THE VISION OF THE DEPARTMENT OF MANUFACTURING ENGINEERING:

To be outstanding institute where students can gain acumen and to brew them so that they unswervingly meet the needs of the society.

THE MISSION OF THE DEPARTMENT OF MANUFACTURING ENGINEERING:

- To foster the growth of its members and develop them in new vistas promoting them to their fullest cognition.
- To be nationally recognized as the leader of Manufacturing Engineering in education and research.
- Bring augmentation to the Department, College and University.
- Discern the potential of its members.
- Have its members vivaciously conscripted nationally by employers and graduate programs.
- To evoke new ideas in the minds of its members and infuse nascent technology to modern era of manufacturing.
PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To train students to independently carry out research / investigations and development work to solve practical problems.

II. To train students to write and present a technical report/ documents.

III. To train students to demonstrate mastery in the area of computer integrated manufacturing at a higher level.

IV. To train students to pursue professional career in manufacturing industries/educational institutions/research & development organisations as well as in allied fields and excel as an individual and also as a team player in multidisciplinary environments.

V. To train students to provide solutions to industrial/research problems considering economic, environmental and social contexts for sustainable development.

VI. To train students to solve technical problems with creativity, innovation, confidence and self-responsibility.

PROGRAMME OUTCOMES (POs):

The programme outcomes of the Computer Integrated Manufacturing Postgraduate students are given below:

PO 1: Ability to independently carry out research / investigations and development work to solve practical problems.

PO 2: Ability to write and present a substantial technical report/ documents.

PO 3: Ability to demonstrate mastery in the area of computer integrated manufacturing at a higher level.

PO 4: Ability to pursue professional career in manufacturing industries/educational institutions/research & development organisations as well as in allied fields and excel as an individual and also as a team player in multidisciplinary environments.

PO 5: Ability to provide solutions to industrial/research problems considering economic, environmental and social contexts for sustainable development.

PO 6: Ability to solve technical problems with creativity, innovation, confidence and self-responsibility.
PROGRAMME SPECIFIC OUTCOMES (PSOs):
On completion of the Computer Integrated Manufacturing (CIM) programme the post graduates will have the following programme specific outcomes.

1. Ability to apply inter-disciplinary knowledge in various functional areas of Computer Integrated Manufacturing and will be familiar with engineering hardware/software and equipments as practiced in manufacturing industries to formulate and solve real time problems.
2. Identify and apply automation and use the latest technology in continuous improvement of manufacturing systems and processes with the integration of design system.
3. Encouraged and motivated to have out-of-box thinking in becoming entrepreneurs/ start-ups by developing new manufacturing systems and assessing the feasibility of technical, financial and social perspectives.
4. Demonstrate ability to communicate the outcomes of research and development activities in journals and presenting in national and international forums such as conferences.

PEO / PO Mapping:

<table>
<thead>
<tr>
<th>PROGRAMME EDUCATIONAL OBJECTIVES</th>
<th>PROGRAMME OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>I</td>
<td>✓</td>
</tr>
<tr>
<td>II</td>
<td>✓</td>
</tr>
<tr>
<td>III</td>
<td>✓</td>
</tr>
<tr>
<td>IV</td>
<td>✓</td>
</tr>
<tr>
<td>V</td>
<td>✓</td>
</tr>
<tr>
<td>Year</td>
<td>Semester</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
</tr>
<tr>
<td>Y1</td>
<td>S1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Y1</td>
<td>S2</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Y2</td>
<td>S3</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Y2</td>
<td>S3</td>
</tr>
<tr>
<td>Y4</td>
<td>S4</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></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>MA5157</td>
<td>Statistical Methods for Engineers</td>
<td>FC</td>
<td>3 1 0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>ED5153</td>
<td>Computer Applications in Design</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CI5101</td>
<td>Computer Aided Manufacturing</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>CI5151</td>
<td>Solid Freeform Manufacturing</td>
<td>PCC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>RM5151</td>
<td>Research Methodology and IPR</td>
<td>RMC</td>
<td>2 0 0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>Program Elective I</td>
<td></td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>Audit Course – I*</td>
<td></td>
<td>AC</td>
<td>2 0 0</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

#### TOTAL 19 1 8 28 22

* Audit Course is optional.

