC</td>
<td>3 1 0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>GE5251</td>
<td>Environmental Sciences</td>
<td>BSC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

### Engineering Science (ESC)

<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>GE5151</td>
<td>Engineering Graphics</td>
<td>ESC</td>
<td>1 0 4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>GE5162</td>
<td>Workshop Practices Laboratory</td>
<td>ESC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>GE5153</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>4</td>
<td>EE5202</td>
<td>Basic Electrical, Electronics Engineering and Measurements</td>
<td>ESC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>GE5152</td>
<td>Engineering Mechanics</td>
<td>ESC</td>
<td>3 1 0</td>
<td>4</td>
<td>4</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>6.</td>
<td>GE5161</td>
<td>Problem Solving and Python Programming Laboratory</td>
<td>ESC</td>
<td>0 0 4</td>
<td>4 2</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>EE5212</td>
<td>Basic Electrical, Electronics Engineering and Measurements Laboratory</td>
<td>ESC</td>
<td>0 0 4</td>
<td>4 2</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>PR5451</td>
<td>Kinematics and Dynamics of Machines</td>
<td>ESC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>9.</td>
<td>RO5301</td>
<td>Digital Electronics and Microprocessor</td>
<td>ESC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>10.</td>
<td>PR5301</td>
<td>Thermodynamics and Fluid Mechanics</td>
<td>ESC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PROFESSIONAL CORE COURSES (PCC)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>RO5302</td>
<td>Electrical Drives and Actuators</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>AU5352</td>
<td>Mechanics of Solids</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>RO5311</td>
<td>Electrical Drives and Actuators Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4 2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>RO5312</td>
<td>Mechanics of Solids and Machines Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4 2</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>RO5401</td>
<td>Manufacturing Technology</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>RO5402</td>
<td>Robot Kinematics</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>RO5403</td>
<td>Materials for Robots</td>
<td>PCC</td>
<td>3 0 2</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>RO5411</td>
<td>Thermal and Fluid mechanics Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4 2</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>ME5461</td>
<td>Manufacturing Technology Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4 2</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>RO5501</td>
<td>Embedded Systems and Programming</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>RO5502</td>
<td>Sensors and Transducers</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>EE5402</td>
<td>Control Systems</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>13</td>
<td>RO5503</td>
<td>Design of Robot Elements</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>RO5511</td>
<td>Embedded Systems Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4 2</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>RO5512</td>
<td>Sensors and Control Systems Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4 2</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>RO5513</td>
<td>Modelling and Simulation of Robot Elements Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4 2</td>
<td>2</td>
</tr>
<tr>
<td>17</td>
<td>RO5601</td>
<td>Robot Dynamics and Control</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>18</td>
<td>RO5602</td>
<td>Robot Path Planning</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>19</td>
<td>RO5603</td>
<td>Fluid Power and Industrial Automation</td>
<td>PCC</td>
<td>3 0 2</td>
<td>5 4</td>
<td>4</td>
</tr>
<tr>
<td>20</td>
<td>RO5611</td>
<td>Robot Kinematics and Dynamics Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4 2</td>
<td>2</td>
</tr>
<tr>
<td>21</td>
<td>RO5701</td>
<td>Robotic Vision and Intelligence</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>22</td>
<td>RO5702</td>
<td>Mobile Robotics</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>23</td>
<td>RO5703</td>
<td>Machine Learning for Intelligent Systems</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>24</td>
<td>RO5711</td>
<td>Robotic Programming, Vision and Intelligence Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4 2</td>
<td>2</td>
</tr>
</tbody>
</table>
## PROFESSIONAL ELECTIVE COURSES

### PROFESSIONAL ELECTIVE 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></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>1</td>
<td>RO5001</td>
<td>Robots and Systems in Smart Manufacturing</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>RO5002</td>
<td>Robot and Machine Elements Design</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>ME5071</td>
<td>Automobile Engineering</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>RO5003</td>
<td>Linear Integrated Circuits</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>RO5004</td>
<td>Applied Signal Processing</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>ME5009</td>
<td>Mechanical Vibrations And Noise Control</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### PROFESSIONAL ELECTIVE 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></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>1</td>
<td>RO5005</td>
<td>Drone Technologies</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>AU5651</td>
<td>Electric and Hybrid Vehicles</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>RO5006</td>
<td>Applied Image Processing</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>RO5007</td>
<td>Industrial computer and Single Board Computers</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>RO5008</td>
<td>Smart mobility and Intelligent Vehicles</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>RO5009</td>
<td>Immersive Technologies and Haptics</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>RO5010</td>
<td>Motion Control System</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### PROFESSIONAL ELECTIVE 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></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>1</td>
<td>RO5011</td>
<td>Microrobotics</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>RO5012</td>
<td>CNC Machine Tools and Programming</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>RO5013</td>
<td>Automotive Mechatronics</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>RO5014</td>
<td>Robot Operating System (ROS)</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>ME5081</td>
<td>Process Planning and Cost Estimation</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>MF5005</td>
<td>Electronics Manufacturing Technology</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>BM5010</td>
<td>Brain Computer Interface and Applications</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>RO5015</td>
<td>Multi Body Dynamics</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</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></td>
<td></td>
<td></td>
<td></td>
<td>L    T    P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>RO5016</td>
<td>Computer Vision and Deep Learning</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>RO5017</td>
<td>Agricultural Automation</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>RO5018</td>
<td>Automotive System Modelling and Simulation</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>RO5019</td>
<td>Condition Monitoring and Fault Diagnostics</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>RO5020</td>
<td>Micro Electro Mechanical Systems</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>AE5026</td>
<td>UAV System Design</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>EI5009</td>
<td>Model Predictive Control</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

<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></td>
<td></td>
<td></td>
<td></td>
<td>L    T    P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>RO5021</td>
<td>Collaborative Robotics</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>PR5004</td>
<td>Unconventional Machining Processes</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>RO5022</td>
<td>Vehicle Dynamics and Control</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>BM5701</td>
<td>Biomechanics</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>GE5451</td>
<td>Total Quality Management</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>MF5501</td>
<td>Metrology And Computer Aided Inspection</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>PR5022</td>
<td>Integrated Product Development</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

<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></td>
<td></td>
<td></td>
<td></td>
<td>L    T    P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>RO5023</td>
<td>Humanoid Robotics</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>RO5024</td>
<td>Virtual Instrumentation</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>MF5652</td>
<td>Additive Manufacturing</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>RO5025</td>
<td>Aircraft Mechatronics</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>RO5026</td>
<td>Optimization Techniques</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>RO5027</td>
<td>Total Integrated Automation</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>RO5028</td>
<td>Advanced Driver Assistance System</td>
<td>PEC</td>
<td>3    0    0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
OBJECTIVES
- To build lexical competency and accuracy that will help learners to use language effectively.
- To learn various reading strategies that will enable learners to comprehend the different modes of reading materials of varied levels of complexity.
- To comprehend the linguistic aspects of various rhetorical structures and functions of Technical English and use them effectively in writing.

UNIT I INTRODUCING ONESELF
Theory:
Reading: Descriptive passages (From Newspapers / Magazines) – Writing: Writing a coherent paragraph (Native Place, School Life) – Grammar: Simple present tense, Present continuous tense – Vocabulary development: One word substitution.

UNIT II DIALOGUE WRITING
Theory:
Reading: Reading a print interview (Comprehension and inference questions) - Writing: Writing a checklist - Dialogue writing – Grammar: Simple past tense – Question formation (Wh-Questions, ‘Yes’ or ‘No’ Questions, Tag Questions) – Vocabulary Development: Lexical items relevant to the theme of the given unit.

UNIT III FORMAL LETTER WRITING
Theory:

UNIT IV WRITING LETTERS OF COMPLAINT
Theory:

UNIT V WRITING DEFINITIONS AND PRODUCT DESCRIPTION
Theory:

TOTAL : 45 PERIODS

LEARNING OUTCOMES:
On completion of the course, the students will be able to:
- Use appropriate language structures and lexical items in authentic contexts.
- Read both general and technical texts and comprehend their denotative and connotative meanings.
- Write different kinds of formal documents with grammatical and lexical appropriacy.

Assessment Pattern
- Two written internal assessments to test learner’s progress in grammar, vocabulary, reading and writing skills.
- End Semester exam to be tested in two parts: Theory exam for three hours and listening and speaking skills for two hours.
ENGINEERING MATHEMATICS – I
(Common to all branches of B.E. / B.Tech. Programmes in I Semester)

L 3 T 1 P 0 C 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

UNIT II DIFFERENTIAL CALCULUS

UNIT III FUNCTIONS OF SEVERAL VARIABLES

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

UNIT V MULTIPLE INTEGRALS

TOTAL :60 PERIODS

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

TEXT BOOKS:

REFERENCES:

PH5151 ENGINEERING PHYSICS
(Phys 101)
(Course code of the subject)
(L T P C = 3 0 0 3) (Common to all branches of B.E / B.Tech programmes)

UNIT IV BASIC QUANTUM MECHANICS 9
Photons and light waves - Electrons and matter waves - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization - Particle in an infinite potential well - Normalization, probabilities and the correspondence principle.

UNIT V APPLIED QUANTUM MECHANICS 9
The harmonic oscillator - Barrier penetration and quantum tunneling - Tunneling microscope - Resonant diode - Finite potential wells - particle in a three dimensional box - Bloch’s theorem for particles in a periodic potential, Kronig-Penney model and origin of energy bands.

TOTAL: 45 PERIODS

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

TEXT BOOKS

REFERENCES

CY5151 ENGINEERING CHEMISTRY (COMMON TO ALL BRANCHES) 3 0 0 3

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

UNIT II  NANOCHEMISTRY

UNIT III  PHOTOCHEMISTRY AND SPECTROSCOPY

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

UNIT V  WATER TECHNOLOGY

TOTAL: 45 PERIODS

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

REFERENCES:

GE5151 ENGINEERING GRAPHICS L T P C
1 0 4 3

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Drawing free hand sketches of basic geometrical shapes and multiple views of objects.
2. Drawing orthographic projections of lines and planes.
3. Drawing orthographic projections of solids.
4. Drawing development of the surfaces of objects.
5. Drawing isometric and perspective views of simple solids.

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

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

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

UNIT III PROJECTION OF SOLIDS
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to both the principal planes by rotating object method and auxiliary plane method.
UNIT IV  PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES  15
Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes.

UNIT V  ISOMETRIC AND PERSPECTIVE PROJECTIONS  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 and miscellaneous problems.  Perspective projection of simple solids-Prisms pyramids and cylinders by visual ray method and vanishing point method.

COMPUTER AIDED DRAFTING (DEMONSTRATION ONLY)  3
Introduction to drafting packages and demonstration of their use

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Draw free hand sketching of basic geometrical shapes and multiple views of objects.
2. Draw orthographic projections of lines and planes
3. Draw orthographic projections of solids
4. Draw development of the surfaces of objects
5. Draw isometric and perspective views of simple solids.

TEXT BOOKS:

REFERENCES:

Publication of Bureau of Indian Standards:

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

அல்கு II  மரபு – பாடல் விழாவிகள் போன்ற வரலாறு விளங்கும் நடுகல்:

அல்கு III  சம்பந்த கல்விகள் என்றும் சிற்றிலக்கியங்கள்:

அல்கு IV  சிற்றிலக்கிய கல்விகள் என்றும் கல்விகள்.
TEXT-CUM-REFERENCE BOOKS

1. தமிழ் வரலை - மக்கள் பாணத்தில் - தமிழக் பொடும் - மக்கள் பாணத்தில் கல்லுக்கான குழு காளை (எடுத்துக்காட்டு: செயல்பெண் பாணத்தில் மக்கள் பாணத்தில் குழு காளை).
2. கல்விக் குழு - முன்னோடியில் ஒன்றான குழு (எடுத்துக்காட்டு: குழு வழிகாட்டு).
3. சிந்து - தொன்றாக தொழில்பெண் மக்கள் நாகரிகக் கட்டுரை (எடுத்துக்காட்டு: குழு வழிகாட்டு).
4. கூடுகள் - அறிவுக்கான நாகரிகக் கட்டுரை (எடுத்துக்காட்டு: குழு வழிகாட்டு).
5. Social Life of 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)

GE5154 HERITAGE OF TAMILS L T P C

UNIT I LANGUAGE AND LITERATURE

UNIT II  HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

UNIT III  FOLK AND MARTIAL ARTS 3
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV  THINAI CONCEPT OF TAMILS 3
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V  CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3
Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS
1. தமிழக வரலொறு – மக்களும் பண் பொடும் – மக. மக. பிள்மள (தவளியீடு: தமிழ்நொடு பொடநூல் மற் றும் கல்வியியல் பணிகள் கழகம்).
2. கல்வியின் கமுப்பு – முமனவர் இலசு.சுந்தரம். (விகடன் பிரசுரம்).
3. சொகுபுரம் – தொடக்க துத்திகக்குருமிலி தலங்களால் வக தாக்கியில் (கதக்கலியீடு துத்திகக்குருமிலின் தலங்களால் வக தாக்கியில்).
4. ஗ூர்நந்து – அலுத்தியக்கத்தக்க தகத்கிருந்து (கதக்கலியீடு கதை தொடக்கிலின்).
5. Social Life of 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) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
PHYSICS LABORATORY: (Any Seven Experiments)

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

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

TOTAL: 30 PERIODS

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

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

COURSE OBJECTIVES:
- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and polymers by spectroscopy and viscometry methods.

LIST OF EXPERIMENTS:
1. Estimation of HCl using Na₂CO₃ as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler’s method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline / thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
12. Pseudo first order kinetics-ester hydrolysis.
14. Phase change in a solid.

TOTAL: 30 PERIODS

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

TEXT BOOKS:

GE5162 WORKSHOP PRACTICES LABORATORY L T P C
(Common to all Branches of B.E. / B.Tech. Programmes) 0 0 4 2

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

GROUP – A (CIVIL & ELECTRICAL)

PART I CIVIL ENGINEERING PRACTICES 15

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

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

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

GROUP – B (MECHANICAL AND ELECTRONICS)

PART III  MECHANICAL ENGINEERING PRACTICES  15

WELDING WORK:
   a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding. 
   b) Practicing gas welding.

BASIC MACHINING WORK:
   a) (simple)Turning. 
   b) (simple)Drilling. 
   c) (simple)Tapping. 

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

SHEET METAL WORK:
   a) Making of a square tray

FOUNDRY WORK:
   a) Demonstrating basic foundry operations.

PART IV  ELECTRONIC ENGINEERING PRACTICES  15

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

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

**ELECTRONIC EQUIPMENT STUDY:**

a) Studying a FM radio.
b) Studying an electronic telephone.

**TOTAL = 60 PERIODS**

**COURSE OUTCOMES:**

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

1. Understand the concept of plumbing work and fittings in common household applications.
2. Ability to saw, plan and join wood materials used in common household wood applications.
3. Become familiar with wiring various electrical joints in common household electrical applications.
4. Perform various weld joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical household equipments; Make a tray out of metal sheet using sheet metal work.
5. Become familiar with soldering and testing simple electronic circuits; Assemble and test simple electronic components on PCB.

<table>
<thead>
<tr>
<th>CO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>2</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>2</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

**GE5163 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

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.

HS5251 PROFESSIONAL COMMUNICATION

OBJECTIVES
- To comprehend various reading materials relevant to technical context and understand the main and supporting ideas of the reading materials.
- To write effective job applications along with detailed CV for internship or placements.
- To explore definitions, essay and report writing techniques and practice them in order to develop associated skills.

UNIT I TECHNICAL COMMUNICATION
Theory:
Reading: Reading the Interview of an Achiever and Completing Exercises (Skimming, Scanning and Predicting) – Writing: Writing a Short Biography of an Achiever Based on Given Hints – Grammar: Asking and Answering Questions, Punctuation in Writing, Prepositional Phrases

UNIT II SUMMARY WRITING
Theory:
Reading: Reading Technical Essays/ Articles and Answering Comprehension Questions – Writing: Summary Writing – Grammar: Participle Forms, Relative Clauses
UNIT III  PROCESS DESCRIPTION  6
Theory:
- Reading: Reading Instruction Manuals – Writing: Writing Process Descriptions – Writing Instructions
- Grammar: Use of Imperatives, Active and Passive Voice, Sequence Words

UNIT IV  REPORT WRITING  6
Theory:
- Reading: Reading and Interpreting Charts/Tables and Diagrams – Writing: Interpreting Charts/Tables and Diagrams, Writing a Report – Grammar: Direct into Indirect Speech, Use of Phrases

UNIT V  WRITING JOB APPLICATIONS  6
Theory:
- Reading: Reading a Job Interview, SOP, Company Profile and Completing Comprehension Exercises – Writing: Job Applications and Resumes And Sops-Grammar: Present Perfect and Continuous Tenses.

TOTAL : 30 PERIODS

LEARNING OUTCOMES
On completion of the course, the students will be able to:
- Read and comprehend technical texts effortlessly.
- Write technical reports and job application for internship or placement.
- Learn to use language effectively in a professional context.

Assessment Pattern
- Two written internal assessments to test learner’s progress in grammar, reading and writing skills.
- End Semester exam to be tested in two parts: Theory exam for three hours and listening and speaking skills along with vocabulary for two hours.

MA5252  ENGINEERING MATHEMATICS – II  L T P C
(Common to all branches of B.E. / B.Tech. Programmes in II Semester)  3 1 0 4

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

UNIT I  VECTOR CALCULUS  12
- Gradient and directional derivative – Divergence and Curl – Irrotational and Solenoidal vector fields
- Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green’s theorem, Stoke’s theorem and Gauss divergence theorem – Verification and application in evaluating line, surface and volume integrals.
UNIT II  ANALYTIC FUNCTION  
Analytic functions – Necessary and sufficient conditions for analyticity - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions - Bilinear transformation \( w = c + z, \ az, \ 1/z, \ z^2 \).

UNIT III  COMPLEX INTEGRATION  

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

UNIT V  LAPLACE TRANSFORMS  

TOTAL : 60 PERIODS

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

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

TEXT BOOKS:

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

UNIT I  INTRODUCTION TO COMPUTING AND PROBLEM SOLVING  9

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

SUGGESTED EVALUATION METHODS:
- Assignments on pseudocodes and flowcharts.
- Tutorials on Python programs.

UNIT II  CONDITIONALS AND FUNCTIONS  9

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

SUGGESTED EVALUATION METHODS:
- Tutorials on the above activities.
- Group discussion on external learning.

UNIT III  SIMPLE DATA STRUCTURES IN PYTHON  10
SUGGESTED ACTIVITIES:
- Implementing python program using lists, tuples, sets for the following scenario:
  - Simple sorting techniques
  - Student Examination Report
  - Billing Scheme during shopping.
- External learning - List vs. Tuple vs. Set – Implementing any application using all the three data structures.

SUGGESTED EVALUATION METHODS:
- Tutorials on the above activities.
- Group Discussion on external learning component.

UNIT IV STRINGS, DICTIONARIES, MODULES 10

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

SUGGESTED EVALUATION METHODS:
- Tutorials on the above activities.

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

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

SUGGESTED EVALUATION METHODS:
- Tutorials on the above activities.
- Case Studies.

TOTAL: 45 PERIODS

COURSE 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: Write simple Python programs 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.

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>CO3</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO6</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TEXT BOOKS:

REFERENCES:

EE5202 BASIC ELECTRICAL, ELECTRONICS ENGINEERING AND MEASUREMENTS 3 0 0 3

COURSE OBJECTIVES:
1. To introduce the basics of electric circuits and analysis
2. To impart knowledge in the basics of working principles and application of electrical machines
3. To introduce analog devices and their characteristics
4. To educate on the fundamental concepts of linear integrated circuits
5. To introduce the functional elements and working of measuring instruments.

UNIT – I ELECTRICAL CIRCUITS 10
DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm’s Law - Kirchhoff’s Laws –Independent and Dependent Sources – 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.

UNIT – II ELECTRICAL MACHINES 10

UNIT – III ANALOG ELECTRONICS 9

UNIT – IV LINEAR INTEGRATED CIRCUITS 9
Ideal OP-AMP characteristics, Basic applications of op-amp – Inverting and Non-inverting Amplifiers, summer, differentiator and integrator-S/H circuit, D/A converter (R-2R ladder), A/D converters- Flash type ADC using OP-AMPS . Functional block, characteristics of 555 timer–Astable multi-vibrator mode.
UNIT – V MEASUREMENTS AND INSTRUMENTATION


TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:
CO 1: Recognize the working principle and applications of electrical machines, electronic elements and measurement instruments.
CO 1: Explain the basic concepts of analog electronics circuits
CO 2: Compute the electric circuit parameters for simple problems.
CO 3: Construct the various electrical and electronic circuits for given applications.
CO 4: Select the appropriate electrical and electronics measurement instruments.

<table>
<thead>
<tr>
<th>Mapping of COs with POs and PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>COs/POs &amp; PSOs</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>CO1</td>
</tr>
<tr>
<td>CO2</td>
</tr>
<tr>
<td>CO3</td>
</tr>
<tr>
<td>CO4</td>
</tr>
<tr>
<td>CO5</td>
</tr>
<tr>
<td>CO/PO &amp; PSO</td>
</tr>
</tbody>
</table>

TEXT BOOKS:

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

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

UNIT I  STATICS OF PARTICLES  (9+3)

UNIT II  EQUILIBRIUM OF RIGID BODIES  (9+3)

UNIT III  DISTRIBUTED FORCES  (9+3)
Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration. Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia, Radius of Gyration of an Area, Parallel-Axis Theorem, Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three-Dimensional Body by Integration

UNIT IV  FRICTION  (9+3)

UNIT V  DYNAMICS OF PARTICLES  (9+3)

TOTAL  (L: 45 + T: 15)=60 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

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

TEXT BOOKS:

REFERENCES:

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>2</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>3</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>4</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>5</td>
<td>0.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>
PHYSICS FOR ELECTRONIC SCIENCES

OBJECTIVE

- To make the students to understand the basics of crystallography and its importance in completion materials properties.
- To understand the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials.
- To instill knowledge on physics of semiconductors, determination of charge carriers and device applications.
- To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications.
- To inculcate an idea of significance of nanostructures, quantum confinement and ensuing nanodevice applications.

UNIT I CRYSTALLOGRAPHY

Crystal structures - Bravais lattices – packing factor of SC, BCC, FCC, HCP and diamond structures – Close-packed crystal directions and planes — Surface crystallography — surface structure for BCC and close packed structures - surface to volume ratio: plane, cylinder, cube, sphere - Number of atoms and number of surface atoms in a structure: unit cell approach - imperfections and impurities.

UNIT II ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS


UNIT III SEMICONDUCTORS AND TRANSPORT PHYSICS


UNIT IV OPTICAL PROPERTIES OF MATERIALS

Classification of optical materials – Absorption emission and scattering of light in metals, insulators & Semiconductors - LED’s – Organic LED’s – Plasma light emitting devices – LCD’s – Laser diodes – Optical data storage techniques (including DVD, Blue-ray disc, Holographic data storage).

UNIT V NANO DEVICES


TOTAL: 45 PERIODS
COURSE OUTCOMES:
After completion the above subject, students will be able to understand
CO1: Know basics of crystallography and its importance for materials properties
CO2: Come to have firm knowledge on the electrical and magnetic properties of materials and their applications
CO3: Acquire adequate understanding of semiconductor physics and functioning of semiconductor devices
CO4: Understand the optical properties of materials and working principles of various optical devices
CO5: Appreciate the importance of nanotechnology, physics of nano devices, low-dimensional structures and their applications

<table>
<thead>
<tr>
<th>Cos / POs &amp; PSO</th>
<th>P O s</th>
<th>P S O s</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3 3 3 3</td>
<td>1 1</td>
</tr>
<tr>
<td>CO2</td>
<td>3 3 3 3</td>
<td>1 1</td>
</tr>
<tr>
<td>CO3</td>
<td>3 3 3 3</td>
<td>1 1</td>
</tr>
<tr>
<td>CO4</td>
<td>3 3 3 3</td>
<td>1 1</td>
</tr>
<tr>
<td>CO5</td>
<td>3 3 3 3</td>
<td>1 1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO</td>
<td>3 3 3 3</td>
<td>1 1</td>
</tr>
</tbody>
</table>

Average: 3 - Substantial
1 – Slight, 2 – Moderate, 3 – Substantial

REFERENCES
TEXT-CUM-REFERENCE BOOKS

1. Tamil Encyclopedia – Educational Service Corporation (in print)
2. Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
3. Social Life of the Tamils - The Classical Period (Dr. S. S. Singaravelu) (Published by: International Institute of Tamil Studies).
4. Historical Heritage of the Tamils (Dr. S. V. Subatamanian, Dr. K. D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
5. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies).
6. 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)
7. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K. K. Pillay) (Published by: The Author)
8. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
UNIT I  WEAVING AND CERAMIC TECHNOLOGY  3
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II  DESIGN AND CONSTRUCTION TECHNOLOGY  3
Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III  MANUFACTURING TECHNOLOGY  3

UNIT IV  AGRICULTURE AND IRRIGATION TECHNOLOGY  3
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V  SCIENTIFIC TAMIL & TAMIL COMPUTING  3

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS
1. கையடையும் கூட்டலு - மேளதுற்று பல்ளவரின் - சதுக்க பிறந்தனர் (தமிழ் புத்தகங்கள்: புதிய குழுப்புரை - பல்ளவர் முக்களின் விளக்கம்).
2. வரலோறு நொகரிகம் - வெள்ளையும் குடைச்.குருக்கார். (மேலும் விளக்கம்).
3. ஜூஹ் - தாவரக் திண்மக்களின் குறிப்பிட்டு துண்டு தகவல்களின் (இன்னும் புதுப்பிடிப்பு).
4. பேருண வேலு - அருமைக்காடை நாகியில். (நூறு புதுப்பிடிப்பு).
5. Social Life of 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) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
COURSE OBJECTIVES:

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To articulate where computing strategies support in providing Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

EXPERIMENTS:

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

COURSE 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: Structure simple Python programs for solving problems.
CO4: Decompose a Python program into functions.
CO5: Represent compound data using Python data structures.
CO6: Apply Python features in developing software applications.

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO2</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO3</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO4</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO6</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
COURSE OBJECTIVES
1. To train the students in conducting load tests on electrical machines
2. To gain practical experience in characterizing electronic devices
3. To train the students to use DSO/multi-meters for measurements

ELECTRICAL
1. Verification of ohms and Kirchhoff’s Laws.
2. Load test on Self Excited DC Generator
3. Load test on DC Shunt Motor.
4. Load test on Single phase Transformer
5. Load Test on Induction Motor

ELECTRONICS
7. Design of Inverting and non-inverting amplifier.
8. Design of ADC and DAC.
9. Design of timer and counter

MEASUREMENTS
10. Measurement of Amplitude, Frequency, Time, Phase Measurement using DSO.
12. Measurement of DC and AC Power using wattmeter’s

COURSE OUTCOMES:
After completing this course, the students will be able to
1. Use experimental methods to verify the Ohm’s and Kirchhoff’s Laws.
2. Analyze experimentally the load characteristics of electrical machines
3. Analyze the characteristics of basic electronic devices. Use DSO to measure the various parameters

CO-PO MAPPING:

<table>
<thead>
<tr>
<th>COs/POs &amp;PSOs</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TOTAL: 60 PERIODS
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.
MA5355 TRANSFORM TECHNIQUES AND PARTIAL DIFFERENTIAL EQUATIONS

COURSE OBJECTIVES:
- To introduce the effective mathematical tools for the solutions of partial differential equations that model physical processes;
- To introduce Fourier series analysis which is central to many applications in engineering;
- To develop the analytic solutions for partial differential equations used in engineering by Fourier series;
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic;
- To develop Z-transform techniques which will perform the same task for discrete time systems as Laplace Transform, a valuable aid in analysis of continuous time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12
Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Lagrange’s Linear equation – Solution of linear equations of higher order with constant coefficients – Linear non-homogeneous partial differential equations.

UNIT II FOURIER SERIES 12
Dirichlet’s conditions – General Fourier series – Odd and even functions – Half-range Sine and cosine series – Complex form of Fourier series – Parseval’s identity – Harmonic Analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATION 12

UNIT IV FOURIER TRANSFORM 12

UNIT V Z-TRANSFORM AND DIFFERENCE EQUATIONS 12

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
- Solve partial differential equations which arise in application problems.
- Analyze the functions as an infinite series involving sine and cosine functions.
- Obtain the solutions of the partial differential equations using Fourier series.
- Obtain Fourier transforms for the functions which are needed for solving application problems.
- Manipulate discrete data sequences using Z transform techniques.

TEXT BOOKS:
REFERENCES:

PR5451 KINEMATICS AND DYNAMICS OF MACHINES

COURSE OBJECTIVES:
- To impart knowledge on various types of mechanisms and synthesis.
- To impart skills and analyze the position, velocity and acceleration of mechanisms.
- To understand the effects of friction in motion in transmission and machine components.
- To familiarize higher pairs like cams and gears.
- To study the undesirable effects of unbalances resulting from prescribed motions in mechanisms.

UNIT I MECHANISMS

UNIT II FRICTION
Types of friction – friction in screw and nut – screw jack – pivot, collar and thrust bearings – plate and cone clutch – belt (Flat and V) and rope drives – creep in belts – open and crossed belt drives – Ratio of tensions – Effect of centrifugal and initial tensions – condition for maximum power transmission.

UNIT III GEARS AND CAMS

UNIT IV VIBRATION

UNIT V BALANCING
Static and dynamic balancing – single and several masses in different planes – primary and secondary balancing of reciprocating masses – Balancing of single and multi-cylinder engines – Governors and Gyroscopic effects.

TOTAL: 60 PERIODS
COURSE OUTCOMES:
At the end of the course, students will be able to:
CO1: Apply the kinematics and dynamics of machinery in design and analysis of engineering problems.
CO2: Demonstrate the ability to synthesize and analysis mechanisms
CO3: Design and analyze cam and their motion.
CO4: Select the gears and gear trains for their applications.
CO5: Examine the concept of free, forced and damped vibrations.

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

TEXT BOOKS:

REFERENCES:

RO5301 DIGITAL ELECTRONICS AND MICROPROCESSOR L T P C
                                            3 0 0 3

COURSE OBJECTIVES:
1. To present the Digital fundamentals, Boolean algebra and its applications in digital systems
2. To familiarize with the design of various combinational digital circuits using logic gates
3. To introduce the analysis and design procedures for synchronous and asynchronous sequential circuits
4. To explain the various semiconductor memories and related technology
5. To introduce the electronic circuits involved in the making of logic gate

UNIT – I DIGITAL FUNDAMENTALS
Number Systems – Decimal, Binary, Octal, Hexadecimal, 1’s and 2’s complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization.
UNIT – II COMBINATIONAL & SYNCHRONOUS SEQUENTIAL CIRCUITS

UNIT – III ASYNCHRONOUS SEQUENTIAL CIRCUITS AND MEMORY DEVICES

UNIT – IV 8085 PROCESSOR

UNIT – V PROGRAMMING PROCESSOR
Instruction - format and addressing modes – Assembly language format – Data transfer, data manipulation& control instructions – Programming: Loop structure with counting & Indexing – Look up table - Subroutine instructions – stack -8255 architecture and operating modes

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon the completion of this course, the students will be able to
CO1: Recognize fundamental operating concepts behind digital logic circuits and microprocessors.
CO2: Know the procedures for Combinational, synchronous and asynchronous sequential circuits
CO3: Apply the use of electronic circuits involved in the design of logic gates and semiconductor memories
CO 4: Design the DLC and Microprocessor 8085.
CO 5: Recommend the correct circuits using DLC and Microprocessor.

<table>
<thead>
<tr>
<th>Mapping of COs with POs and PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cos / POs &amp;PSOs</strong></td>
</tr>
<tr>
<td>CO1</td>
</tr>
<tr>
<td>CO2</td>
</tr>
<tr>
<td>CO3</td>
</tr>
<tr>
<td>CO4</td>
</tr>
<tr>
<td>CO5</td>
</tr>
<tr>
<td><strong>CO/PO &amp; PSO Average</strong></td>
</tr>
</tbody>
</table>

TEXT BOOKS:
REFERENCES

RO5302 ELECTRICAL DRIVES AND ACTUATORS

COURSE OBJECTIVES:
1. To familiarize a relay and power semiconductor devices
2. To get a knowledge on drive characteristics
3. To obtain the knowledge on DC motors and drives.
4. To obtain the knowledge on AC motors and drives.
5. To obtain the knowledge on Stepper and Servo motor.

UNIT – I RELAY AND POWER ELECTRONIC DEVICES
Study of Switching Devices – Relay and Types. Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT-. SCR, MOSFET and IGBT - Triggering and commutation circuit - Introduction to Driver and snubber circuits.

UNIT – II DRIVE CHARACTERISTICS

UNIT – III DC MOTORS AND DRIVES

UNIT – IV STEPPER MOTORS

UNIT – V INDUCTION AND SERVO MOTORS AND DRIVES
AC Permanent Magnet Synchronous Servo Motors – Linear Electrical Motors – VFD Drives – AC Servo Drives - Modern Servo Drives – Overview of Motion Control - Applications

COURSE OUTCOMES
Upon the completion of this course, the students will be able
CO 1: Recognize the working principle of switching device, motors and drives.
CO 2: Relate the working of drives and motors together.
CO 3: Apply the switching device and circuits for motors control.
CO 4: Use the appropriate motors for based on the specific requirements
CO 5: Select the appropriate motor for given applications.

TOTAL: 45 PERIODS
Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3</td>
<td>1</td>
<td>1.4</td>
<td>2</td>
<td>1.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES

AU5352 MECHANICS OF SOLIDS

COURSE OBJECTIVES:
The objective of this course is
1. To know about how a solid (materials, structures) behaves when it is exposed to forces and deformations.
2. To apply the fundamental concepts of principle of superposition, equilibrium, compatibility, force deformation, and stress-strain relationships to the solid and structural mechanics problems.
3. To analyze determinate and indeterminate bars, beams, to determine axial forces, torques, shear forces, and bending moments.
4. To have physical insight into distribution of stresses and strains in structural members.
5. To identify the biaxial stresses in acting in a body or an element.

UNIT I STRESS - STRAIN, AXIAL LOADING
Stress and strain, elastic limit, Hooke's law, factor of safety, shear stress, shear strain, relationship between elastic constants. Stresses in stepped bars, uniformly varying sections, composite bars due to axial force. Lateral strain, Poisson's ratio, volumetric strain, changes in dimensions and volume. Thermal stresses and impact loading.

UNIT II STRESSES IN BEAMS
Beam – Definition, types of end supports, types of beam, types of loading. Shear force diagram and bending moment diagram for cantilever, simply supported and overhanging beams under point load, UDL, UVL and moments. Euler beam theory - Bending equation, section modulus, Bending stress in beams – Shear stress in beams.
UNIT III  DEFLECTION OF BEAMS AND COLUMNS  9

UNIT IV  TORSION AND SPRINGS  9
Theory of torsion and assumptions - torsion equation, polar modulus, stresses in solid and hollow circular shafts, power transmitted by a shaft, shafts in series and parallel, deflection in shafts fixed at the both ends. Springs – types, Deflection expression for closed coiled helical spring – Stress in springs - design of springs.

UNIT V  BIAXIAL STRESS  9
Principal stresses, normal and tangential stresses, maximum shear stress - analytical and graphical method. Stresses in combined loading. Thin walled cylinder under internal pressure – changes in dimensions – volume. Spherical shells subjected to internal pressure – deformation in spherical shells – Lamé’s theory.

COURSE OUTCOMES:
At the end of the course, the students are expected to
i. Know about how a solid (materials, structures) behaves when it is exposed to forces and deformations.
ii. Apply the fundamental concepts of principle of superposition, equilibrium, compatibility, force-deformation, and stress-strain relationships to the solid and structural mechanics problems
iii. Analyze determinate and indeterminate bars, beams, to determine axial forces, torques, shear forces, and bending moments
iv. Have physical insight into distribution of stresses and strains in structural members
v. Identify the biaxial stresses in acting in a body or an element.

TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVES
1. To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics
2. To impart industry oriented learning
3. To evaluate the use of computer-based analysis tools to review the major classes of machines and their physical basis for operation

LIST OF EXPERIMENTS
1. Load test on DC Motor
2. Load test on 3 Phase Induction Motor
3. Load test on 3 Phase Synchronous Motor.
4. Rheostat based Speed control of motors (AC and DC)
5. Switching circuits of MOSFET, IGBT, SCR and TRAIC.
6. Gate pulsation generation using PWM signals.
7. Speed control of DC motor using Power Electronic Drive.
8. Position and direction control DC servomotor using Power Electronic Drive.
11. VFD control of single phase and three-phase induction motor using Power Electronic Drive.
12. AC servomotor position, direction and speed control using Power Electronic Drive.

COURSE OUTCOMES:
Upon the completion of this course, the students will be able to:
CO 1: To learn about the load test on DC motor, Induction motor and synchronous motor
CO 2: To understand the control of DC motor using power electric drive
CO 3: To develop the ability to works on AC, DC motor using power electric drive

CO-PO MAPPING:

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO/PO &amp; PSO Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEs</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial
COURSE OBJECTIVES
1. To study the mechanical properties of materials when subjected to different types of loading.
2. Applying the principles of kinematics involved in various mechanisms
3. Applying the principles of Dynamics involved in various Experiments

PART I  MECHANICS OF SOLIDS LABORATORY

List of Experiments:
1. Tension test on mild steel rod
2. Torsion test on mild steel rod
3. Hardness test on metal beam (Rockwell, Vicker’s and Brinell Hardness Tests)
4. Compression test on helical spring
5. Deflection test on carriage spring
6. Impact Test (Izod and Charpy)

PART II  MECHANICS OF MACHINES LABORATORY

List of Experiments:
1. Study of gears, gear trains and harmonic gears.
2. To determine mass moment of inertia and radius of gyration using compound pendulum.
3. To determine the torsional frequency of a single and double rotor system.
4. To perform experiment on Watt Governors to prepare performance characteristic Curves, and to find effect and sensitivity.
5. To perform experiment on Porter Governors to prepare performance characteristic Curves, and to find effect and sensitivity.
6. To find transverse vibration of free-beam with & without concentrated Masses.
7. To study the Profile and Jump Phenomenon of Cam.
8. Experiment of motorized gyroscope.

COURSE OUTCOMES:
Upon the completion of this course, the students will be able
CO1: Perform Tension, Torsion, Hardness, Compression, and Deformation test on Solid materials.
CO2: Apply the measurement of various kinematic parameters.
CO3: Apply the vibration parameters in various experiments.
CO-PO MAPPING:

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
| CO/PO & PSO   |   |   |   |   |   |   |   |   |   |    |    |    | Average:

1 – Slight, 2 – Moderate, 3 – Substantial

GE5361 PROFESSIONAL DEVELOPMENT

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: 10 Hours

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

MS EXCEL: 10 Hours

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

**MS POWERPOINT:**
10 Hours
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

**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.

**GE5251 **
**ENVIRONMENTAL SCIENCES**

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

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

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

UNIT III NATURAL RESOURCES
Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land 47 degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT

UNIT V HUMAN POPULATION AND THE ENVIRONMENT

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
- To identify the causes, effects and environmental pollution and natural disasters and contribute to the preventive measures in the immediate society.
- To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
To recognize different forms of energy and apply them for suitable applications in for technological advancement and societal development.

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

TEXT BOOKS:

REFERENCES:

PR5301 THERMODYNAMICS AND FLUID MECHANICS

COURSE OBJECTIVES
1. To make students understand the basic laws of thermodynamics.
2. To make the students to familiarize with the concepts, laws and methodologies for the analysis of gas turbines and compressors.
3. To introduce the basic concepts of fluid mechanics.
4. To make students understand the working principle of different types of pumps and hydraulic turbines.

UNIT – I BASIC CONCEPTS AND LAWS OF THERMODYNAMICS

UNIT – II INTRODUCTION TO APPLICATIONS OF THERMODYNAMICS
UNIT – III  BASIC CONCEPT OF FLUID MECHANICS & FLOW OF FLUIDS  9

UNIT – IV  DIMENSIONAL AND MODEL ANALYSIS  9
Dimension – need for dimensional analysis, Rayleigh’s and Buckingham’s method applied to flow problems, limitation of dimensional analysis. Model analysis – similitude, dimensionless numbers and their significance, similarity laws, model studies, limitation of scale models.

UNIT – V  HYDRAULIC MACHINES  9

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon the completion of this course, the students will be able
CO1: Understand and apply the basic laws of thermodynamics and fluid mechanics for different applications.
CO2: Use the basic concepts and methodologies for the analysis of gas turbine and compressors.
CO3: Recognize the concepts in fluid mechanics and also know about the flow of fluids
CO4: Understand the need of dimensional and model analysis.
CO5: Understand the working principle of different types of pumps and hydraulic turbines.

<table>
<thead>
<tr>
<th>COs/Pos &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:
RO5401 MANUFACTURING TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:
1. To learn about casting process and its classifications
2. To learn about welding process.
3. To learn about various Machining process
4. To learn about forming and shaping of plastics.
5. To learn about metal forming and powder metallurgy

UNIT – I CASTING
Casting types, procedure to make sand mould, types of core making, moulding tools, machine moulding, special moulding processes – CO2 moulding, shell moulding, investment moulding, permanent mould casting, pressure die casting, centrifugal casting, continuous casting, casting defects.

UNIT – II WELDING

UNIT – III MACHINING
General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, Universal drilling machine, Cylindrical grinding machine, Capstan and Turret lathe. Basics of CNC machines. General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Plasma arc machining, Tand Electron beam machining and Laser beam machining.

UNIT – IV FORMING AND SHAPING OF PLASTICS

UNIT – V METAL FORMING AND POWDER METALLURGY
Principles and applications of the following processes: Forging, Rolling, Extrusion, Wire drawing and Spinning, Powder metallurgy – Principal steps involved advantages, disadvantages and limitations of powder metallurgy.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1. Recognize casting process and its classifications
CO2. Recognize about welding process.
CO3. Recognize about various Machining process
CO4. Recognize about forming and shaping of plastics.
CO5. Recognize about metal forming and powder metallurgy

<table>
<thead>
<tr>
<th>COs/POs&amp;PSOs</th>
<th>CO1</th>
<th>CO2</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSOs</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average: 1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES

RO5402 ROBOT KINEMATICS

COURSE OBJECTIVES
1. To introduce Robots history, terminologies, classification and configurations.
2. To get knowledge about basic Geometrical and Algebraic approach to solve forward kinematics of serial manipulator.
3. To get knowledge about advanced forward kinematics of serial manipulator.
4. To get knowledge about inverse kinematics of various serial manipulator.
5. To get knowledge about Jacobian aspects and infinitesimal motion of robot mechanisms.

UNIT – I OVERVIEW OF ROBOTICS

UNIT – II FORWARD KINEMATICS - GEOMETRICAL AND ALGEBRAIC APPROACH
Need for forward and Inverse Kinematics Equation – Parameters in Design and Control – Methods of forward and inverse kinematics- Geometrical and Algebraic Approach in Forward Kinematics Solution, 1 DOF - 2 DOF Planar Robot (2P and 2R); 3DOF 2RP Spatial Robot.
UNIT – III  FORWARD KINEMATIC MODELING – DENAVIT-HARTEBERG (DH) 9

APPROACH

UNIT – IV  INVERSE KINEMATICS 9

Introduction to inverse kinematics -Issues in inverse kinematics - Inverse kinematics of 2 DOF Planar robot - 2 and 3DOF planar and Spatial robot - Tool configuration - Inverse kinematics of 3 axis robot and 6 axis Robot - Inverse kinematics Computation- Closed loop solution

UNIT – V  JACOBIAN AND DIFFERENTIAL MOTION 9


TOTAL : 45 PERIODS

COURSE OUTCOMES
At the end of the course students able to
CO 1: Explain the history, classifications and basic terminologies of robotics and various configuration of robots.
CO 2: Evaluate forward kinematic model for planar and spatial robot manipulator.
CO 3: Evaluate forward kinematic model for multi-DOF robot manipulators.
CO 4: Evaluate inverse kinematic model for multi-DOF robot manipulators.
CO 5: Evaluate differential motion of robot.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOK

REFERENCES
COURSE OBJECTIVES:
1. To impart knowledge on the various structural features of metallic materials.
2. To desire the various ferrous and nonferrous alloys and their applications.
3. To illustrate the role of heat treatment and surface modification of materials.
4. To review nonmetallic materials and composites with their applications
5. To enable student to select material for applications including the modern materials.

UNIT – I ALLOYS AND PHASE DIAGRAM

UNIT – II FERROUS AND NON FERROUS METALS

UNIT – III HEAT TREATMENT AND SURFACE MODIFICATION
Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR - Types and stages of annealing, stress relief, recrystallization and spheroidizing – normalizing, hardening and tempering of steel – Introduction to case hardening, Thermal spraying, CVD, PVD and nonmetallic coatings.

UNIT – IV NON METALLIC MATERIALS AND COMPOSITES
Polymers- Thermo, Thermoset Polymers, PE, PS, PVS PMMA, PC, PET, ABS- Engineering Polymers, PA, PPS, PI, PFE- Natural and Synthetic rubbers, Elastomers - Adhesives – Ceramics - Natural and Synthetic Ceramic - Composites – classification - structural composites and applications of composites

UNIT – V FUNCTIONAL MATERIALS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Identify the various structural features of metallic materials.
CO2: Recognize the various ferrous and nonferrous alloys with their applications.
CO3: Relate the heat treatment, Coating, microstructure and properties.
CO4: Explain the various nonmetallic materials and composites with their applications.
CO5: Suggest suitable materials for a given application.
Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:

RO5411 THERMAL AND FLUID MECHANICS LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES
1. To learn to conduct performance test on various pumps
2. To determine the loses in compressors, and various pipes
3. To learn to conduct the performance test on various thermal systems

A. FLUID MECHANICS
1. Determine the coefficient of discharge using Flow through Venturimeter/ Orifice/ Rotameter
2. Conduct the performance test and plot the Characteristics curves for Centrifugal pumps
3. Conduct the performance test and plot the Characteristics curves for Gear pump
4. Conduct the performance test and plot the Characteristics curves for Reciprocating pump
5. Conduct the performance test and plot the Characteristics curves for Francis turbine
6. Determination the major and minor losses in flow through pipes
7. Pressure distribution around a circular cylinder in high Reynolds number flow

B. THERMAL
1. Determine the viscosity of the oil using Redwood /Saybolt viscometer
2. Determination of Flash and Fire point of the oil
3. Draw the valve timing and port timing diagram for the 4S and 2S engines
4. Conduct the performance test and plot the Characteristics curves for Reciprocating air compressor
5. Conduct the performance test on Vapor compression Refrigeration system
6. Conduct the performance test on Air-conditioning system
7. Composite plane wall apparatus
8. Convective heat transfer coefficient by natural convection

TOTAL: 60 PERIODS

COURSE OUTCOMES:
CO1: Conduct performance test on various pumps
CO2: Determine the loses in compressors, and various pipes
CO3: Conduct the performance test on various thermal systems

CO-PO MAPPING:

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></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>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></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>CO/PO &amp; PSO</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

ME5461 MANUFACTURING TECHNOLOGY LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:
The main learning objective of this course is to provide hands on training to the students in:

1. Select appropriate tools, equipments and machines to complete a given job.
2. Develop component using casting processes.
3. Perform various joints by Gas Metal Arc Welding (GMAW) processes.
4. Perform various manufacturing processes such as rolling, drawing, turning, shaping, drilling, milling.
5. Fabricate gears using gear making machines.

LIST OF EXPERIMENTS
1. Fabricating simple structural shapes using Gas Metal Arc Welding machine.
2. Preparing green sand moulds with cast patterns.
3. Casting aluminum parts using stir casting machine.
4. Reducing the thickness of the plates using rolling machine.
5. Reducing the diameter of on circular parts using wire drawing process machine.
6. Taper Turning and Eccentric Turning on circular parts using lathe machine.
7. Knurling, external and internal thread cutting on circular parts using lathe machine.
8. Shaping – Square and Hexagonal Heads on circular parts using shaper machine.
11. Cutting spur and helical gear using milling machine.
15. Broaching components using broaching machine.

Total (P: 60) = 60 Periods

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

1. Select appropriate tools, equipments and machines to complete a given job.
2. Create components using casting processes.
3. Perform various welding process using GMAW.
4. Perform various machining process such as rolling, drawing, turning, shaping, drilling, milling.
5. Fabricate the gears using various gear generation and forming processes.

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

RO5501 EMBEDDED SYSTEMS AND PROGRAMMING L T P C 3 0 0 3

COURSE OBJECTIVES:
1. To familiarize the architecture and fundamental units of microcontroller.
2. To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.
3. To design the interface circuit and programming of I/O devices, sensors and actuators.
4. To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.
5. To acquaint the knowledge of real time embedded operating system for advanced system developments.

UNIT – I MICROCONTROLLER

UNIT – II PROGRAMMING AND COMMUNICATION

UNIT – III PERIPHERAL INTERFACING
I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of
Servomotor – Traffic Light

UNIT – IV ARM PROCESSOR

UNIT – V SINGLE BOARD COMPUTERS(SBC) AND PROGRAMMING

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO 1: Select the microcontroller based on the features and specifications.
CO 2: Setup the programming platform and establish the various communications.
CO 3: Design the microcontroller based interfacing of sensors, actuators and other I/O’s for controller development.
CO 4: Use and program the ARM processor growing needs of mechatronic systems.
CO 5: Establish and use the real time embedded operating systems and programming languages for peripheral interfacing and control.

<table>
<thead>
<tr>
<th>COs/Pos&amp;PS Os</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES
COURSE OBJECTIVES:

- To understand the concepts of measurement technology.
- To learn the various motion, proximity and ranging sensors.
- To learn the various Force, Magnetic and Heading Sensors.
- To learn the various Optical, Pressure and Temperature Sensors.
- To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.

UNIT – I INTRODUCTION


UNIT – II MOTION, PROXIMITY AND RANGING SENSORS


UNIT – III FORCE, MAGNETIC AND HEADING SENSORS


UNIT – IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS


UNIT – V SIGNAL CONDITIONING AND DAQ SYSTEMS


TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Recognize with various calibration techniques and signal types for sensors.

CO2: Describe the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.

CO3: Apply the various sensors in the Automotive and Mechatronics applications.

CO4: Select the appropriate sensor for different applications.

CO5: Acquire the signals from different sensors using Data acquisition systems.

Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POs</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TEXT BOOKS:

REFERENCES:

EE5402 CONTROL SYSTEMS

COURSE OBJECTIVES:
• To make the students familiarize various representations of systems.
• To make the students analyze the stability of linear systems in time domain and frequency domain.
• To make the students analyze the stability of linear systems in frequency domain.
• To make the students design compensator based on the time and frequency domain Specifications.
• To develop linear models mainly state variable model and Transfer function model

UNIT – I MODELING OF LINEAR TIME INVARIANT SYSTEM (LTIV) 9
Control system: Open loop and Closed loop – Feedback control system characteristics – First principle modelling: Mechanical, Electrical and Electromechanical systems – Transfer function representations: Block diagram and Signal flow graph.

UNIT – II TIME DOMAIN ANALYSIS 9

UNIT – III FREQUENCY DOMAIN ANALYSIS 7

UNIT – IV STATE VARIABLE ANALYSIS 11
State variable formulation – Non uniqueness of state space model – State transition matrix – Eigen values – Eigen vectors-Free and forced responses for Time Invariant and Time Varying
Systems – Controllability – Observability

UNIT – V  DESIGN OF FEED BACK CONTROL SYSTEM


TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion the above subject, students will be able to understand

CO1: Represent simple systems in transfer function and state variable forms.
CO2: Analyse simple systems in time domain.
CO3: Analyse simple systems in frequency domain.
CO4: Infer the stability of systems in time and frequency domain.
CO5: Interpret characteristics of the system and find out solution for simple control problems.

<table>
<thead>
<tr>
<th>COs/ Pos &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Average</td>
<td>2.2</td>
<td>2.2</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:

NPTEL Video Lecture Notes on “Control Engineering” by Prof.S.D.Agashe, IIT Bombay

RO5503  DESIGN OF ROBOT ELEMENTS

<table>
<thead>
<tr>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:
1. To introduce the students to the fundamentals of machine design, material selection and to solve the basic design problems.
2. To learn to derive various parameters for modelling links and joints in a robot.
3. To learn about Fundamentals of Computer Graphics
4. To learn and understand curves and surfaces in robot modelling.
5. To learn to derive various parameters for modelling end-effectors of a robot.

UNIT – I FUNDAMENTALS OF MECHANICAL DESIGN 8

UNIT – IV DESIGN OF LINKS AND JOINTS 9

UNIT – III FUNDAMENTALS OF COMPUTER GRAPHICS 9
Product cycle- Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation.

UNIT – IV CURVES AND MODELLING 9
Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Fundamentals of solid modeling, Different solid representation schemes, Half -spaces, Boundary representation (B-rep), Constructive solid geometry (CSG), Sweep representation, Analytic solid modeling, Perspective, Parallel projection, Hidden line removal algorithms.

UNIT – V DESIGN OF GRIPPERS 9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1: Derive various parameters for modelling links and joints in a robot.
CO2: Recognize various end-effectors and derive various parameters for modelling end-effectors of a robot.
CO3: Know about various fundamentals of Computer Graphics
CO4: Recognize curves and surfaces in robot modelling.
CO5: Derive various parameters for modelling end-effectors of a robot.
Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>1 – Slight, 2 – Moderate, 3 – Substantial</td>
<td></td>
</tr>
</tbody>
</table>

**TEXT BOOKS:**

**REFERENCES:**

**RO5511 EMBEDDED SYSTEMS LABORATORY**

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

**COURSE OBJECTIVES**
- To give the hands on experience on designing a microcontroller based I/O interface circuits.
- To acquire the practice on programming the interfaces of keyboards, sensors, actuators, timers and counters, display devices and communication protocols using 8051 microcontroller and ARM processor.