### PRACTICALS

<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>8.</td>
<td>CI5111</td>
<td>Computer Aided Design and Computer Aided Engineering Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>CI5112</td>
<td>Computer Aided Manufacturing Laboratory</td>
<td>PCC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

### TOTAL 20 0 12 32 24

* Audit Course is optional.
### SEMESTER 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></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td>Program Elective IV</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>Program Elective V</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Open Elective</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>CI5311</td>
<td>Inplant Training / Internship</td>
<td>EEC</td>
<td>0 0 4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>CI5312</td>
<td>Dissertation I</td>
<td>EEC</td>
<td>0 0 12</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9 0 16</td>
<td>25</td>
<td>17</td>
</tr>
</tbody>
</table>

### SEMESTER IV

<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></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>1.</td>
<td>CI5411</td>
<td>Dissertation II</td>
<td>EEC</td>
<td>0 0 24</td>
<td>24</td>
<td>12</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>0 0 24</td>
<td>24</td>
<td>12</td>
</tr>
</tbody>
</table>

**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 75**
## FOUNDATION COURSE [FC]

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>COURSE CODE</th>
<th>Course Title</th>
<th>Periods per week</th>
<th>Credits</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MA5157</td>
<td>Statistical Methods for Engineers</td>
<td>3 1 0</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

## PROGRAM CORE COURSES (PCC)

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Periods per week</th>
<th>Credits</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ED5153</td>
<td>Computer Applications in Design</td>
<td>3 0 0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>CI5101</td>
<td>Computer Aided Manufacturing</td>
<td>3 0 0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>CI5151</td>
<td>Solid Freeform Manufacturing</td>
<td>3 0 0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>CI5111</td>
<td>Computer Aided Design and Computer Aided Engineering Laboratory</td>
<td>0 0 4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>CI5112</td>
<td>Computer Aided Manufacturing Laboratory</td>
<td>0 0 4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>CI5251</td>
<td>Advances in Manufacturing Technology</td>
<td>3 0 0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>CI5201</td>
<td>Advanced Metrology</td>
<td>3 0 0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>CI5202</td>
<td>Manufacturing Planning and Control Systems</td>
<td>3 0 0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>MN5073</td>
<td>Mechatronics in Manufacturing Systems</td>
<td>3 0 0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>CI5211</td>
<td>Advanced Metrology Laboratory</td>
<td>0 0 4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>11.</td>
<td>CI5212</td>
<td>Advanced Manufacturing Technology Laboratory</td>
<td>0 0 4</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
### PROGRAM ELECTIVE COURSES [PEC]
#### SEMESTER I, 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>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CI5001</td>
<td>Electronics Packaging</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CI5002</td>
<td>Advances in Welding and Casting Technology</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CI5003</td>
<td>Precision Engineering</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>MS5151</td>
<td>Manufacturing Management</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

#### SEMESTER II, 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>Contact Periods</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CI5004</td>
<td>Applied Materials Engineering</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CI5005</td>
<td>Micro and Nano Manufacturing</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>IL5084</td>
<td>Supply Chain Management</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>IL5077</td>
<td>Lean Manufacturing and Six Sigma</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>IL5071</td>
<td>Advanced Optimization Techniques</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

#### SEMESTER II, 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>Contact Periods</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CI5006</td>
<td>Sensors for Manufacturing and Condition Monitoring</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CI5007</td>
<td>Finite Element Analysis in Manufacturing Engineering</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CI5008</td>
<td>System simulation for Manufacturing Engineers</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>QE5073</td>
<td>Product Innovation and Development</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

#### SEMESTER III, ELECTIVE IV

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Category</th>
<th>Periods per week</th>
<th>Contact Periods</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CI5009</td>
<td>Competitive Manufacturing Systems</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CI5010</td>
<td>Industrial Robotics and Intelligent Systems</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>CI5071</td>
<td>Design for Manufacturing and Assembly</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>IL5076</td>
<td>Industrial Automation and Robotics</td>
<td>PEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
### SEMESTER III, ELECTIVE V

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Category</th>
<th>Periods per week</th>
<th>Contact Periods</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CI5011</td>
<td>Manufacturing Information Systems</td>
<td>PEC</td>
<td>3 L 0 0</td>
<td>3 3</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>CI5072</td>
<td>Sustainable Manufacturing</td>
<td>PEC</td>
<td>3 L 0 0</td>
<td>3 3</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>IL5074</td>
<td>Enterprise Resource Planning</td>
<td>PEC</td>
<td>3 L 0 0</td>
<td>3 3</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>ED5072</td>
<td>Advanced Machine Tool design</td>
<td>PEC</td>
<td>3 L 0 0</td>
<td>3 3</td>
<td></td>
</tr>
</tbody>
</table>
## RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS COURSES (RMC)

<table>
<thead>
<tr>
<th>SL.No</th>
<th>Code No.</th>
<th>Course Title</th>
<th>Periods per week</th>
<th>Credits</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RM5151</td>
<td>Research Methodology and Intellectual Property Rights</td>
<td>2 0 0</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