**LIST OF EXPERIMENTS**
1. Assembly Language Programming and Simulation of 8051.
2. Alphanumeric and Graphic LCD Interfacing using 8051 Microcontroller.
3. Input switches and keyboard interfacing of 8051.
4. Sensor Interfacing with ADC to 8051 and DAC & RTC Interfacing with 8051.
5. Timer, Counter and Interrupt Program Application for 8051.
6. Step Motor (Unipolar & Bipolar Motor) and PWM Servo Motor Control to Interfacing with 8051.
7. UART Serial and Parallel Port Programming of 8051.
8. I²C, SPI and CAN Programming of 8051.
9. Interfacing and Programming of Bluetooth and Wi-Fi with 8051
15. IOT application using SBC.

TOTAL = 60 PERIODS

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

CO1: Design and use a microcontroller based system control with I/O interface circuit.
CO2: Program the interfaces of keyboards, sensors, actuators, timers and counters, display devices and communication protocols using 8051 microcontroller and ARM processor.
CO3: Use the single board computers for real time applications.

RO5512 SENSORS AND CONTROL SYSTEMS L T P C
LABORATORY 0 0 4 2

COURSE OBJECTIVES
1. To learn about various force, pressure and vibration measuring sensors.
2. To learn about various Temperature, light and magnetic field measuring sensors.
3. To learn about various displacement and speed measuring sensors.

LIST OF EXPERIMENTS
SENSORS
1. Determination of Load, Torque and Force using Strain Gauge.
3. Determination of Displacement using LVDT.
4. Determine the Characteristics of Various Temperature Sensors.
5. Determine the Characteristics of Various Light Detectors (Optical Sensors).
7. Determine angular velocity of gyroscope.
8. Vibration measurement using Accelerometer.
9. Direction measurement using Magnetometer.
10. Speed, Position and Direction Measurement Using Encoders.
11. Force measurement using 3 axis force sensor.
13. Data acquisition, visualization and analysis of signals.
(Any 8 experiments)

CONTROL SYSTEMS LABORATORY
Experiments
1. Mathematical Modelling and Simulation of a Physical Systems and Simulation and Reduction of Cascade and Parallel, and Closed Loop Sub-System.
2. Simulation and Analysis of First and Second Order System Equations in Time and Frequency Domain.
3. Simulation and Analysis of System using Root-Locus and Bode Plot.
4. Simulation and Implementation of PID Combination for First Order Systems.
5. Simulation and Implementation of PID Combination Second Order Systems.
6. Auto tuning of PID parameters and analysis of PID Control.
7. Test of controllability and observability in continuous and discrete domain in simulation platform

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon the completion of this course, the students will be able to;
CO1: Demonstrate the various contact and non-contact sensors.
CO2: Analyze and Identify appropriate sensors for given applications.
CO3: Create a sensor system for given requirements.

| COs/POs & PSOs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSOs
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

COURSE OBJECTIVES
1. Make the students knowledgeable in modeling the basic components of a robot
2. Make the students knowledgeable in modeling some common joints, links and transmission assembly for a robot.
3. Make the students knowledgeable in modeling a robot and its end effector.

LIST OF EXPERIMENTS
1. 2D Sketch of a Gear.
2. 2D Sketch and 3D modelling of Sheet Metal Components
3. 3D Modelling Mounting clamp for motor.
4. 3D Modeling of GT2 pulley and belt drive system
5. 3D Modelling Ball Screw and Nut assembly.
6. 3D Modelling and motion simulation of Rotational Joint assembly.
7. 3D Modelling and motion simulation of Prismatic Joint assembly.
8. 3D modelling and simulation of Cartesian Robot
9. 3D modelling and simulation of Articulated / Spherical / Cylindrical Robot.
10. 3D modelling and motion simulation of 2 fingered gripper assembly.
11. Study on Harmonic Gear drive.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon the completion of this course, the students will be able to;
CO1: Create basic components of a robot in CAD software
CO2: Create some common joints, links and transmission assembly for a robot in CAD software.
CO3: Create a robot and its end effector in CAD software.

CO-PO MAPPING:

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO</td>
<td>Average</td>
<td></td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

RO5601 ROBOT DYNAMICS AND CONTROL L T P C
3 0 0 3

COURSE OBJECTIVES

1. To learn and understand generalized co-ordinates, Jacobian matrix Mass Distribution and other fundamental equations.
2. To understand Lagrangean and Hamiltonian mechanics.
3. To understand nonlinearities in control system.
4. To understand various force control strategies.
5. To understand various concepts in linearizing a non-linear signal.

UNIT - I ROBOT FORCE MODELS 9

UNIT - II ROBOT DYNAMICS 9

UNIT - III ROBOT CONTROL SYSTEM 9

UNIT - IV CONTROL OF MANIPULATORS 9

UNIT - V FORCE CONTROL

TOAL: 45 PERIODS

COURSE OUTCOME
Upon the completion of this course, the students will be able to;
CO1: Describe generalized co-ordinates, Jacobian matrix Mass Distribution and equation of motion.
CO3: Describe the control architecture of robot manipulator.
CO4: Evaluate linear and nonlinearities in control system.
CO5: Explain various force control strategies.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs 1</th>
<th>POs 2</th>
<th>POs 3</th>
<th>POs 4</th>
<th>POs 5</th>
<th>POs 6</th>
<th>POs 7</th>
<th>POs 8</th>
<th>POs 9</th>
<th>POs 10</th>
<th>POs 11</th>
<th>POs 12</th>
<th>PSOs 1</th>
<th>PSOs 2</th>
<th>PSOs 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVES
1. Introduce basic trajectory planning problems.
2. Provide a basic review of various path planning theory of manipulator.
3. Provide a basic review of various path planning theory of mobile robot.
4. Introduction to the most widely used classical motion planning algorithms.
5. Introduce sufficient terminology and concepts in ROS for robot programming.

UNIT - I  TRAJECTORY PLANNING APPROACHES  9

UNIT - II  TRAJECTORY PLANNING OF MANIPULATOR  9
Joint space techniques – Motion profiles – Cubic polynomial, Linear Segmented Parabolic Blends and cycloidal motion - Cartesian space technique – Straight line and circular trajectories.

UNIT - III PATH PLANNING OF MOBILE ROBOT  9

UNIT - IV PATH PLANNING ALGORITHMS  9

UNIT - V ROS PROGRAMMING  9
Robot language classification - Programming methods:Lead through method, teach pendent method - Syntax features and applications of various programming languages – Examples - Inter locking commands - Safety features - Introduction to Robot Operating System (ROS) - ROS examples - Introduction to programming using ROS - Industrial ROS – ROS examples - Programming for point to point /continuous – operations - Case Study

COURSE OUTCOME
Evaluate basic trajectory planning problems.
Know about the various path planning theory of manipulator.
Recognize various path planning theory of mobile robot.
Demonstrate the most widely used classical motion planning algorithms.
Apply sufficient terminology and concepts in ROS for robot programming.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
TEXTBOOKS

REFERENCES:
2. Robot Motion Planning by J.C. Latombe, 2010

RO5603 FLUID POWER SYSTEMS AND INDUSTRIAL AUTOMATION

COURSE OBJECTIVES:
1. To recognize the standard symbols and to understand the functions of basic fluid power generation and actuation elements.
2. To realize the functions of fluid regulation and control elements and its typical uses in fluid power circuit and to acquire the practice on assembling the various types of pneumatic circuits.
3. To familiar and exercise the design procedure of various types of pneumatic and hydraulic fluid power circuits and to provide a training to create the various types of hydraulic circuits.
4. To learn about the fundamentals of Programmable Logic Controller.
5. To familiarize the Data Communication and Supervisory Control Systems.

UNIT – I FLUID POWER SYSTEM GENERATION AND ACTUATORS

UNIT – II CONTROL AND REGULATING ELEMENTS
Control and Regulating Elements — Direction, Flow and Pressure Control Valves - Methods of

UNIT – III CIRCUIT DESIGN FOR HYDRAULIC AND PNEUMATICS 9
Typical Design Methods – Sequencing Circuits Design - Combinational Logic Circuit Design - Cascade Method – KV Mapping - Electrical Control of Pneumatic and Hydraulic Circuits - Use of Relays, Timers, Counters and PLC in pneumatics and hydraulics

UNIT – IV PROGRAMMABLE LOGIC CONTROLLER 9

UNIT – V DATA COMMUNICATION AND SUPERVISING CONTROL SYSTEMS 9
TOTAL: 45 PERIODS

Laboratory

FLUID POWER DRIVES
1. Experimental Verification of Speed Control Circuits in Pneumatic and Hydraulic Trainer.
2. Experimental Verification of Single and Double Acting Cylinder Circuits Using Different Directional Control Values.
3. Experimental Verification of Electro-Pneumatic Circuits.
4. Experimental Verification of Pneumatic Sequencing Circuits.
5. Experimental Verification of Logic, Metre-in and Metre-out Pneumatic Circuits.
7. Control of PLC Based Electro Pneumatic Sequencing Circuits.
8. Control of PLC Based Electro Hydraulic Sequencing Circuits.
(any 5 experiments)

INDUSTRIAL AUTOMATION
1. Design a Ladder Logic Program for various Logic Gates AND, OR, NOT, NOR, NAND, EX-OR and EX-NOR.
2. Develop Ladder Diagram Programming to set Timer and Counter in PLC.
3. Develop PLC Program to Control Traffic Light.
4. Develop PLC Program to Maintain the Pressure and Level in a Bottle Filling System.
5. Develop Ladder Diagram Program in PLC For Material Filling, Object Shorting, Orientation Check and Material Property Check.
6. Develop the Ladder Diagram Program in PLC for Material Handling, Delaying Conveyor, Feeding, Pick and Place Operation.
7. Sensor and Actuator Interfacing in PLC and PLC to PLC Communication.
(any 5 experiments)

TOTAL: 30 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO 1: Recognize the various concepts of fluid power and PLC systems.
CO 2: Comprehend functions of fluid power and PLC systems.
CO 3: Explain the various standard fluid power circuits, functions, communication and IO details of PLC.
CO 4: Demonstrate the standard fluid power circuits and PLC based interfaces.
CO 5: Construct the fluid power circuits and PLC based automation system.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOK

REFERENCES

RO5611 ROBOT KINEMATICS AND DYNAMICS LABORATORY L T P C 0 0 4 2

COURSE OBJECTIVES
1. To model and simulate a robot and verify its kinematics
2. To model and simulate a robot and generate a trajectory plan.
3. To model and simulate a robot and verify its dynamics

LIST OF EXPERIMENTS
2. Verification of D-H transformation for 6DOF Serial manipulator
4. Verification of Forward Kinematics for 3R spatial Robot.
5. Kinematic Analysis of 2R planar robot for varying trajectories using Robo analyzer
6. Workspace Analysis of 2R planar robot manipulator for a specified trajectory
7. Kinematic Analysis of 6 DOF robot for varying trajectories using Robo analyzer
8. Inverse Dynamic Analysis of 6 DOF robot robot for varying trajectories using Robo analyzer
9. Forward and Inverse Dynamics of 2R planar robot using Robo analyzer
10. Creation of Robot in ROS using Gazebo/V-REP
11. Motion Simulation of Robot in ROS using Gazebo/V-REP/Moveit/Industrial.
12. Simulation of Trajectory Analysis of 2R and 3R manipulators using MATLAB-SIMULINK

**TOTAL: 60 PERIODS**

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:**

1. PC workstation - 30 No's
2. Robot analyzer (open source) installed on computer - 30 No’s
3. ROS with Gazebo/moveit/v-rep installed on computer - 30 No’s

**COURSE OUTCOMES:**

CO1. Analyse the kinematics and dynamics for various robots.

CO2. Simulate and evaluate the kinematics and dynamics for various robots.

CO3. Create a robot and program a trajectory plan for the robot.

---

RO5701 ROBOT VISION AND INTELLIGENCE L T P C
3 0 0 3

**COURSE OBJECTIVES:**

1. To understand the basics concepts of optics and vision systems.
2. To learn and understand the fundamentals of image processing
3. To impart knowledge on object recognition and feature extraction.
4. To understand algorithms in image processing.
5. To demonstrate the various applications of machine vision system.

**UNIT I IMAGE ACQUISITION**

9

**UNIT II IMAGE PROCESSING FUNDAMENTALS**

9

**UNIT III OBJECT RECOGNITION AND FEATURE EXTRACTION**

9
Image segmentation- Edge Linking-Boundary detection-Region growing-Region splitting and merging- Boundary Descriptors-Freeman chain code-Regional Descriptors- recognition-structural methods- Recognition procedure, mahalanobic procedure

**UNIT IV COLLISION FRONTS ALGORITHM**

9
Introduction, skeleton of objects. Gradients, propagation, Definitions, propagation algorithm, Thinning Algorithm, Skeleton lengths of Top most objects.

**UNIT V ROBOT VISION APPLICATION**

9
Case study - Automated Navigation guidance by vision system – vision based depalletizing line tracking. Automatic part Recognition. Image processing techniques implementation through Image Processing software

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO 1: Know the various types of sensors, lightings, hardware and concept of machine vision.
CO 2: Acquire the image by the appropriate use of sensors, lightings and hardware.
CO 3: Apply the various techniques of image processing in real time applications.
CO 4: Select the suitable sensors, lightings and hardware.
CO 5: Apply the vision techniques in Robot vision system.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOK:

REFERENCES

RO5702 AUTONOMOUS MOBILE ROBOTICS L T P C 3 0 0 3

COURSE OBJECTIVES
1. To introduce mobile robotic technology and its types in detail.
2. To learn the kinematics of wheeled and legged robot.
3. To familiarize the intelligence into the mobile robots using various sensors.
4. To acquaint the localization strategies and mapping technique for mobile robot.
5. To aware the collaborative mobile robotics in task planning, navigation and intelligence.

UNIT – I INTRODUCTION TO MOBILE ROBOTICS 6
UNIT – II KINEMATICS

UNIT – III PERCEPTION

UNIT – IV LOCALIZATION

UNIT – V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS

TOTAL: 45 PERIODS

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOK

REFERENCES:

RO5703 MACHINE LEARNING FOR INTELLIGENT SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:
1. To introduce basic machine learning techniques such as regression, classification
2. To learn about clustering and segmentation
3. To learn about fuzzy logic, fuzzification and defuzzification
4. To learn about basics of neural networks and neuro fuzzy networks.
5. To learn about Reinforcement learning.

UNIT – I INTRODUCTION TO MACHINE LEARNING
Philosophy of learning in computers, Overview of different forms of learning, Classifications vs. Regression, Evaluation metrics and loss functions in Classification, Evaluation metrics and loss functions in Regression, Applications of AI in Robotics.

UNIT – II CLUSTERING AND SEGMENTATION METHODS
Introduction to clustering, Types of Clustering, Agglomerative clustering, K-means clustering, Mean Shift clustering, K-means clustering application study, Introduction to recognition, K-nearest neighbor algorithm, KNN Application case study, Principal component analysis (PCA), PCA Application case study in Feature Selection for Robot Guidance.

UNIT – III FUZZY LOGIC

UNIT – IV NEURAL NETWORKS

UNIT – V RNN AND REINFORCEMENT LEARNING
Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning, Examples for reinforcement learning, Markov decision process, Major components of RL, Q-learning. Application Case Study of reinforcement learning in Robotics

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Know about the concepts in basic machine learning techniques such as regression, classification
CO2: Recognize the methods in clustering and segmentation
CO3: Model a fuzzy logic system with fuzzification and defuzzification
CO4: Recognize the concepts of neural networks and neuro fuzzy networks.
CO5: Gain knowledge on Reinforcement learning.

Mapping of COs with POs and PSOs
<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

**TEXT BOOKS**

**REFERENCES**

**RO5711**  
ROBOTIC PROGRAMMING, VISION AND INTELLIGENCE LABORATORY  
L T P C  
0 0 4 2

**COURSE OBJECTIVES**
1. To understand various lighting techniques, design and image acquisition of machine vision system.
2. To practice Feature Extraction, Image pre-processing and pattern recognition.
3. To apply machine learning technique to classification and object detection.

**LIST OF EXPERIMENTS**
1. Study on different kinds of vision sensors and lighting techniques for machine vision.
3. Experimentation on image acquisition towards the computation platform.
4. Pre-processing techniques in image processing.
5. Edge detection and region of interest extraction.
6. Experimentation with image processing algorithm for feature extraction.
7. Experimentation with pattern recognition.
10. Experimentation for Stereo vision.
11. Robot assisted image acquisition.
12. Vision based defect identification

**TOTAL: 60 PERIODS**

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:**
1. Camera with lenses and camera mounting interfaced with PC/any system - 5 No
2. Camera with any single board computers (system on chip models) – 5 No’s.
3. Open CV / python with supported library/ licensed image processing software- 10 No’
Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

COURSE OUTCOMES:
Upon completing this course Students able to
CO1: Select appropriate lighting techniques and image acquisition device for robot vision system.
CO2: Apply Feature Extraction, Image pre-processing and pattern recognition algorithm in real time robot.
CO3: Create a machine learning technique to classification and object detection.

COURSE OBJECTIVES:
1. To get a knowledge of working on Industrial robots and their load handling capacity
2. To enlist with an application of robots in various operation
3. To familiar with a material handling system
4. To impart the knowledge on robotic welding
5. To obtain the knowledge on various type of robot welding operation

UNIT – I INTRODUCTION
Types of industrial robots - Load handling capacity - general considerations in Robotic material handling-material transfer - machine loading and unloading - CNC machine tool loading - Robot centered cell

UNIT – II SELECTION OF ROBOTS AND OTHER APPLICATIONS

UNIT – III MATERIAL HANDLING
concepts of material handling - principles and considerations in material handling systems design - conventional material handling systems - industrial trucks - monorails - rail guided vehicles - conveyor systems -cranes and hoists - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems(ASRS) - bar
code technology - radio frequency identification technology - Introduction to Automation Plant design softwares.

UNIT – IV ROBOTIC WELDING 8
Robotic welding system, Programmable and flexible control facility – Introduction-Types- Flex Pendant-Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding

UNIT – V APPLICATIONS OF ROBOTS IN WELDING AND ALLIED PROCESSES 8
Application of robot in manufacturing: Exploration of practical application of robots in welding: Robots for car body’s welding, robots for box fabrication, robots for microelectronic welding and soldering – Applications in nuclear, aerospace and ship building, case studies for simple and complex applications

COURSE OUTCOMES:
The Student must be able to
CO 1: Learn about the basic concepts of Industrial Robot.
CO 2: Ability in selecting the required robots
CO 3: Apply their knowledge in handling the materials.
CO 4: Learn about the Welding operation and also related to Programming
CO 5: Know the various applications of robots.

<table>
<thead>
<tr>
<th>Mapping of COs with POs and PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>COs/POs &amp; PSOs</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>CO1</td>
</tr>
<tr>
<td>CO2</td>
</tr>
<tr>
<td>CO3</td>
</tr>
<tr>
<td>CO4</td>
</tr>
<tr>
<td>CO5</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXTBOOKS:

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

1. Designing machine members subjected to static and variable loads.
2. Designing flexible elements like belts, ropes, and chain drives for engineering applications.
3. Designing shafts and threaded fasteners for various applications.
4. Designing and selecting bearings and robot grippers.
5. Designing gears and gearbox for machine tools and applications.

UNIT I FUNDAMENTAL CONCEPTS IN DESIGN
Introduction to Robots - factors influencing robot design, selection of materials based on mechanical properties - Modes of failure - Factor of safety - stresses due to bending and torsion moment - Eccentric loading, Design against fluctuating loads - theories of failures.

UNIT II DESIGN OF FLEXIBLE ELEMENTS AND BEARINGS
Introduction to flexible elements, Design of belt drives - Flat, Vee, and Timing Belts, Design of chain drives - Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfield Number, Raimondi & Boyd graphs - Selection of Rolling Contact bearings.

UNIT III DESIGN OF SHAFTS AND THREADED FASTENERS
Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity, and critical speed - Keys and splines, Threaded fasteners - Bolted joints - Simple and eccentrically loaded bolted joints.

UNIT IV DESIGN OF GEARS AND GEAR BOXES
Design of Gears (Spur, Helical and Bevel) - Geometric progression - Standard step ratio - Ray diagram, kinematic layout - Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications.

UNIT V DESIGN OF ROBOT GRIPPERS AND END EFFECTORS
Types of End Effectors and Gripper Mechanisms, Force analysis, Miniature Grippers and Micro Grippers, Compliance, Selected case studies - Sheet metal handling, pretension of cuboid/ cylindrical / objects, coils, irregular surfaces and flexible objects, handling castings, and medical applications.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon successful completion of the course, students should be able to:
CO1: Design machine members subjected to static and variable loads.
CO2: Design flexible elements like belt, ropes and chain drives for engineering applications.
CO3: Design shafts and threaded fasteners for various applications.
CO4: Design gear and gear box for machine tool applications.
CO5: Design and bearings and robot grippers.

<table>
<thead>
<tr>
<th>Co/PO &amp; PSOs Average</th>
<th>P0s 1</th>
<th>P0s 2</th>
<th>P0s 3</th>
<th>P0s 4</th>
<th>P0s 5</th>
<th>P0s 6</th>
<th>P0s 7</th>
<th>P0s 8</th>
<th>P0s 9</th>
<th>P0s 10</th>
<th>P0s 11</th>
<th>P0s 12</th>
<th>PSOs 1</th>
<th>PSOs 2</th>
<th>PSOs 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO1/PO &amp; PSO Average</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXTBOOKS:

REFERENCES:

ME5071 AUTOMOBILE ENGINEERING

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Classifying the types of chassis and identify different class of automobiles
2. Outline the engine systems and their emission control.
3. Illustrating the functions of various transmission systems.
4. Imparting the working of different braking and steering systems.
5. Understanding the working of electrical and electronic components.
UNIT I  INTRODUCTION TO AUTOMOBILE AND TYPES  

UNIT II  POWERTRAIN AND FUEL MANAGEMENT SYSTEMS  
Reciprocating Engine systems, Hybrid systems. Pollutant emissions and their control; Catalytic converter systems, Electronic Engine Management systems for SI and CI engines. Liquid and gaseous alternate fuels - Alcohol, LPG, CNG, and Hydrogen.

UNIT III  CLUTCH AND TRANSMISSION SYSTEMS  
Clutch system and types, Gear box and types - manual, automatic, and AMT, propeller shafting, Differential, Axles - function, and types. Wheels, Tyres - types, construction and specification, suspension system - types and functioning.

UNIT IV  BRAKING AND SUSPENSION SYSTEMS  
Braking system - requirements and types, Steering system - working, types and steering geometry parameters. Wheel balancing & Alignment Wind Tunnel testing, Servicing of Vehicles.

UNIT V  ELECTRICAL AND ELECTRONIC SYSTEMS  
Introduction to Battery, Alternator, and Starter Motor systems, working principle, and circuitry, Safety systems - seat belts, air-bag, ABS, Modern electronic features in vehicles like tyre pressure monitoring, ESP, EBD, Automatic headlamp ON, Rain sensing wipers, speed sensing auto locking, OBD. HVAC system

TOTAL = 45 PERIODS

COURSE OUTCOMES:  
Upon completion of this course, the students will be able to:
1. Distinguish the different types of automobiles and chassis.
2. Interpret the various types of engines and their emission control.
3. Select the appropriate transmission systems.
4. Compare the braking and steering systems.
5. Infer the functions of different electrical and electronic components.

TEXTBOOKS:

REFERENCES:
RO5003  LINEAR INTEGRATED CIRCUITS  

COURSE OBJECTIVES: 
1. To introduce the basic building blocks of linear integrated circuits 
2. To learn the linear and non-linear applications of operational amplifiers 
3. To introduce the theory and applications of analog multipliers and PLL 
4. To learn the theory of ADC and DAC 
5. To introduce the concepts of waveform generation and introduce some special function ICs 

UNIT – I  BASICS OF OPERATIONAL AMPLIFIERS  

UNIT – II  APPLICATIONS OF OPERATIONAL AMPLIFIERS  
Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters. 

UNIT – III  ANALOG MULTIPLIER AND PLL  
Analog Multiplier using Emitter Coupled Transistor Pair – Gilbert Multiplier cell – Variable transconductance technique, analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizingand clock synchronization 

UNIT – IV  ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS  

UNIT – V  WAVEFORM GENERATORS AND SPECIAL FUNCTION ICs  
Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator,ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators – IC 723 general purpose regulator – Monolithic switching regulator, Low Drop – Out(LDO) Regulators – Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Optocouplers and fibre optic IC. 

TOTAL: 45 PERIODS
COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO 1: Design linear and nonlinear applications of OP – AMPS
CO 2: Design applications using analog multiplier and PLL
CO 3: Design ADC and DAC using OP – AMPS
CO 4: Generate waveforms using OP – AMP Circuits
CO 5: Analyze special function ICs

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
<th>CO5</th>
<th>CO/PO &amp; PSO Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>POs</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>PSOs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:

RO5004 APPLIED SIGNAL PROCESSING

<table>
<thead>
<tr>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

COURSE OBJECTIVES:
1. To understand the characteristics of various types of signals.
2. To carry out the pre-processing of continuous time signals and systems.
3. To learn DTFT, FFT and Z-Transform methods in signals processing.
4. To design digital IIR, FIR filters for signal processing.
5. To learn about various signal processors and its applications of signals.

UNIT – I INTRODUCTION TO SIGNALS AND SYSTEMS
Elementary signals in continuous and discrete time - graphical and mathematical representation - Elementary operations and classification of continuous and discrete time signals – CT systems and DT systems - Properties of CT systems and DT systems Classification of systems
UNIT – II ANALYSIS OF CONTINUOUS TIME SIGNALS AND SYSTEMS 9
The continuous time Fourier series - Fourier Transform properties - Laplace transform and properties - Impulse response - convolution integrals - Fourier and Laplace transforms in Analysis of CT systems - Frequency response of systems characterized by differential Equations

UNIT – III ANALYSIS OF DISCRETE TIME SIGNALS AND SYSTEMS 9

UNIT – IV DESIGN OF DIGITAL FILTERS 9

UNIT – V DIGITAL SIGNAL PROCESSORS AND APPLICATIONS 9

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
1. Understand the characteristics of various types of signals.
2. Analyze continuous time signals and systems
3. Understand DTFT, FFT and Z-Transform methods in signals processing.
4. Design digital IIR, FIR filters for signal processing
5. Analyze and Apply various signal processors and its applications of signals.

Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>COs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Average 1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Apply the fundamental concepts of vibration.
2. Apply the fundamentals of noise.
3. Describe the various sources of noise for automotive applications.
4. Determine the natural frequencies and mode shapes of the two degree freedom systems.
5. Apply the various control techniques to reduce the vibration and noise to improve the life of the components.

UNIT I  BASIC OF VIBRATION 9
Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree systems, torsional vibration - determination of natural frequencies and critical speed of shafts.

UNIT II  BASIC OF NOISE 9
Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.

UNIT III  AUTOMOTIVE NOISE SOURCES 9

UNIT IV  TWO DEGREE FREEDOM SYSTEM 9
Introduction-Free Vibration Of Undamped And Damped - Forced Vibration With Harmonic Excitation System - Coordinate Couplings And Principal Coordinates – Vibration absorbers

UNIT V  CONTROL OF VIBRATION AND NOISE 9
Major sources of noise – Noise survey techniques – Measurement technique for vehicular noise – Road vehicle noise standards – Industrial noise sources – Control Strategies – Noise control at the source and along the path – use of acoustic barriers – Noise control at the receiver – vibration isolation methods

TOTAL  = 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Apply the fundamental concepts of vibration.
2. Apply the fundamentals of noise.
3. Describe the various sources of noise for automotive applications.
4. Determine the natural frequencies and mode shapes of the two degree freedom systems.
5. Apply the various control techniques to reduce the vibration and noise to improve the life of the components.

TEXT BOOKS:

REFERENCES:
UNIT – III  DRONE FLYING AND OPERATION
Concept of operation for drone - Flight modes - Operate a small drone in a controlled environment - Drone controls F-light operations –management tool –Sensors- Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

UNIT – IV  DRONE COMMERCIAL APPLICATIONS
Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT – V  FUTURE DRONES AND SAFETY
The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
- CO 1: Known about a various type of drone technology
- CO 2: Obtain a knowledge about design, fabrication and programming in drone
- CO 3: Learn about the flying and operation of drone
- CO 4: Knowledge about the various commercial application of drone
- CO 5: Understand the safety risks and guidelines to fly safely

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Average</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES
COURSE OBJECTIVES:
The course should enable the students to:
   i. General aspects of Electric and Hybrid Vehicles (EHV), including architectures, modeling, sizing, sub system design and hybrid vehicle control.
   ii. Understand about vehicle dynamics,
   iii. Design the required energy storage devices,
   iv. Select the suitable electric propulsion systems and
   v. Understand of hybrid electric vehicles.

UNIT I  NEED FOR ALTERNATIVE SYSTEM
Need for hybrid and electric vehicles – main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. Case study on specification of electric and hybrid vehicles.

UNIT II  DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES

UNIT III  ENERGY SOURCES

UNIT IV  MOTORS AND CONTROLLERS
Types of Motors, Characteristic of DC motors, AC single phase and 3-phase motor, PM motors, Switched reluctance motors, Motor Drives and speed controllers, Torque Vectoring, Regenerative Braking. Rectifiers, Inverters, DC/DC converters.

UNIT V  SUBSYSTEMS OF HYBRID AND ELECTRIC VEHICLES

COURSE OUTCOMES:
The students able to understand
   i. Electric and hybrid vehicle operation and architectures
   ii. Design of hybrid and electric vehicles.
   iii. Energy requirement for vehicles.
   iv. Vehicle characteristics, operating modes, and performance parameters of the vehicle
   v. Different subsystems of hybrid and electric vehicles

TEXT BOOKS:

REFERENCES:

RO5006 APPLIED IMAGE PROCESSING 

COURSE OBJECTIVES:
1. To introduce various image processing and preprocessing techniques.
2. To learn about feature detection and matching using Image processing techniques.
3. To learn about segmentation using Image processing techniques.
4. To learn about computational photography.
5. To learn about image recognition using Image processing techniques.

UNIT – I IMAGE FORMATION AND PROCESSING 9
Introduction - Geometric primitives and Transformations - Photometric Image formation - The digital camera. Introduction to image processing - point - spatial - Fourier Transform - Pyramids and wavelets - Geometric transformations - global optimization

UNIT – II FEATURE DETECTION AND MATCHING 9
Introduction - Points and patches - Feature detectors - Feature Descriptors - SIFT - PCA SIFT - Gradient location orientation histogram

UNIT – III SEGMENTATION 9
Introduction - Active contours - Snakes - Scissors - Level sets - Split and merge - Watershed - Region splitting - region merging - and graph based segmentation - mean shift and mode finding - Normalized cuts – graph cuts and energy based methods – application

UNIT – IV COMPUTATIONAL PHOTOGRAPHY 9
Photometric calibration - Radiometric response function - Noise level estimation - Vignetting - Optical blur - High dynamic range imaging - Super resolution and blur removal - Color image demos icing – application

UNIT – V IMAGE RECOGNITION 9

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
- Understand various image processing and preprocessing techniques.
- Design a feature detection algorithm for given application
- Design a segmentation algorithm for given application.
- Understand and recognize various computational photography techniques.
- Design an image recognition for given application.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2 1 1 2</td>
</tr>
<tr>
<td>CO2</td>
<td>2 1 1 2</td>
</tr>
<tr>
<td>CO3</td>
<td>2 1 1 2</td>
</tr>
<tr>
<td>CO4</td>
<td>2 1 1 2</td>
</tr>
</tbody>
</table>

Mapping of COs with POs and PSOs

TOTAL: 45 PERIODS
TEXT BOOKS:

REFERENCES:

COURSE OBJECTIVES:
1. To know the architecture Single board computers
2. To understand the function and uses of Real time operating system
3. To familiar the python programming
4. To develop the embedded based python programming
5. To experiment the application development in SBC using python programming.

UNIT – I INTRODUCTION TO SINGLE BOARD COMPUTERS  9

UNIT – II REAL TIME OPERATING SYSTEM  8

UNIT – III PYTHON PROGRAMMING  10

UNIT – IV EMBEDDED PYTHON PROGRAMMING  9

UNIT – V APPLICATIONS  9

TOTAL: 45 PERIODS
COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Select the Single board computers for mechatronics system development
CO2: Access the library and functions for Real time operating system
CO3: Write the python programming for various applications
CO4: Use the GPIO and peripherals using embedded based python programming
CO5: Develop the application in SBC using python programming.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Average: 1 – Slight, 2 – Moderate, 3 – Substantial

REFERENCES:

RO5008 SMART MOBILITY AND INTELLIGENT VEHICLES

COURSE OBJECTIVES:
The objectives of the course are:
1. To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.
2. To learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems and other sensors for automobile vision system.
3. To learn Basic Control System Theory applied to Autonomous Automobiles.
4. To produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task.
5. To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology.

UNIT – I INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES
UNIT – II  SENSOR TECHNOLOGY FOR SMART MOBILITY 9

UNIT – III  CONNECTED AUTONOMOUS VEHICLE 9
Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy

UNIT – IV  VEHICLE WIRELESS TECHNOLOGY & NETWORKING 9

UNIT – V  CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY 9

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Understand the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles
CO2: Understand the concept of remote sensing and the types of sensor technology needed to implement remote sensing
CO3: Become familiar with the concept of fully autonomous vehicles
CO4: Understand the basic concepts of wireless communications and wireless data networks
CO 5: Understand the concept of the connected vehicle and its role in automated vehicles

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
<th>CO5</th>
<th>CO/PO &amp; PSO Average</th>
<th>P0s</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS
1. “Intelligent Transportation Systems and Connected and Automated Vehicles”, 2016, Transportation Research Board
REFERENCES

RO5009 IMMERSE TECHNOLOGIES AND HAPTICS L T P C
3 0 0 3

COURSE OBJECTIVES:
1. To identify the terminologies of haptic devices.
2. To understand the structure of haptic system and to aware the tele-operation for various applications.
3. To acquire the knowledge on modelling for haptic system development relevant to the human.
4. To emphasize the significance of knowledge in virtual and augmented reality.
5. To know the concepts and hardware of mixed reality.