## OPEN ELECTIVE COURSES (OEC)
(Out of 6 Courses one Course must be selected)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>PERIODS PER WEEK</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>OE5091</td>
<td>Business Data Analytics</td>
<td>OEC</td>
<td>L 3 T 0 P 0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>OE5092</td>
<td>Industrial Safety</td>
<td>OEC</td>
<td>L 3 T 0 P 0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>OE5093</td>
<td>Operations Research</td>
<td>OEC</td>
<td>L 3 T 0 P 0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>OE5094</td>
<td>Cost Management of Engineering Projects</td>
<td>OEC</td>
<td>L 3 T 0 P 0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>OE5095</td>
<td>Composite Materials</td>
<td>OEC</td>
<td>L 3 T 0 P 0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>OE5096</td>
<td>Waste to Energy</td>
<td>OEC</td>
<td>L 3 T 0 P 0</td>
<td>3</td>
</tr>
</tbody>
</table>

## AUDIT COURSES (AC)
Registration for any of these courses is optional to students

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>PERIODS PER WEEK</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>AX5091</td>
<td>English for Research Paper Writing</td>
<td>L 2 T 0 P 0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>AX5092</td>
<td>Disaster Management</td>
<td>L 2 T 0 P 0</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>AX5093</td>
<td>Sanskrit for Technical Knowledge</td>
<td>L 2 T 0 P 0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>AX5094</td>
<td>Value Education</td>
<td>L 2 T 0 P 0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>AX5095</td>
<td>Constitution of India</td>
<td>L 2 T 0 P 0</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>AX5096</td>
<td>Pedagogy Studies</td>
<td>L 2 T 0 P 0</td>
<td>0</td>
</tr>
<tr>
<td>7.</td>
<td>AX5097</td>
<td>Stress Management by Yoga</td>
<td>L 2 T 0 P 0</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td>AX5098</td>
<td>Personality Development Through Life Enlightenment Skills</td>
<td>L 2 T 0 P 0</td>
<td>0</td>
</tr>
<tr>
<td>9.</td>
<td>AX5099</td>
<td>Unnat Bharat Abhiyan</td>
<td>L 2 T 0 P 0</td>
<td>0</td>
</tr>
</tbody>
</table>

## EMPLOYABILITY ENHANCEMENT COURSES (EEC)

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>COURSE CODE.</th>
<th>Course Title</th>
<th>Periods per week</th>
<th>Credits</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CI5213</td>
<td>Mini Project with Seminar</td>
<td>0 0 4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>CI5311</td>
<td>Inplant training / Internship</td>
<td>0 0 4</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>CI5312</td>
<td>Dissertation I</td>
<td>0 0 12</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>CI5411</td>
<td>Dissertation II</td>
<td>0 0 24</td>
<td>12</td>
<td>4</td>
</tr>
</tbody>
</table>
## Summary

### M.E. (Computer Integrated Manufacturing) (Full Time)

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Credits per Semester</th>
<th>Credits Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>1. FC</td>
<td>04</td>
<td>00</td>
</tr>
<tr>
<td>2. PCC</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>3. PEC</td>
<td>03</td>
<td>06</td>
</tr>
<tr>
<td>4. RMC</td>
<td>02</td>
<td>00</td>
</tr>
<tr>
<td>5. OEC</td>
<td>00</td>
<td>00</td>
</tr>
<tr>
<td>6. EEC</td>
<td>00</td>
<td>02</td>
</tr>
<tr>
<td>7. Non Credit / Audit Courses</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td><strong>21</strong></td>
<td><strong>24</strong></td>
</tr>
</tbody>
</table>
COURSE OBJECTIVES:

- To enable them to estimate the value of the parameters involved in the specific distribution from a possible continuum of alternatives.
- To give an idea of testing the statistical hypothesis claimed based on a set of data points using suitable test statistics which follows standard sampling distributions.
- To establish a relationship that make it possible to predict one or more variable in terms of others using correlation and regression analysis.
- To introduce the various experimental designs and their corresponding analysis of variance which play vital role in many real time scenarios.
- To impart knowledge of handling random vectors which represent random variables in multi-dimensional space.

UNIT I  ESTIMATION THEORY  12

UNIT II  TESTING OF HYPOTHESIS  12
Tests based on Normal, t, χ² and F distributions for testing of means, variance and proportions – Analysis of r x c tables – Goodness of fit.

UNIT III  CORRELATION AND REGRESSION  12
Multiple and Partial Correlation - Method of Least Squares- Plane of Regression - Properties of Residuals - Coefficient of Multiple Correlation - Coefficient of Partial Correlation - Multiple Correlation with total and partial correlations - Regression and Partial correlations in terms of lower order coefficients.

UNIT IV  DESIGN OF EXPERIMENTS  12
Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT V  MULTIVARIATE ANALYSIS  12

TOTAL: 60 PERIODS

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

- Obtain the value of the point estimators using the method of moments and method of maximum likelihood.
- Use various test statistics in hypothesis testing for mean and variances of large and small samples.
- Determine the regression line using the method of least square and also to calculate the partial and multiple correlation coefficient for the given set of data points.
- Test the hypothesis for several means using one way, two way or three way classifications.
- Get exposure to the principal component analysis of random vectors and matrices.
REFERENCES:

ED5153 COMPUTER APPLICATIONS IN DESIGN  L   T   P   C 
3   0   0   3

COURSE OBJECTIVES:
1. To understand fundamental concepts of computer graphics and its tools in a generic framework.
2. To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
3. To impart the parametric fundamentals to create and manipulate geometric models using NURBS and solids.
4. To provide clear understanding of CAD systems for 3D modeling and viewing.
5. To create strong skills of assembly modeling and prepare the student to be an effective user of a standards in CAD system.