UNIT – I INTRODUCTION TO HAPTICS
Definition - Importance of Touch - Tactile Proprioception - Tactual Stereo Genesis - Kinesthetic Interfaces - Tactile Interfaces - Human Haptics - Overview of Existing applications - Basics of Force Feedback Devices - Kinesthetic Vs. Tactile Haptic Devices - Configurations of Kinesthetic Devices - Types of Kinesthetic Devices

UNIT – II KINESTHETIC HAPTIC DEVICES AND TELEOPERATION

UNIT – III HUMAN HAPTICS ITS PLATFORM

UNIT – IV VIRTUAL AND AUGMENTED REALITY

UNIT – V MIXED REALITY
Advanced Interaction Techniques, Design and Implementation of an Immersive User Experience - Case Study for MR.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Recognize the haptic technology and its concepts in various haptic systems.
CO2: Classify the elements of haptics system and tele-operation in detail.
CO3: Design and use the devices in human haptic applications.
CO4: Combine and build the virtual and augmented reality based models.
CO5: Develop the design and model the hardware of mixed reality.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs 1</th>
<th>POs 2</th>
<th>POs 3</th>
<th>POs 4</th>
<th>POs 5</th>
<th>POs 6</th>
<th>POs 7</th>
<th>POs 8</th>
<th>POs 9</th>
<th>POs 10</th>
<th>POs 11</th>
<th>POs 12</th>
<th>PSOs 1</th>
<th>PSOs 2</th>
<th>PSOs 3</th>
<th>PSOs 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES

RO5010 MOTION CONTROL SYSTEM L T P C
3 0 0 3

COURSE OBJECTIVES:
1. To introduce the basics in motion control system
2. To knowledge about on architecture of motion control system
3. To understand the features and specifications in motion control drives
4. To learn about intelligent motors.
5. To inculcate the use motion control technologies including controller, driver and motors.
UNIT – I  INTRODUCTION MOTION CONTROL SYSTEMS  
Introduction to Motion Control System - Dynamic System Modeling - Control System Design Fundamentals – Parameters in Control – Actuators and Measurement in Motion Control Systems -Multi-Body Dynamics – Need for Motion Controller – Specification of Motion Control

UNIT – II  ARCHITECTURE OF MOTION CONTROL SYSTEM  

UNIT – III  MOTION CONTROL DRIVES  

UNIT – IV  INTELLIGENT MOTORS WITH INTEGRATED DRIVE  
Intelligent motors – intelligent drives – features of drives – programmable I/Os- communication protocols – features – Software - Programming – current, position and speed loops – Application in robots and portable systems

UNIT – V  PROGRAMMING OF MOTION CONTROLLER  

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO 1: Appreciate the architecture of motion controllers and its features.
CO 2: Realize the hardware and software features of the motion controller.
CO 3: Select the controllers, drivers and motors according to the requirement
CO 4: Build the programmes for various applications
CO 5: Use the motion controller for various applications

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
<th>CO5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSOs</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>POs</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

CO/PO & PSO Average

1 – Slight, 2 – Moderate, 3 – Substantial

REFERENCES
2. Sabanovic Asif, Motion Control Systems, John Wiley & Sons Inc, 2011,
5. Operating instructions Compax3 T30 Programmable motion control according to
COURSE OBJECTIVES:
1. To expose students to the fundamental aspects of the emerging field of micro robotics.
2. To expose students to micro scale, technologies for fabricating small devices, bio-inspired design, and applications of the field.
3. To expose students to various Mathematical formalism for flexures, Electrostatic actuators, Piezo-electric actuators, Magnetostrictive actuator and other sensors.
4. To apply micro robotics to various applications
5. To engage students in implementation of microrobotics

UNIT – I INTRODUCTION TO MICROROBOTICS
Introduction to Micro robotics -MST (Micro System Technology) - Micromachining - Working principles of Microsystems Applications of Microsystems - Micro-fabrication principles-Design selection criteria for micromachining - Packaging and Integration aspects - Micro-assembly platforms and manipulators

UNIT – II SCALING LAWS AND MATERIALS FOR MEMS
Introduction - Scaling laws - Scaling effect on physical properties scaling effects on Electrical properties - scaling effect on physical forces - Physics of Adhesion - Silicon - compatible material system - Shape memory alloys - Material properties - Piezoresistivity, Piezoelectricity and Thermoelectricity

UNIT – III FLEXURES, ACTUATORS AND SENSORS
Elemental flexures - Flexure systems - Mathematical formalism for flexures - Electrostatic actuators - Piezo-electric actuators - Magneto-strictive actuators - Electromagnetic sensors - Optical-based displacement sensors - Motion tracking with microscopes

UNIT – IV MICROROBOTICS

UNIT – V IMPLEMENTATION OF MICROROBOTS

TOTAL: 45 PERIODS

The Student will be able to
CO 1: Formulate the specifications and design of mechatronic systems (choice of sensors, actuators, embedded systems)
CO 2: Explain and apply the concepts of mass, energy, and momentum balance.
CO 3: Model design, and optimize energy conversion systems and Industrial processes and experimentally the steady-state or dynamic response of solids and fluids.
CO 4: Apply adapt, and synthesize learned engineering skills to create novel solutions.
CO 5: Expound and Iterate multiple design concepts based on the models and simulations in scientific terms and apply the principles of tribology and contact mechanics.
Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>P0s</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO  Average</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:

RO5012 CNC MACHINE TOOLS AND PROGRAMMING

COURSE OBJECTIVES:
1. Explain the mechanics of metal cutting and the factors affecting machinability
2. Explain the working of basic and advanced turning machines.
3. Teach the basics of machine tools with reciprocating and rotating motions and abrasive finishing processes.
4. Explain the constructional features of CNC machine tools.
5. Explain the basics of CNC programming and the machine tools through planning, writing codes and setting up CNC machine tools.

UNIT I MECHANICS OF METAL CUTTING
Mechanics of chip formation, forces in machining, types of chip, cutting tools – Single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT II TURNING MACHINES

UNIT III RECIPROCATING MACHINE TOOLS
Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making.
Drilling, reaming, boring, tapping, type of milling operations- attachments - types of milling cutters – machining time calculation - Gear cutting, gear hobbing and gear shaping – gear finishing methods Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods

UNIT IV  
CNC MACHINES
9
Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centers - Work holding methods in Turning and machining centers, Coolant systems, Safety features.

UNIT V  
PROGRAMMING OF CNC MACHINE TOOLS
9
Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers – Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1 Analyse the mechanics of metal cutting process and to identify the factors involved in improving machinability.
CO2 Understand the constructional features and working principles of basic and advanced turning machines.
CO3 Evaluate and select suitable machining operation to manufacture a given component.
CO4 Understand the constructional features and working principles of CNC machine tools.
CO5 Program CNC machine tools through planning, writing codes and setting up CNC machine tools to manufacture a given component.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXTBOOKS:

REFERENCES:
COURSE OBJECTIVES:

1. The intention and purpose of this course is to study the basics of electronics, emission controls and its importance in automobiles.
2. To study the Ignition and Injection system in Automobiles
3. To study the various sensors and actuators used in automobiles for improving fuel economy and emission control.
4. To study the various blocks of mechatronic control units used for control of fuel, ignition and exhaust systems.
5. To learn about different types of chassis and mechatronics safety systems in automobile

UNIT – I – INTRODUCTION

UNIT – II – IGNITION AND INJECTION SYSTEMS

UNIT – III – SENSOR AND ACTUATORS IN AUTOMOTIVES

UNIT – IV – ENGINE CONTROL SYSTEMS

UNIT – V – CHASSIS AND SAFETY SYSTEMS

TOTAL: 45 PERIODS

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

CO1: Know the importance of emission standards in automobiles.

CO2: Understand the electronic fuel injection/ignition components and their function.
CO3: Choose and use sensors and equipment for measuring mechanical quantities, temperature and appropriate actuators.

CO4: Diagnose electronic engine control systems problems with appropriate diagnostic tools.

CO5: Analyze the chassis and vehicle safety system.

<table>
<thead>
<tr>
<th>CO/POs &amp; PSO</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
<th>CO5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

POs

<table>
<thead>
<tr>
<th>POs</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

PSOs

<table>
<thead>
<tr>
<th>PSOs</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES

RO5014 ROBOT OPERATING SYSTEM

<table>
<thead>
<tr>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

COURSE OBJECTIVES:
1. To introduce Robot Operating System (ROS) and programming
2. To develop the Robot environment
3. To obtain the simulation robots in ROS with GAZEBO
4. To simulate robots with V-Rep
5. To understand mapping, navigation and motion planning ROS with Move-it

UNIT – I ROS ESSENTIALS
Introduction to ROS- Advantages and Disadvantages of ROS - ROS Framework- ROS package C++, Python – ROS computation Graph – nodes, Messages, topics, services, bags, ROS Master- ROS Community- Basic programming and Syntax overview in C++ and Python – start with ROS programming - Creating Environment - Services-Actions and Nodes- Simple Interaction with the Simulation environment

UNIT – II BUILD YOUR OWN ROBOT ENVIRONMENT
UNIT – III  SIMULATION ROBOTS IN ROS WITH GAZEBO

UNIT – IV  ROS WITH VREP
V-REP is a multi-platform robotic simulator - Simulating the robotic arm using V-REP - Adding the ROS interface to V-REP joint - Simulating a differential wheeled robot, Adding a laser sensor, 3D vision sensor

UNIT – V  MAPPING, NAVIGATION AND MOTION PLANNING ROS WITH MOVEIT
Move it Instation - Generating the Self-Collision matrix .virtual joints, planning groups, robot poses, robot end effector - MoveIt Architecture Diagram - Trajectory from RViz GUI executing in Gazebo - Planning scene overview diagram- Collision Checking - Motion Planning, Pick and Place Behaviors using Industrial Robots with ROS Moveit – ROS with MATLAB - ROS with Industrial

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
1. Understand the concept of ROS and programming.
2. Develop the Robot environment for simulation.
3. Simulate robots in ROS with GAZEBO
4. Simulate robots with V-Rep
5. Understand mapping, navigation and motion planning ROS with Move-it.

<table>
<thead>
<tr>
<th>Mapping of COs with POs and PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>COs/POs &amp; PSOs</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>CO1</td>
</tr>
<tr>
<td>CO2</td>
</tr>
<tr>
<td>CO3</td>
</tr>
<tr>
<td>CO4</td>
</tr>
<tr>
<td>CO5</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES
COURSE OBJECTIVES:
The main learning objectives of this course are to:
1. Elucidate the steps involved in preparing a process plan for a given Product.
2. Provide an overview for costestimation of a given product.
3. Explain the allocation of overhead costs in manufacturing.
4. Elucidate the procedure to estimate the cost of castings and forging products.
5. Explain the costs involved in machining and estimate the machining cost.

UNIT I PROCESS PLANNING
Defining process planning – Drawing interpretation – Material selection process and methods –
Selection of Production Processes from Tables – Selection of Process Parameters from Tables –
Factors to be considered in selecting: Processes; Process Sequencing; Operation Sequencing;
Equipment & Tool Selection; Tool Holding Devices; Measuring Instruments – Computer Aided
Process Planning – Retrieval / Variance CAPP and Generative CAPP - Case Study in Process
Planning.

UNIT II FUNDAMENTAL OF ESTIMATING AND ELEMENTS OF COST
Concept and Purpose of Estimating, Functions of Estimating Department, Concept of Costing,
Costing versus Estimating, Types of Estimates, Importance of Estimates, Estimating Procedure,
Cost Estimators and their Qualifications, Principal Constituents in a Cost Estimate – Elements of

UNIT III OVERHEADS AND DEPRECIATION
Overheads, Allocation or Distribution of Overhead Cost, Depreciation and Methods to Calculate it,
Interest on Capital, Idleness Costs, Repair and Maintenance Cost

UNIT IV ESTIMATION OF CASTING, FORGING & WELDING COSTS
Estimation of cost for Casting processes, Welding processes and Forging processes.

UNIT V ESTIMATION OF MACHINING TIME AND COST
Estimation of Machining Time and Cost – Lathe operations, Drilling, Milling, Shaping Planing, and
Grinding operations.

TOTAL = 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Create a Process Plan for a given Product.
2. Identify Cost elements for a given Product.
3. Allocate Overhead to different departments in manufacturing a product.
5. Analyze the costs for machining a product

TEXT BOOKS:

REFERENCES:
New Delhi, 1997.
MF5005                      ELECTRONICS MANUFACTURING TECHNOLOGY               L T P C
                                                                                         3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on wafer preparation and PCB fabrication
- To introduce Through Hole Technology (THT) and Surface Mount Technology (SMT) with various types of electronic components
- To elaborate various steps in Surface Mount Technology (SMT)
- To be acquainted with various testing and inspection methods of populated PCBS
- To outline repair, rework and quality aspects of Electronic assemblies.

UNIT I                        INTRODUCTION TO ELECTRONICS MANUFACTURING                        9
History, definition, wafer preparation by growing, machining, and polishing, diffusion, microlithography, etching and cleaning, Printed circuit board – fabrication, types, single sided, double sided, multi-layer and flexible printed circuit board

UNIT II                       COMPONENTS AND PACKAGING                                             9
Introduction to packaging, types-Through hole technology (THT) and Surface mount technology (SMT), Through hole components – axial, radial, multi leaded, odd form Surface-mount components- active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, flip chip, chip on board, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends.

UNIT III                      SURFACE MOUNT TECHNOLOGY                                                 9
SMT Process, SMT equipment and material handling systems, handling of components and assemblies - moisture sensitivity and ESD, safety and precautions needed, IPC and other standards, stencil printing process - solder paste material, storage and handling, stencils and squeegees, process parameters, quality control. Component placement- equipment type, flexibility, accuracy of placement, throughput, packaging of components for automated assembly, soldering- wave soldering, reflow process, process parameters, profile generation and control, adhesive, underfill and encapsulation process
UNIT IV  
INSPECTION AND TESTING

Inspection techniques, equipment and principle- AOI, X-ray. Defects and Corrective action - stencil printing process, component placement process, reflow soldering process, electrical testing of PCB assemblies- In circuit test, functional testing, fixtures and jigs.

UNIT V  
REPAIR, REWORK, QUALITY AND RELIABILITY OF ELECTRONICS ASSEMBLIES

Repair and rework of PCB- Coating removal, base board repair, conductor repair, thermo-mechanical effects and thermal management, Reliability fundamentals, reliability testing, failure analysis, design for manufacturability, assembly, reworkability, testing, reliability, and environment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students should be able to:
• CO1: Perceive wafer preparation and PCB fabrication
• CO2: Recognize the importance of Through Hole Technology (THT) and Surface Mount Technology (SMT)
• CO3: Demonstrate various steps in Surface Mount Technology (SMT)
• CO4: Identify various testing and inspection methods of populated PCBS
• CO5: Discuss various techniques in repair, rework, quality and reliability of electronics Assemblies

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>2</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>3</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>4</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>5</td>
<td>0.9</td>
<td>0.6</td>
</tr>
</tbody>
</table>

TEXT BOOKS:

REFERENCES:
OBJECTIVES:
- To understand the basic concepts of brain computer interface
- To study the various signal acquisition methods
- To study the signal processing methods used in BCI

UNIT I  INTRODUCTION TO BCI  9
Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive
and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.

UNIT II  ELECTROPHYSIOLOGICAL SOURCES  9
Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials
- P300 - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms.

UNIT III  FEATURE EXTRACTION METHODS  9
Time/Space Methods – Fourier Transform, PSD – Wavelets – Parametric Methods –
AR,MA,ARMA models – PCA – Linear and Non-Linear Features.

UNIT IV  FEATURE TRANSLATION METHODS  9
Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization–
Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.

UNIT V  APPLICATIONS OF BCI  9
Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual
Feedback and control - External device control, Case study: Brain actuated control of mobile
Robot.

COURSE OUTCOMES:
At the end of the course, the student will be able to:
CO1: Describe BCI system and its potential applications.
CO2: Analyze event related potentials and sensory motor rhythms.
CO3: Compute features suitable for BCI.
CO4: Design classifier for a BCI system.
CO5: Implement BCI for various applications.

TOTAL: 45 PERIODS

TEXT BOOKS:
2. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, “Brain-Computer Interfaces: 

REFERENCES:
### COURSE OUTCOMES

<table>
<thead>
<tr>
<th>COURSE OUTCOMES</th>
<th>PROGRAMME OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>PO1</td>
</tr>
<tr>
<td>CO2</td>
<td>✓</td>
</tr>
<tr>
<td>CO3</td>
<td>✓</td>
</tr>
<tr>
<td>CO4</td>
<td>✓</td>
</tr>
<tr>
<td>CO5</td>
<td>✓</td>
</tr>
</tbody>
</table>

### COURSE OBJECTIVES:
1. To understand the important concepts of multi-body dynamics
2. To familiar the various computational methods multi-body dynamics.
3. To characterize the nonlinear concepts of multi-body dynamics.
4. To recognize the need of control in nonlinear dynamics multi body interactions.
5. To interpret the nonlinear dynamics of multi-body systems and its realization of control.

### UNIT – I  INTRODUCTION TO DYNAMICS 9

### UNIT – II  COMPUTATIONAL METHODS FOR DYNAMIC ANALYSIS 9

### UNIT – III  NONLINEAR SYSTEMS AND CONCEPTS 8

### UNIT – IV  SYSTEM CHARACTERIZATION 8
Stability, Controllability, Observability - Phase Plane Analysis - Phase Portrait - Limit Cycle - Describing Function - Assumption – Limit Cycles

### UNIT – V  CONTROL OF NONLINEAR MECHANICAL SYSTEMS 10

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
- CO1: Use the important concepts in multi-body dynamics.
- CO2: Formulate mathematical model for capturing the dynamics of multi-body interactions.
CO3: Describe the nonlinear behavior of multi-body dynamics
CO4: Practice the control in nonlinear dynamics of multi body interactions.
CO5: Demonstrate control for the nonlinear behavior of multi body systems.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>1 2 3</td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>2 3 2 2</td>
<td>2 2 2 3 1</td>
</tr>
<tr>
<td>CO2</td>
<td>3 2 2</td>
<td>2 2 2 3 1</td>
</tr>
<tr>
<td>CO3</td>
<td>3 2 2</td>
<td>2 2 2 3 1</td>
</tr>
<tr>
<td>CO4</td>
<td>3 2 2</td>
<td>2 2 2 3 1</td>
</tr>
<tr>
<td>CO5</td>
<td>2 3 2 2</td>
<td>2 2 2 3 1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>2 3 2 2</td>
<td>2 2 2 3 1</td>
</tr>
</tbody>
</table>

1 – slight, 2 – moderate, 3 – substantial

REFERENCES

COURSE OBJECTIVES:
1. To familiar the fundamentals of image processing and functioning of camera.
2. To appreciate 3 dimensional structure and motions.
3. To learn the visual servicing for robotic applications
4. To understand the fundamentals of Neural network
5. To appreciate and develop the deep learning networks for image processing

UNIT – I IMAGE FORMATION AND CAMERA CALIBRATION
Basics: Sampling Theorem – Numerical Differentiation – Singular Value Decomposition

UNIT – II 3-D STRUCTURE AND MOTION
Computational Stereopsis – Geometry, Parameters – Correspondence Problem, Epipolar Geometry, Essential Matrix And Fundamental Matrix, Eight Point Algorithm – Reconstruction by Triangulation, Visual Motion – Motion Field of Rigid Objects – Optical Flow – Estimation of Motion Field – 3D Structure and Motion from Sparse and Dense Motion Fields – Motion Based Segmentation – Image Processing.

UNIT – III ACTIVE AND ROBOT VISION
LIDAR - Construction, Working Principle, Specifications and Selection Criteria. Point Cloud

UNIT – IV  INTRODUCTION TO NEURAL NETWORKS  8

UNIT – V  DEEP LEARNING  10

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Process and practice the basic images.
CO2: Develop the 3-Dimensional structures and motions.
CO3: Model the visual serving for robotic applications
CO4: Acquire and practice the basic neural networks.
CO5: Develop and train the deep learning networks for image processing.

Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOK

REFERENCES

RO5017  AGRICULTURAL AUTOMATION  L  T  P  C
3  0  0  3

COURSE OBJECTIVES:

1. To learn about Farming related Machines.
2. To understand the global position and information system in machines.
3. To know about traction and testing
4. To familiarize the concept on weed management
5. To learn about machinery selection.

UNIT – I  INTRODUCTION

UNIT – II  PRECISION AGRICULTURE
Sensors – types and agricultural applications, Global Positioning System (GPS) - GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable Rate Applications and Controller Area Networks

UNIT – III  TRACTION AND TESTING
Hitching- Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches, Tires and Traction models, Traction predictor spread sheet, Soil Compaction, Traction Aids, Tractor Testing.