UNIT – I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS  9
Geometric Transformations: Coordinate Transformations, Windowing and Clipping, 2D Geometric transformations-Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation, 3D transformations.

UNIT – II CURVES AND SURFACES MODELLING  9
Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.

UNIT – III NURBS AND SOLID MODELING  9

UNIT – IV VISUAL REALISM  9
Animation - Conventional, Computer animation, Engineering animation - types and techniques.
UNIT – V  ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE MANAGEMENT


TOTAL: 45 PERIODS

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

1. Solve 2D and 3D transformations for the basic entities like line and circle.
2. Formulate the basic mathematics fundamental to CAD system.
3. Use the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling.
4. Create geometric models through animation and transform them into real world systems

REFERENCES:


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

0.3- Low 0.6- Medium 0.9- High

Attested

[Signature]

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
COURSE OBJECTIVES:
- To introduce the evolution of CAD, CAM, CIM, engineering product specification and interpreting geometric specifications.
- To train the candidates on the integration of Computer Aided Design and Computer Aided Manufacturing.
- To impart knowledge on manual part program and generation of CNC part program using Computer Aided Manufacturing packages.
- To introduce with the implementation of CAD and CAM in manufacturing process.
- To introduce the importance of Internet of Things in Computer Aided Manufacturing.

UNIT I  INTRODUCTION TO CAM  9
Introduction CAD, CAM, CAE, CIM, system configuration for CAM including hardware and software, evolution of product realization, historical development, engineering product specification. Geometric Tolerancing - ASME standard, interpreting geometric specifications, multiple part features and datum.

UNIT II  CAD AND CAM INTEGRATION  9

UNIT III  PROGRAMMING OF CNC MACHINES  9
Structure of CNC program, Coordinate system, G & M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, mirroring features, Manual part programming for CNC turning, machining center, wire electric discharge machining, abrasive water jet cutting machine, bulk and sheet metal forming, generation of CNC program using CAM softwares.

UNIT IV  CAD AND CAM FOR MANUFACTURING PROCESSES  9
Classification of Manufacturing process, construction and operations, Integration of CAD and CAM in CNC turning center, machining center, electric discharge machining, wire electric discharge machining, abrasive water jet cutting machine, bulk forming, sheet metal forming.

UNIT V  IOT IN CAM  9
Introduction, overview of IOT enabled manufacturing system, Real-time and multi-source manufacturing information sensing system, IOT enabled smart assembly station, cloud computing based manufacturing resources configuration method, Real-time key production performances analysis method, Real-time information driven production scheduling system.

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Recognize the importance of CAD, CAM, CIM, Engineering product specification and interpreting geometric specifications.
CO2: Improve knowledge on the integration of CAD and CAM.
CO3: Exhibit competency in manual part program and generation of CNC part program using CAM packages.
CO4: Describe the implementation of CAD and CAM in manufacturing processes.
CO5: Explain applications of IOT in computer aided manufacturing.

TOTAL: 45 PERIODS
CI5151

SOLID FREEFORM MANUFACTURING

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To acquaint the students with evolution of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM), proliferation into various fields and its effects on supply chain.
- To gain knowledge on Design for Additive Manufacturing (DFAM) and its importance in quality improvement of fabricated parts.
- To acquaint with polymerization and sheet lamination processes and their applications.
- To acquaint with material extrusion and powder bed fusion processes.
- To gain knowledge on jetting and direct energy deposition processes and their applications.

UNIT I

INTRODUCTION


UNIT II

DESIGN FOR ADDITIVE MANUFACTURING


UNIT III

VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES


REFERENCES:


UNIT IV MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES 9

UNIT V JETTING AND DIRECT ENERGY DEPOSITION PROCESSES 9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Recognize the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain.
CO2: Evaluate the design for AM and its importance in the quality of fabricated parts.
CO3: Acquire knowledge on principles and applications of polymerization and sheet lamination processes with case studies.
CO4: Acquire knowledge on principles of material extrusion and powder bed fusion processes and design guidelines.
CO5: Perceive jetting and direct energy deposition processes and their applications.

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th></th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>0.6</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO2</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO4</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>

REFERENCES:
COURSE OBJECTIVES:
To impart knowledge and skills required for research and IPR:
- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I  RESEARCH PROBLEM FORMULATION  6
Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II  LITERATURE REVIEW  6
Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III  TECHNICAL WRITING/ PRESENTATION  6
Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV  INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)  6

UNIT V  INTELLECTUAL PROPERTY RIGHTS (IPR)  6
Traditional knowledge Case Studies, IPR and IITs.

TOTAL HOURS: 30

COURSE OUTCOMES:
1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

<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:
COURSE OBJECTIVES:
- To familiarize the students with CAD and CAE modules.
- To create basic sketches and to design part modelling for the given mechanical components.
- To generate assemblies from the part model with respect to the constraints and to various data exchange formats.
- To familiarize the students with reverse engineering as a tool to create 3D models for 3D printing.
- To gain practical knowledge in CAE module through Finite Element Analysis.

LIST OF EXPERIMENTS:

CAD MODULE
1. Sketching and Part modelling (Solid modelling, Surface modelling, Feature manipulation) of mechanical components using CAD software package.
2. Assembly (Constraints, Exploded Views, Interference check) and Drafting (Layouts, Geometric Dimensions & Tolerance Standards, Sectional Views, & Detailing) of mechanical components using CAD software package.
3. Working with CAD Data Exchange formats: IGES, PDES, PARASOLID, DXF and STL
4. Study and exercise on freeform modelling.
5. Reverse engineering the given product/component and convert the data into 3D model.

CAE MODULE
1. Finite Element Analysis (FEA) using Pre-processing (solid modelling, meshing, analysis setup) and post processing (graphical display and report) with CAE software package
2. Finite Element Analysis (FEA) for plastic deformation using nonlinear material models with CAE software package

COURSE OUTCOMES:
At the end of this course, the students shall be able to:

CO1: Acquire knowledge on CAD and CAE modules.
CO2: Build and design interactive CAD models.
CO3: Interpret the given mechanical components and to design for 3D printing.
CO4: Demonstrate the use of FEA package.
CO5: Build, assemble parts and evaluate the information and resources using FEA.

<table>
<thead>
<tr>
<th>PO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
<td>0.9</td>
<td></td>
<td>0.6</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO2</td>
<td>0.3</td>
<td>0.3</td>
<td>0.9</td>
<td></td>
<td>0.3</td>
<td></td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO3</td>
<td>0.6</td>
<td>0.9</td>
<td>0.3</td>
<td>0.6</td>
<td></td>
<td>0.6</td>
<td></td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO4</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.3</td>
<td>0.6</td>
<td>0.9</td>
<td></td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td></td>
<td>0.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>

TOTAL: 60 PERIODS

LIST OF ITEMS (Hardware/Software) REQUIRED:
2. CAD software Package
3. Open source CAD software for Additive Manufacturing
4. CAE Software package
COURSE OBJECTIVES:
• To familiarize students with manual CNC part programming for milling and turning machines.
• To generate part programs using CAM packages for milling and turning machines.
• To train students with dimensional and geometric measurements for machined features using video measuring system and coordinate measuring machine.
• To get hands on knowledge on programming logic controller - ladder programming and robot programming.
• To introduce the concept of printing parts using additive manufacturing and to introduce Relational database management system in Material requirements planning.

LIST OF EXPERIMENTS
1. Programming and simulation for various operations using canned cycle for CNC turning Centre.
2. Programming and simulation for machining of internal surfaces in CNC turning Centre.
3. Programming and simulation for profile milling operations.
4. Programming and simulation for circular and rectangular pocket milling.
5. Programming and simulation using canned cycle for CNC Milling such as peck drilling and tapping cycle.
6. CNC code generation using CAM software packages – Milling.
7. CNC code generation using CAM software packages – Turning.
8. Dimensional and geometric measurement of machined features using VMS and CMM.
9. PLC ladder logic programming.
10. Robot programming for Material handling applications.
11. Study on RDBMS and its application in problems like inventory control MRP.
12. Design and fabrication of a component using extrusion based additive manufacturing.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Exhibit competency in manual CNC part programming for milling and turning machines.
CO2: Demonstrate generation of part programs using CAM packages for milling and turning Machines.
CO3: Acquire knowledge on dimensional and geometric measurements of machined features using video measuring system and coordinate measuring machine.
CO4: Demonstrate PLC ladder programming and robot programming.
CO5: Recognize the concept of printing parts using additive manufacturing and appreciate the application RDBMS in MRP.

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>0.9</td>
<td>0.3</td>
<td>0.3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>CO2</td>
<td>0.9</td>
<td>0.3</td>
<td>0.3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>CO3</td>
<td>0.9</td>
<td>0.3</td>
<td>0.3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>CO4</td>
<td>0.9</td>
<td>0.3</td>
<td>0.6</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.3</td>
</tr>
</tbody>
</table>

LIST OF EQUIPMENTS REQUIRED:
1. Computers 30
2. CAM Software for 3 axis machining or more
3. CNC Production type turning or Machining center
4. Video Measuring System
5. Coordinate Measuring Machine
6. Surface Roughness tester
7. 5 -axis Robot
8. Programmable Logic Controller with ladder logic programming software
9. RDBMS Package with relevant modules like Inventory Control and MRP
10. 3D Printer
COURSE OBJECTIVES:
- To teach the concepts of metrology.
- To train the students in various aspects of measurement of surface roughness.
- To train the students in the area of interferometry and form measurements.
- To train the students with understanding the fundamental principles of computer aided inspection and laser metrology.
- To introduce the basic principles of image processing and machine vision in context to metrological applications.

UNIT I CONCEPTS OF METROLOGY

UNIT II MEASUREMENT OF SURFACE ROUGHNESS

UNIT III INTERFEROMETRY AND FORM MEASUREMENTS

UNIT IV COMPUTER AIDED INSPECTION AND LASER METROLOGY

UNIT V MACHINE VISION AND IMAGE PROCESSING

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Explain the fundamental concepts of measurement, standards, calibration, maintenance of laboratory facilities and handling of metrological equipments.
CO2: Explain roughness and its applications in manufacturing research, learn the important concepts, principles and applications related to interferometry.
CO3: Discuss the use of interferometry related sophisticated measurement and inspection facilities.
CO4: Execute the concepts of Computer aided inspection technologies for industrial Situations, design and develop new inspection techniques.
CO5: Describe the importance of image processing techniques and the possibilities of developing new heuristics for image processing related to metrology.
<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th></th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CO1</td>
<td>0.6</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>CO2</td>
<td>0.6</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>CO3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>CO4</td>
<td>0.9</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.3</td>
<td>0.6</td>
</tr>
</tbody>
</table>

REFERENCES:

CI5202 MANUFACTURING PLANNING AND CONTROL SYSTEMS

OBJECTIVES:
- To introduce students with Current Trends in Manufacturing Planning and Control System and Forecasting activities.
- To impart basic concepts of Aggregate Production Planning.
- To elaborate on Inventory management and Resource Requirements.
- To be familiarized with the functions of Shop Floor Control and associated systems.

UNIT I MANUFACTURING PLANNING AND CONTROL AND FORECASTING
Introduction: Production Planning and Control - Limitations with Traditional Production Planning and Control- Need and Evolution of Manufacturing Planning and Control (MPC) System - Basic framework - Demand Management in MPC System- Forecasting: Time Horizon, Design of Forecasting Systems - Developing the Forecast Logic- Qualitative methods: Delphi Technique, Market Research, Quantitative methods - Time Series - Moving Averages, Exponential Smoothing - Regression- Measure of Forecast Accuracy- Numerical Problems

UNIT II AGGREGATE PRODUCTION PLANNING

UNIT III RESOURCE PLANNING

Attested

[Signature]

Chief Academic Officer
UNIT IV  
SHOP FLOOR CONTROL  
Shop Floor Control - Functions - Shop Floor Control System - Order Release - Order Scheduling - Order Progress - Operation Scheduling-Priority Rules for Job Sequencing - The Factory Data Collection System - Online and Offline Data Collection Systems - Case studies.

UNIT V  
PROCESS MONITORING AND CONTROL  

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Describe various activities of Manufacturing Planning and Control System and Forecasting activities.
CO2: Outline the concepts of Aggregate Production Planning.
CO3: Perceive Inventory management and Resource Requirements.
CO4: Evaluate the functions of Shop Floor Control and associated systems.

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>PSO</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO2</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO4</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
</tr>
</tbody>
</table>

REFERENCES

COURSE OBJECTIVES:
- To interpret and compare different non-traditional machining processes.
- To recognize different precision machining processes.
- To interpret modern metal forming processes.
- To differentiate between micromachining and microfabrication.
- To formulate smart manufacturing systems.
UNIT I UNCONVENTIONAL MACHINING

UNIT II PRECISION MACHINING

UNIT III MODERN METAL FORMING

UNIT IV MICRO MACHINING AND MICRO FABRICATION

UNIT V INDUSTRY 4.0
Introduction - Industry 4.0 - Smart manufacturing: Smart design, smart machining, smart monitoring, smart control, smart scheduling - Internet of Things - Industrial Internet of Things - Framework: Connectivity devices and services - Intelligent networks of manufacturing - Cloud computing - Data analytics - Cyber physical systems - Machine to Machine communication - case studies.

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Categories different non-traditional machining processes.
CO2: Infer the different precision machining processes.
CO3: Recognize the modern metal forming processes.
CO4: Interpret different micro machining and micro fabrication techniques.
CO5: Demonstrate the Industry 4.0 and smart manufacturing system concepts.