UNIT – IV  SOIL TILLAGE AND WEED MANAGEMENT
Tillage Methods and Equipment, Mechanics of Tillage Tools, Performance of Tillage Implements, Hitching of Tillage Implements, Weed Management - Conventional Cropping Systems, Tools, Crop Rotation, Mechanical Cultivation

UNIT – V  MACHINERY SELECTION
Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage Blowers and Miscellaneous Conveyors, Machinery Selection - Field Capacity and Efficiency, Draft and Power Requirements, Machinery Costs.

TOTAL: 45 PERIODS

COURSE OUTCOMES
The Student will be able to
CO 1: Design robot for agriculture purposes.
CO 2: Integrate sensor and system for required agricultural applications.
CO 3: Develop suitable testing and tracking devices.
CO 4: Implement suitable Weed Management system.
CO 5: Develop and select suitable machinery for specific tasks.

<table>
<thead>
<tr>
<th>COs/POs &amp; POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mapping of COs with POs and PSOs</td>
<td></td>
</tr>
<tr>
<td>PSOs</td>
<td>1</td>
</tr>
<tr>
<td>-------</td>
<td>---</td>
</tr>
<tr>
<td>CO1</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>1</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

**TEXT BOOKS:**

**REFERENCE BOOKS:**

**RO5018 AUTOMOTIVE SYSTEM MODELLING AND SIMULATION**

<table>
<thead>
<tr>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

**COURSE OBJECTIVES:**
1. To understand the various steps involved in the design of automotive components
2. To show their knowledge in designing engine components.
3. To complete design exercise and arrive at important dimensions of chassis components.
4. To learn the use of standard practices in design.
5. To determine the dimensions of front and rear axles

**UNIT – I DESIGN OF CYLINDER, PISTON AND CONNECTING ROD**

Choice of material for cylinder and piston, design of cylinder, design of piston, piston pin, piston rings and piston assembly. Material for connecting rod, design of connecting rod assembly. Case study on piston for car with Modelling and simulation.

**UNIT – II DESIGN OF CRANK SHAFT AND VALVES**

Material for crankshaft, design of crankshaft under bending and twisting. Design aspects of intake & exhaust manifolds, inlet & exhaust valves, valve springs, tappets and valve train. Design of cam& camshaft. Design of rocker arm. Cam profile generation. 3D Engine simulation: Introduction to thermal and flow analysis in engine cylinder, modeling of cylinder and piston for combustion analysis

**UNIT – III DESIGN OF CLUTCHES AND GEAR**

Design of single plate clutch, multi plate clutch and cone clutch assembly. Torque capacity of

UNIT – IV DESIGN OF VEHICLE FRAME AND SUSPENSION

Study of loads-moments and stresses on frame members. Design Of frame for passenger and commercial vehicle - Design of leaf Springs-Coil springs and torsion bar springs. Case study on development of frame for ATV. Modelling and simulation of suspension system

UNIT – V DESIGN OF FRONT AND REAR AXLE

Design of propeller shaft. Design details of final drive gearing. Design details of full floating, semi-floating and three quarter floating rear shafts and rear axle housings. Analysis of loads-moments and stresses at different sections of front axle. Determination of optimum dimensions and proportions for steering linkages, Design of front axle beam. Modelling and simulation of steering system, transmission system

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Analyse the stress and strain imparted on automotive components.

CO2: Compute the design and find the dimension of the vehicle components.

CO3: Identify optimal design solutions to real-world problems in compliance with industry standards.

CO4: Demonstrate the design skill by creating new design strategy with the application of the knowledge

CO5: Interpret the modern system in vehicle and would help in developing the system with less impact to the environment.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:

CONDITION MONITORING AND FAULT DIAGNOSTICS

COURSE OBJECTIVES:
1. To Understand the basics of various condition monitoring methods.
2. To Identify the selection of condition monitoring sensors for various applications.
3. To study various signal processing for condition monitoring applications.
4. To Know about various failure analysis, maintenance and machine learning.
5. To provide a basic understanding with case studies on different fault diagnosis method.

UNIT – I CONDITION MONITORING TECHNIQUES AND MACHINE CONDITION MONITORING
Condition Monitoring in manufacturing industries; Noise monitoring, Wear and debris Analysis, Thermography, Cracks monitoring, Ultrasonic techniques - Case studies. Vibration, Acoustic emission and vibro-acoustics signal analysis; intelligent fault detection system, Case studies.

UNIT – II SENSORS FOR FAULT DIAGNOSTICS
Introduction - Contaminant monitoring sensors - Corrosion monitoring sensors - Force monitoring sensors - Gas leakage monitoring - sensors Air pollution monitoring sensors - Liquid contamination monitoring sensors - Non-destructive testing techniques - Optical examination - Temperature sensing

UNIT – III SIGNAL PROCESSING AND ANALYSIS
Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions. Time domain and Frequency domain and Time-frequency domain analysis.

UNIT – IV FAILURE ANALYSIS, MAINTENANCE AND MACHINE LEARNING
Maintenance Principles, Failure mode analysis - Equipment down time analysis – Breakdown analysis - condition based maintenance, Vibration, Acoustic emission and vibro-acoustics signal analysis; intelligent fault detection system, Case studies.

UNIT – V MONITORING SYSTEMS CASE STUDIES

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
1. Understand the basics of various condition monitoring methods.
2. Select suitable condition monitoring sensors for various applications.
3. Recall various signals processing for condition monitoring applications.
4. Know about various failure analysis, maintenance and machine learning.
5. Apply different fault diagnosis method for various applications.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3 2 1 2 1</td>
<td>1 3 3 2 3</td>
</tr>
<tr>
<td>CO2</td>
<td>3 2 1 2 1</td>
<td>1 3 3 2 3</td>
</tr>
<tr>
<td>CO3</td>
<td>3 2 1 2 1</td>
<td>1 3 3 2 3</td>
</tr>
<tr>
<td>CO4</td>
<td>3 2 1 2 1</td>
<td>1 3 3 2 3</td>
</tr>
<tr>
<td>CO5</td>
<td>3 2 1 2 1</td>
<td>1 3 3 2 3</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3 2 1 2 1</td>
<td>1 3 3 2 3</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES

RO5020 MICRO ELECTRO MECHANICAL SYSTEMS L T P C

COURSE OBJECTIVES:
1. To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
2. To educate on the rudiments of Micro fabrication techniques.
3. To introduce various sensors and actuators
4. To introduce different materials used for MEMS
5. To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

UNIT – I INTRODUCTION

UNIT – II SENSORS
Characteristics of sensors - Electrostatic sensors – Parallel plate capacitors – Piezoresistive sensors – Piezoresistive sensor materials - Stress and strain analysis – Flexural beam bending - Torsional deflection– Applications to Inertia, Pressure, Tactile and Flow sensors –
Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials

UNIT – III ACTUATORS

UNIT – IV MICROMACHINING

UNIT – V APPLICATIONS OF MEMS INERTIAL SENSORS

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO 2: Analyse Various MEMS sensors and its Stress and strain
CO 3: Apply various MEMS actuators in Real time system.
CO4: Understand various micro machining processes, Structural and Sacrificial Materials
CO5: Apply various mems inertial, tactile, pressure and flow sensors in real time system

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:

AE5026 UAV SYSTEM DESIGN  L  T  P  C  3  0  0  3

COURSE OBJECTIVES: Of this course are
01. To introduce the basic concepts of unmanned aerial vehicles.
02. To make students familiarise with the design aspects of UAV.
03. To impart knowledge on the hardware components and their application in the UAV systems.
04. To infer about the communication and control detail of UAV.
05. To introduce the basic operational futures of UAV systems.

UNIT I INTRODUCTION TO UAV 9
History of UAV --classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications.

UNIT II THE DESIGN OF UAV SYSTEM 9

UNIT III AVIONICS HARDWARE 9
Autopilot –AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply-processor, integration, installation, configuration, and testing.

UNIT IV COMMUNICATION PAYLOADS AND CONTROLS 9
Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range –modems-memory system-simulation-ground test-analysis-trouble shooting.

UNIT V DEVELOPMENT OF UAV SYSTEMS 9
Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing-Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.

COURSE OUTCOMES:
Upon completion of this course, Students will be able to
CO1: Acquire knowledge on the importance of UAVs with respect to their applications.
CO2: Identify and distinguish between various subsystems and configurations of UAV.

CO3: Perform ground test and troubleshooting with respect to UAV operation.

CO4: Distinguish between needs of mini and micro UAVs.

CO5: Gain insights with design standards and regulatory aspects of UAVs.

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

REFERENCES:

EI5009 MODEL PREDICTIVE CONTROL

COURSE OBJECTIVES:
1. To teach the students the general principles of model predictive control scheme.
2. To provide a comprehensive description of model predictive control schemes namely as dynamic matrix control, generalized predictive control scheme and State space based model predictive control scheme.
3. To highlight the key features of MPC for its Industrial Success.
4. To introduce the skills required to formulate both unconstrained and constrained optimal control schemes.
5. To develop the skills needed to design Model Predictive Control schemes to achieve the desired performance.

UNIT – I MODEL PREDICTIVE CONTROL SCHEMES
Introduction to Model Predictive Control - Model Predictive Control Elements - Model Predictive Control Schemes: Dynamic Matrix Control and Model Algorithmic Control – Case Studies

UNIT – II GENERALIZED PREDICTIVE CONTROL SCHEME
Generalized Predictive Control Scheme – Simple Implementation of Generalized Predictive Control Scheme for Industrial Processes – Multivariable Generalized Predictive Control Scheme – Case Studies
UNIT – III  STATE SPACE BASED MODEL PREDICTIVE CONTROL SCHEME  9
State Space Model Based Predictive Control Scheme - Review of Kalman Update based filters – State Observer Based Model Predictive Control Schemes – Case Studies

UNIT – IV  CONSTRINED MODEL PREDICTIVE CONTROL SCHEME  9
Constraints Handling: Amplitude Constraints and Rate Constraints – Constraints and Optimization – Constrained Model Predictive Control Scheme – Case Studies.

UNIT – V  ADVANCED TOPICS IN MPC  9
Robust Model Predictive Control Scheme – Adaptive Model Predictive Control Scheme – Multiple Model based Model Predictive Control Scheme - Fast Methods for Implementing Nonlinear Model Predictive Control Scheme – Case Studies

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Ability to describe the advantages and disadvantages of various MPC schemes.
CO2: Ability to formulate and solve unconstrained/constrained model predictive control schemes for a given process.
CO3: Ability to implement Model Predictive Control algorithms in MATLAB/SCILAB and validate through simulations.
CO4: Ability to design and implement robust, adaptive MPC schemes on the simulated model of benchmark processes
CO5: Ability to Identify, formulate and solve problems in the field of Process Control domain using MPC.

Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
<th>CO5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

POs

<table>
<thead>
<tr>
<th>POs</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PSOs

<table>
<thead>
<tr>
<th>PSOs</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

CO/PO & PSO Average

<table>
<thead>
<tr>
<th>Average</th>
<th>3</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES
COURSE OBJECTIVES:
1. To know the fundamentals of Collaborative Robotics
2. To introduce Swarm robot and trajectory planning for Swarm
3. To introduce Modular Robotics and its Mechanics
4. To learn about various Natural models of robot collaboration
5. To introduce the concept of Reconfigurable robot

UNIT – I INTRODUCTION TO COBOTICS 9

UNIT – II SWARM ROBOTICS 9
Introduction, mapping, kinematics and trajectory error compensation, state transitions, collective decision making and methodologies, swarm robot scenarios-aggregation, clustering dispersion, pattern formation, sorting, flocking and collective motion, shepherding, heterogeneous swarms, Error Detection and Security.

UNIT – III MODULAR ROBOTICS 9
Module Designs - Modular Robot Representation -Modular Serial Robot Kinematics - Kinematic Calibration for Modular Serial Robots- Modular Serial Robot Dynamics - Modular Parallel Robot Kinematics

UNIT – IV NATURALLY INSPIRED COLLABORATION 9

UNIT – V RECONFIGURABLE ROBOTS 9
V-Shaped Formation Control for Robotic Swarms Constrained by Field of View – formation of reconfigurable virtual linkage - Reconfigurable Formation Control of Multi-Agents - Self-Assembly Modular Robot Platform Based on Sambot - Swarm Dynamics Emerging from Asymmetry.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Understand the fundamentals of Collaborative Robotics
CO2: Understand Swarm robot and trajectory planning for Swarm
CO3: Understand the concept Modular Robotics and its Mechanics
CO4: Analyse various Natural models for robot collaboration
CO5: Understand concept of Reconfigurable robot

<table>
<thead>
<tr>
<th>Mapping of COs with POs and PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COs/POs &amp; PSOs</strong></td>
</tr>
<tr>
<td>C01</td>
</tr>
<tr>
<td>C02</td>
</tr>
<tr>
<td>C03</td>
</tr>
<tr>
<td>C04</td>
</tr>
<tr>
<td>C05</td>
</tr>
<tr>
<td><strong>CO/PO &amp; PSO</strong></td>
</tr>
</tbody>
</table>
Average

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES

PR5004 UNCONVENTIONAL MACHINING PROCESSES L T P C
3 0 0 3

COURSE OBJECTIVES:
• To make acquainted the various unconventional machining processes and its applications
• To encourage the students for developing the models (experimental/theoretical) of unconventional machining Processes
• To inculcate specialized knowledge and skill in unconventional machining processes using the principles and methods of engineering analysis and design.
• To cultivate the ability to develop and implement new improved manufacturing processes resulting in creation and distribution of value in engineering applications.
• To impart knowledge about the significance of controlling process parameters for the optimal performance for newly developed engineering materials used in industries and research organizations.

UNIT I MECHANICAL ENERGY BASED PROCESSES

UNIT II CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES

UNIT III ELECTRICAL ENERGY BASED PROCESSES

UNIT IV THERMAL ENERGY BASED PROCESSES
9 Laser Beam machining (LBM) - Plasma Arc machining (PAM) - Electron Beam Machining (EBM) – Ion Beam Machining (IBM) - Principle – Parameters – Equipment – Types– MRR - Applications.
UNIT V HYBRID MACHINING

Abrasive based hybrid machining processes - Thermal based hybrid machining processes - Electro based hybrid machining processes – Vibration assisted EDM - Vibration assisted ECM.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO1: The students will be in a position to select and employ an appropriate unconventional machining process for a specific application in industries.
CO2: To categorized the various unconventional manufacturing process based on energy sources and mechanism employed
CO3: To select the best suitable advanced manufacturing process for processing of unconventional materials employed in modern manufacturing industries
CO4: To study the parametric influences during processing of materials using developed models
CO5: Analyze the processes and evaluate the role of each process parameter during machining of various advanced materials.

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

TEXT BOOKS:

REFERENCES:

RO5022 VEHICLE DYNAMICS AND CONTROL

<table>
<thead>
<tr>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

COURSE OBJECTIVES:
1. To Develop physical and mathematical models to predict the dynamic response of vehicles
2. To Apply vehicle design performance criteria and how to use the criteria to evaluate vehicle dynamic response
3. To Use dynamic analyses in the design of vehicles.
4. To understand the principle behind the lateral dynamics.
5. To Evaluate the longitudinal dynamics and control in an automobile
UNIT – I  INTRODUCTION  9
History of road and off road vehicle system dynamics - dynamics of the motor vehicle, coordinate systems- vehicle fixed coordinates system, wheel angles, typical data of vehicles. Fundamental approaches to vehicle dynamics modeling lumped mass, vehicle fixed coordinate system, motion variables, earth fixed coordinate system, Definitions- modeling and simulation of dynamic behavior of vehicle, motion analysis, force analysis, and energy analysis.

UNIT – II  LONGITUDINAL DYNAMICS  9
Introduction to longitudinal dynamics - Performance of road vehicles: forces and moments on vehicle, equation of motion, tire forces, rolling resistance, weight distribution, tractive effort/tractive resistance and power available from the engine/ power required for propulsion, road performance curves- acceleration, grade ability, drawbar pull and the problems related to these terms. Calculation of maximum acceleration braking torque, braking force, brake proportioning, braking efficiency, stopping distance, load distribution (three wheeled and four wheeled vehicles), calculation of acceleration, tractive effort and reactions for different drives, Stability of a vehicle on slope, (Problems related to these). Steer-By-Wire Systems

UNIT – III  LATERAL DYNAMICS  9
Introduction to lateral dynamics - Steering geometry, types of steering systems, fundamental condition for true rolling, development of lateral forces. slip angle, cornering force, cornering stiffness, pneumatic trail, self-aligning torque, power consumed by tire, tire stiffness, hysteresis effect in tires, steady state handling characteristics. yaw velocity, lateral acceleration, curvature response & directional stability. Stability of a vehicle on a curved track and a banked road. Gyroscopic effects, weight transfer during acceleration, cornering and braking, stability of a rigid vehicle and equations of motion of a rigid vehicle, cross wind handling, the problems related to these terms.

UNIT – IV  VERTICAL DYNAMICS  9
Introduction to vertical dynamics - Human response to vibrations, classification of vibration, specification and vibration , sources of vibration, suspension systems, Modal Analysis, One DOF, two DOF, free and forced vibration, damped vibration, magnification and transmissibility, vibration absorber, functions of suspension system. Body vibrations: bouncing and pitching. Doubly conjugate points (only basic idea). Body rolling: Roll center and roll axis, roll axis and the vehicle under the action of side forces, stability against body rolling. Vehicle dynamics and suspension design for stability, choice of suspension spring rate, chassis springs and theory of chassis springs, gas & hydraulic dampers and choice of damper, damper characteristics, mechanics of an independent suspension system. Design and analysis of passive, semi-active and active suspension using quarter car, half car and full car mode- Hydraulic Actuators for Active Suspensions

UNIT – V  VEHICLE AERODYNAMIC AND DYNAMIC CONTROL SYSTEM  9

TOTAL: 45 PERIODS
COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO 1: To understand the vehicle system dynamics
CO 2: Evaluate the driving/braking resistances and their influences on vehicle dynamics
CO 3: Identify and analyze the dynamics systems such as suspension systems, body vibrations, steering mechanisms.
CO 4: To analyze and solve engineering problems related to vehicle dynamics.
CO 5: Comparing and identifying the different types of control systems in automobiles

<table>
<thead>
<tr>
<th>Mapping of COs with POs and PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1, CO2, CO3, CO4, CO5</td>
</tr>
<tr>
<td>POs</td>
</tr>
<tr>
<td>PSOs</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
</tr>
</tbody>
</table>

Average: 1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES
4. P. M. Heldt, “Automotive Chassis”, Chilton Co. NK

BM5701 BIOMECHANICS L T P C
3 0 0 3

OBJECTIVES:
- To study about the mechanics involved with various physiological systems.
- To gain knowledge in deriving the mathematical models related to blood vessels.
UNIT I INTRODUCTION

UNIT II MECHANICS OF PHYSIOLOGICAL SYSTEMS
Heart valves, power developed by the heart, prosthetic valves. Constitutive equations for soft tissues, dynamics of fluid flow in cardiovascular system and effect of vibration - shear stresses in extra-corporeal circuits.