TOTAL: 45 PERIODS

<table>
<thead>
<tr>
<th>PO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>0.6</td>
<td>0.3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>0.6</td>
<td>0.3</td>
<td>0.3</td>
<td>0.6</td>
<td>0.9</td>
<td>0.3</td>
<td>0.9</td>
<td>0.3</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>CO3</td>
<td>0.3</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td>0.3</td>
<td>0.9</td>
<td>0.3</td>
<td>0.6</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>0.3</td>
<td>0.3</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>0.3</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES:
COURSE OBJECTIVES:

- To provide overview of various electrical and electronic control techniques used in modern manufacturing systems.
- To know the basic working principle of sensors and transducers of use for manufacturing systems.
- To know the basic working principle of drives and actuators of use for manufacturing systems.
- To know the features, modules and interfaces of microcontrollers and microprocessors.
- To gain the knowledge of integration of mechatronic systems in automation of modern manufacturing systems.

UNIT I  INTRODUCTION TO MECHATRONICS IN MODERN MANUFACTURING  12


UNIT II  SENSORS AND TRANSDUCERS  8


UNIT III  DRIVES AND ACTUATORS  8


UNIT III  MICROPROCESSORS AND MICROCONTROLLERS  8


UNIT V  INTEGRATION OF MANUFACTURING SYSTEMS  9


TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to

CO1 : Imply the knowledge to study the mechatronics in modern manufacturing systems.
CO2 : Identify and select the sensors and transducers based on the application.
CO3 : Identify the principles and functions of drives and actuators.
CO4 : Get knowledge of microprocessor and microcontrollers and its functions.
CO5 : Apply the knowledge about integration of mechatronic systems in manufacturing.

Attested

DIRECTOR
Centre for Academic Courses
Annai University, Chennai-600 025
REFERENCES:
1. Beno Benhabib, Manufacturing, design, production, automation and integration, Marcel Dekker, 2003

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

CI5211 ADVANCED METROLOGY LABORATORY L T P C 0 0 4 2

COURSE OBJECTIVES:
- To introduce the practical applications of various measurement concepts.
- To gain knowledge on the design perspective of advanced measuring machines.
- To make the students understand the fundamental principles of measuring techniques by practicing exercises on various measuring instruments.
- To perform metallographic study of the given samples and heat treatment study of steel.
- To familiarize the importance of measurement and inspection in manufacturing industries.

LIST OF EXPERIMENTS:
1. Calibration of comparators using slip gauges
2. Assessment of gauge surfaces using optical flats
3. Measurement of Surface roughness of specimens using contact method
4. Non-contact surface roughness measurement of specimens
5. Counting of fringes produced by Michelson’s interferometer
6. Measurement of dimensional features using machine vision system
7. Study exercises on clean room behaviour
8. Roundness and cylindricity measurement of components
9. Study on flatness measurement of surface using autocollimator
10. Measurement of dimensional features of a specimen - Contact type using CMM.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Operate sophisticated measuring machines with ease.
CO2: Improve the confidence in developing of new concepts and new measuring machines.
CO3: Recognize various technical terms and perform measurement tasks accurately.
CO4: Operate the right instrument and method of measurement for a particular Application.
CO5: Recognize the fundamental concepts of measurements, standards, calibrations, maintenance of laboratory facilities and handling of equipments.
COURSE OBJECTIVES:
- To familiarize the students with manual part program and generation of program using CAM package.
- To gain knowledge in robot programming.
- To acquaint the students with traditional and nontraditional micro machining processes.
- To gain knowledge on fabrication of composite materials.
- To familiarize the students with extrusion based additive manufacturing.

LIST OF EXPERIMENTS
1. Generation of CNC part programs and machining components for 5 axis CNC machining centre.
2. Machining using CNC wire EDM.
3. Thin film multilayer coating using PVD coating equipment
4. Machining using Abrasive water jet machine
5. Micro machining – micro turning, micro drilling & micro milling
6. Nontraditional micro machining – Electro Chemical Micro Machining (EMM)
7. Manufacturing of Polymer based composites using Resin Transfer Moulding Machine (RTM)
8. Fabrication of metal matrix composite using stir casting setup
9. Design and fabrication of components using additive manufacturing methods.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Demonstrate manual part program and to generate CNC program using CAM package.
CO2: Gain knowledge of robot programming.
CO3: Compare traditional and nontraditional micro machining processes.
CO4: To fabricate composite materials.
CO5: Build parts, using extrusion based additive manufacturing process.
CI5213  MINI PROJECT WITH SEMINAR  L T P C  0 0 4 2

COURSE OBJECTIVES:
- To drive them to acquire knowledge and fundamentals in the areas of Computer Integrated Manufacturing and to apply them.
- To encourage students to identify an Industrial problem that promotes creativity and innovation.
- To solve real life problems.
- To bring out the leadership and technical ability of the students.
- To enrich communication skills of the student through presentation of their project work.

Each student will choose a technical problem and solve it. At the end of the semester, each student has to submit the report and presentation for evaluation.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:

CO1: Develop creative and innovative ideas.
CO2: Develop skills to read, write and comprehend.
CO3: Learn concepts, models, frameworks and tools that engineering graduates need in a world.
CO4: Exhibit competency in solving real life problems.
CO5: Effectively communicate the technical contents.

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td>0.9</td>
</tr>
<tr>
<td>CO3</td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td>CO4</td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td></td>
</tr>
</tbody>
</table>

CI5311  INPLANT TRAINING / INTERNSHIP  L T P C  0 0 4 2

COURSE OBJECTIVES:
- To familiarize students with real life situations in industrial organizations.
- To accelerate the learning process.
- To train the students to apply their gained knowledge in an Industrial organization.
- To expose students with best working practices and with ethical values.
- To inculcate integrity, responsibility, and self-confidence in student’s mind.

DURATION:
The students have to undergo practical Inplant Training / Internship for four weeks (During Second Semester holidays) in recognized industrial establishments/educational institutions / research and development organizations under the guidance of a faculty member. Periodically they have to communicate to the guide about the progress in the industry. At the end of the training they have to submit a project report with following information:

1. Profile of the Industry
2. Product range
3. Organization structure
4. Plant layout
5. Processes/Machines/Equipment/devices
6. Personnel welfare schemes
7. Details of the training undergone
8. Learning points.

II. The presentation of the above will be carried out during third semester.
COURSE OUTCOMES:
At the end of this course, the students shall be able to:

CO1: Describe structure of the Industrial organization.
CO2: Realize the various functions of management.
CO3: Understanding of groups and group dynamics.
CO4: Describe the industrial culture.
CO5: Develop skills to read, write and comprehend.

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5</td>
<td>6</td>
<td>1 2 3</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>CO1</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO2</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO4</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>

CI5312 DISSEMINATION I
L T P C
0 0 12 6

COURSE OBJECTIVES:
- To identify industrial problem and solve them.
- To develop good written and oral communication skills and leadership skills.
- To train the students in preparing the project reports and to face reviews.
- To develop the ability to solve a specific industrial problem.
- To accelerate the learning process.

EVALUATION
- Project work evaluation is based on Regulations of Credit System University Departments - Postgraduate programmes of Anna University

TOTAL: 180 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:

CO1: Apply the knowledge gained from theoretical and practical courses in solving problems.
CO2: Recognize the importance of literature review.
CO3: Realize the importance of solving problems using literature review.
CO4: Recognize the modern concepts in technology and design.
CO5: Develop skills to read, write and comprehend.

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5</td>
<td>6</td>
<td>1 2 3</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>CO1</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO2</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO4</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>
COURSE OBJECTIVES:
- To produce factual results of their applied research idea in the Manufacturing Engineering.
- To improve research and development activities.
- To develop technical competency to provide solutions for problems.
- To accelerate the learning process.
- To develop good communication skills.

EVALUATION
- Project work evaluation is based on Regulations of Credit System University Departments - Postgraduate programmes of Anna University

TOTAL: 360 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:

CO1: Apply the knowledge gained from theoretical and practical courses in solving problems.
CO2: Demonstrate a strong working knowledge of ethics and professional responsibility.
CO3: Demonstrate effective organizational leadership and change skills.
CO4: Realize the importance of solving problems using literature review.
CO5: Develop skills to read, write and comprehend.

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO2</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO3</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO4</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>

CI5001 ELECTRONICS PACKAGING

OBJECTIVES:
- To introduce wafer preparation and PCB fabrication.
- To acquaint the students with through hole and surface mount components.
- To familiarize the students with steps involved in soldering post solder cleaning and its importance in PCB manufacturing.
- To gain knowledge on surface mount technology.
- To outline the various inspections, testing and repair methods used in PCB.

UNIT I INTRODUCTION TO ELECTRONICS MANUFACTURING
History, definition, wafer preparation - crystal pulling, rod grinding, wire cutting, edge profiling Lapping, polishing, laser inspection, epitaxy, fabrication of laminates and printed circuit boards, types- single sided, double sided, multi-layer and flexible printed circuit board, design, materials, manufacturing, inspection. Electronic packaging – Through Hole Technology (THT) and Surface Mount Technology (SMT)
UNIT II  THROUGH HOLE AND SURFACE MOUNT COMPONENTS  
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  SOLDERING AND CLEANING  

UNIT IV  SURFACE MOUNT TECHNOLOGY  
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 storage and handling, stencils and squeegees, process parameters, quality control - Component Placement, Equipment Type, Chip shooter, IC placer, Flexibility, Accuracy of Placement, Throughput, reflow soldering, adhesive, underfill and encapsulation process, applications, storage and handling, process & parameters.

UNIT V  INSPECTION, TEST AND REWORK FOR PCB  

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Realize wafer preparation and PCB fabrication.
CO2: Elaborate on through hole and surface mount technology components.
CO3: Discuss the steps involved in soldering post solder cleaning and its importance in PCB manufacturing.
CO4: Improve knowledge on surface mount technology.
CO5: Locate the required inspections, testing and repair methods used