UNIT III ORTHOPAEDIC MECHANICS
Mechanical properties of cartilage, diffusion properties of articular cartilage, mechanical properties of bone, kinetics and kinematics of joints, Lubrication of joints.

UNIT IV MATHEMATICAL MODELS
Introduction to Finite Element Analysis, Mathematical models - pulse wave velocities in arteries, determination of in-vivo elasticity of blood vessel, dynamics of fluid filled catheters.

UNIT V ORTHOPAEDIC APPLICATIONS

COURSE OUTCOMES:
At the end of the course, the student will be able to
CO1: Understand the use of mechanics in medicine.
CO2: Understand the mechanics of physiological systems.
CO3: Distinguish the reason for abnormal patterns.
CO4: Analyze the biomechanical systems using mathematical models.
CO5: Design and develop the models specific to orthopedic applications.

TEXT BOOKS:

REFERENCES:

GE5451 TOTAL QUALITY MANAGEMENT

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

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

UNIT II TQM PRINCIPLES

UNIT III TQM TOOLS & TECHNIQUES I

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

UNIT V QUALITY MANAGEMENT SYSTEM

TOTAL: 45 PERIODS

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

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

PO1: Teaching need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
PO2: Explaining TQM Principles for application.
PO3: Defining the basics of Six Sigma and applying Traditional tools, New tools, Benchmarking and FMEA.
PO4: Describing Taguchi’s Quality Loss Function, Performance Measures and applying Techniques like QFD, TPM, COQ and BPR.
PO5: Illustrating and applying QMS and EMS in any organization.

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

REFERENCES:

MF5501 METROLOGY AND COMPUTER AIDED INSPECTION  L  T  P  C
3  0  0  3

COURSE OBJECTIVES:
- To impart the basics of metrology, measurement concepts and perform measurement tasks accurately.
- To identify the right measurement practices for linear and angular measurements.
- To be familiarized with the right instrument and method of measurement for surface finish and form measurements.
- To describe the various measurement techniques using laser metrology.
- To gain knowledge on computer aided inspection and advances in metrology.

UNIT I BASIC CONCEPTS OF MEASUREMENTS  9
Important terminologies - Elements of measurements, need for measurement - Factors influencing measurements - Precision and Accuracy - Methods of measurement - Errors in measurements - Causes - Standards and Calibration - Types - Handling of measuring instruments - Do's and Don'ts - Maintenance of Instruments - Clean room.

UNIT II LINEAR AND ANGULAR MEASUREMENTS  9

UNIT III SURFACE FINISH AND FORM MEASUREMENTS  9
Measurement of various elements of screw threads and gears - Radius measurement - Surface finish measurement - Straightness, Flatness and roundness - Principles - Application – Computerized form measuring equipments.

UNIT IV LASER METROLOGY  9
UNIT V     COMPUTER AIDED INSPECTION AND ADVANCES IN METROLOGY

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the student shall be able to:
  • CO1: Recognize the basics of metrology, measurement concepts and perform measurement tasks accurately.
  • CO2: Identify the right measurement practices for linear and angular measurements.
  • CO3: Identify the right instrument and method of measurement for surface finish and form measurements
  • CO4: Describe various measurement techniques using laser metrology.
  • CO5: Recognize the computer aided inspection and advances in metrology.

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>2</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>3</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>4</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>5</td>
<td>0.6</td>
<td>0.3</td>
</tr>
</tbody>
</table>

TEXT BOOKS:

REFERENCES:

PR5022     INTEGRATED PRODUCT DEVELOPMENT     L T P C
           3 0 0 3

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

UNIT I  FUNDAMENTALS OF PRODUCT DEVELOPMENT  9

UNIT II  REQUIREMENTS AND SYSTEM DESIGN  9

UNIT III  DESIGN AND TESTING  9

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

UNIT V  BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY  9

TOTAL: 45 PERIODS

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

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

TEXT BOOKS:
1. Book specially prepared by NASSCOM as per the MoU.
REFERENCES:

COURSE OBJECTIVES:
1. To know the basic knowledge about Humanoid robots.
2. To impart knowledge in kinematics of humanoids.
3. To learn about the dynamics in humanoid robots.
4. To understand the basic in biped walking.
5. To know about the different walking patterns.

UNIT – I INTRODUCTION

UNIT – II KINEMATICS
Kinematic structure, forward and inverse kinematic problems, differential kinematics, Twist, Spatial Velocity, and Spatial Transform, Inverse Differential Kinematic Relations. Differential kinematics at singular configurations: Gait Analysis

UNIT – III ZMP AND DYNAMICS
ZMP Overview, 2D Analysis, 3D Analysis, Measurement of ZMP, General Discussion- ZMP of Each Foot, ZMP for Both Feet Contact, Dynamics of Humanoid Robots, Humanoid Robot Motion and Ground Reaction Force, Momentum, Angular Momentum, Angular Momentum and Inertia Tensor of Rigid Body, Calculation of Robot’s Center of Mass, Link Speed and Angular Velocity, Calculation of Robot’s Momentum and Angular Momentum

UNIT – IV BIPED WALKING
Two Dimensional Walking Pattern Generation, Two Dimensional Inverted Pendulum, Behavior of Linear Inverted Pendulum, Orbital Energy, Support Leg Exchange, Planning a Simple Biped Gait, Extension to a Walk on Uneven Terrain.

UNIT – V WALKING PATTERN GENERATION
ZMP Based Walking Pattern Generation, Cart-Table Model, Off-Line Walking Pattern Generation, Stabilizer, Principles of Stabilizing Control, Stabilizing Control of Honda Humanoid Robot, Advanced Stabilizers.

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO 1: Describe about the evolution of Humanoid robots
CO 2: Expose the basic knowledge in kinematics of humanoids.
CO 3: Calculate the Humanoid Robot Motion and Ground Reaction Force.
CO 4: Identify Two-Dimensional Walking pattern on different terrain.
CO 5: Summarize the Walking Pattern models.

Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO/PO &amp; PSO</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:

RO5024 VIRTUAL INSTRUMENTATION

UNIT – I INTRODUCTION
9
History of Virtual Instrumentation (VI), advantages, block diagram and architecture of a virtual instrument, Programming paradigms – Virtual Instrumentation – Lab VIEW software – Lab VIEW basics – Lab VIEW environment.

UNIT – II VI USING LABVIEW
9
Creating, Editing and debugging a VI in Lab VIEW – Creating a sub VI – Loops and charts – Case and sequence structures – File I/O – VI customization.

UNIT – III DATA ACQUISITION AND CONTROL IN VI
9
Plug-in DAQ boards – Organization of the DAQ VI System – Performing analog input and analog output – Scanning multiple analog channels – Driving the digital I/Os – Buffered data
acquisition – Simple problems

UNIT – IV INSTRUMENT INTERFACES
Current loop, RS 232C/RS 485, GPIB, System basics, Interface basics: USB, PCMCIA, networking basics for office & industrial application VISA & IVI, image acquisition & processing, Motion Control. ADC, DAC, DIO, DMM, waveform generator.

UNIT – V APPLICATION OF VI IN BIOMEDICAL ENGINEERING
Design of virtual applications for Electrocardiography (ECG), Electromyography (EMG), Air Flow and Lung Volume, Heart Rate variability analysis, Noninvasive Blood Pressure Measurement, Biofeedback, Virtual Reality & 3D graphical modeling, Virtual Prototyping.

TOTAL: 45 PERIODS

COURSE OUTCOMES
At the end of the course students able to
CO1: To comprehend and appreciate the significance and role of this course in the present contemporary world.
CO2: Identify salient traits of a virtual instrument.
CO3: Understand the use of VI for data acquisition.
CO4: Experiment, analyze and document different types of interfaces.
CO5: Apply the virtual instrumentation technologies for medical applications

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>COs/POs &amp; PSOs</th>
<th>COs/POs &amp; PSOs</th>
<th>COs/POs &amp; PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1 1 2 1 3 2</td>
<td>CO2 1 2 1 1 2</td>
<td>CO3 1 2 1 1 2</td>
<td>CO4 1 2 1 1 2</td>
</tr>
<tr>
<td>CO5 1 2 1 1 2</td>
<td>CO/PO &amp; PSO Average 1 2 1 1 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mapping of COs with POs and PSOs

TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVES:

- To introduce the development of Additive Manufacturing (AM), various business opportunities and applications.
- To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
- To be acquainted with vat polymerization and material extrusion processes.
- To be familiar with powder bed fusion and direct energy deposition.
- To gain knowledge on applications of binder jetting, material jetting and laminated object manufacturing processes.

UNIT I  INTRODUCTION

UNIT II  DESIGN FOR ADDITIVE MANUFACTURING (DFAM)

UNIT III  VAT POLYMERIZATION AND MATERIAL EXTRUSION

UNIT IV  POWDER BED FUSION AND DIRECT ENERGY DEPOSITION

UNIT V  OTHER ADDITIVE MANUFACTURING PROCESSES

COURSE OUTCOMES:
At the end of this course students shall be able to:
- CO1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
- CO2: Acquire knowledge on process of transforming a concept into the final product in AM technology.
- CO3: Elaborate the vat polymerization and material extrusion processes and its applications.

TOTAL: 45 PERIODS
CO4: Acquire knowledge on process and applications of powder bed fusion and direct energy deposition.
CO5: Evaluate the advantages, limitations, applications of binder jetting, material jetting and laminated object manufacturing processes.

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.3</td>
<td>0.9</td>
<td></td>
<td>0.6</td>
<td></td>
<td>0.9</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.3</td>
<td>0.3</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td></td>
<td>0.6</td>
<td></td>
<td>0.9</td>
<td>0.3</td>
<td>0.9</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0.9</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td>0.6</td>
<td></td>
<td></td>
<td>0.6</td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0.9</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td>0.6</td>
<td></td>
<td></td>
<td>0.6</td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>0.9</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td>0.6</td>
<td></td>
<td></td>
<td>0.6</td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.3</td>
<td></td>
</tr>
</tbody>
</table>

TEXT BOOKS:

REFERENCES:

RO5025 AIRCRAFT MECHATRONICS L T P C
3 0 0 3

COURSE OBJECTIVES:
1. The intention and purpose of this course is to study the basics of aircraft, controls, and its importance in aerospace industry
2. To study the various sensors and actuators used in aerospace Industry
3. To understand various Data buses and protocols used in aircraft Industry
4. To understand the working principle of Display system and its importance in an aircraft
5. To understand various engine control sensors and its measurements

UNIT – I INTRODUCTION
Role for Avionics in Civil and Military Aircraft systems, Avionics sub-systems - design-Introduction to control surface actuation system, Fly-by-wire, Actuators, defining avionics
System/subsystem Requirements & importance of ‘ilities’ - Avionics system architectures – Integrated Modular Avionics - Guidance and Certification Considerations

UNIT – II  AIRCRAFT DATA BUSES AND PROTOCOLS  10

UNIT – III  SENSOR AND ACTUATORS IN AUTOMOTIVES  7
Working principle and characteristics of gyroscope, Accelerometer, magnetometer, Rate gyro-rate of turn and slip indicator, Air data instruments - airspeed, altitude, Vertical speed indicators, Altitude alerting systems, Machmeter, Mach Warning system, Static Air temperature, Angle of attack measurement and Stall Warning system

UNIT – IV  DISPLAY SYSTEMS  10
Trends in display technology, Civil and Military aircraft cockpits, MFDs, MFK, HUD, HDD, HMD, DVI, HOTAS, Synthetic and enhanced vision, situation awareness, Panoramic/big picture display, virtual cockpit-Civil and Military Electrical Power requirement

UNIT – V  ENGINE CONTROL SYSTEMS  10
Aircraft Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments-measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR, Engine Fuel Indicators, engine vibration monitoring, Cockpit Voice Recorder and Flight Data Recorder

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Know the importance of avionics and its subsystem in an aircraft
CO2: Understand various data buses and protocols
CO3: Understand the working principle of various aircraft attitude sensors and its importance in Controls system design
CO4: Know the importance of Cockpit system and its importance in aircraft complex system.
CO5: Understand the importances of sensors in Engine control system.

<table>
<thead>
<tr>
<th>Mapping of COs with POs and PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COs/POs &amp; PSOs</strong></td>
</tr>
<tr>
<td>CO1</td>
</tr>
<tr>
<td>CO2</td>
</tr>
<tr>
<td>CO3</td>
</tr>
<tr>
<td>CO4</td>
</tr>
<tr>
<td>CO5</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES
COURSE OBJECTIVES
1. To understand the concept in operation research
2. To learn about the linear programing
3. To understand the various methods in one dimensional and multi-dimensional
4. To obtain the knowledge in constrained and unconstrained problems
5. To understand the various methods in evolutionary programing

UNIT – I INTRODUCTION TO OPERATIONS RESEARCH
Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT – II LINEAR PROGRAMMING
Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis - Computer programming linear methods

UNIT – III ONE DIMENSIONAL AND MULTI-DIMENSIONAL

UNIT – IV UNCONSTRAINED OPTIMIZATION FOR CONSTRAINED PROBLEMS

UNIT – V EVOLUTIONARY PROGRAMMING

TOTAL HOURS: 45

COURSE OUTCOMES
At the end of the course students able to
CO1: Knowledge on the concept in operation research
CO2: Understand about the linear programing
CO3: Analyze the various methods in one dimensional and multi-dimensional
CO4: Knowledge in constrained and unconstrained problems
CO5: Perform the various methods in evolutionary programing
Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>POs</th>
<th>PSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:

RO5027 TOTAL INTEGRATED AUTOMATION

COURSE OBJECTIVES:
1. To gain knowledge in automation in industries.
2. To gain knowledge in various electrical and electronic programmable automations and their applications.
3. To know about the basic in SCADA and DCS systems.
4. To gain knowledge in communication protocols in an integrated system
5. To know about the advanced in automation industries

UNIT – I TOTALLY INTEGRATED AUTOMATION
Need, components of TIA systems, advantages, Programmable Automation Controllers (PAC), Vertical Integration structure.

UNIT – II HUMAN MACHINE INTERFACE (HMI)
Necessity and Role in Industrial Automation, Need for HMI systems. Types of HMI- Text display - operator panels - Touch panels - Panel PCs - Integrated displays (PLC & HMI).

UNIT – III SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

UNIT – IV COMMUNICATION PROTOCOLS OF SCADA

UNIT – V DISTRIBUTED CONTROL SYSTEMS (DCS) 9

TOTAL: 45 PERIODS

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

CO 1: Knowledge of PLC & PAC automation
CO 2: Knowledge in HMI systems and to integrate it with other systems.
CO 3: Ability to apply SCADA and usage of C programming for report generation
CO 4: Acquiring information’s on communication protocols in automation systems
CO 5: Ability to design and develop automatic control system using distributed control systems.

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CO/PO &amp; PSO</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:
3. CIMPLICITY SCADA Packages Manual, Fanuc India Ltd, 2004

RO5028 ADVANCED DRIVER ASSISTANCE SYSTEM L T P C 3 0 0 3
COURSE OBJECTIVES:
The objectives of the course are:
1. To introduce students with various fundamentals related to advanced driver assistance technologies
2. To impart knowledge on sensors, control and actuation methodologies and create impact of automating vehicles
3. To acquire skills on vehicle prognostics and impaired driver technology
4. To learn about various commonly available Advanced Driver Assistance Systems.
5. To study about Center Console Technology and other display technology.

UNIT – I AUTOMOTIVE FUNDAMENTALS 9

UNIT – II AUTOMOTIVE SENSORS 9
Knock sensors, oxygen sensors, crankshaft angular position sensor, temperature sensor, speed sensor, Pressure sensor, Mass air flow sensor, Manifold Absolute Pressure Sensors, crash sensor, Coolant level sensors, Brake fluid level sensors – operation, types, characteristics, advantage and their applications. Radar, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera

UNIT – III OVERVIEW OF DRIVER ASSISTANCE TECHNOLOGY 9

UNIT – IV ADAS TECHNIQUES 9
Advanced Driver Assistance Systems - Lane Departure (LDW), Active Cruise Control (ACC), Blind Spot Detection, Parking Assist, Autonomous Emergency Braking (AEB), Night Vision, Traffic Sign Recognition (TSR), Intelligent High beam Assistant (IHC), Tire Pressure Monitoring (TPMS), Front Collision Warning System (FCWS), Front Vehicle Departure Warning (FVDW), Adaptive Lighting, Driver Drowsiness Detection, Hill Decent Control, Rear Cross Traffic

UNIT – V ADAS DISPLAY & IMPAIRED DRIVER TECHNOLOGY 9

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Understand the rational for and evolution of automotive electronics
CO2: Identify various sensors used in automobile
CO3: Become familiar with the theory and operation of legacy, new, and emerging ADAS systems and proposed autonomous vehicle systems.
CO4: Understand the fundamentals of sensor data fusion as it relates to ADAS
CO5: Become aware of the possible evolution of vehicle prognostics and impaired driver technology

Mapping of COs with POs and PSOs

<table>
<thead>
<tr>
<th>COs/POs &amp; PSOs</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
</tr>
</thead>
<tbody>
<tr>
<td>POs</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSOs</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COURSES SEES THROUGH KNOWLEDGE
<table>
<thead>
<tr>
<th>CO5</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO/PO &amp; PSO Average</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES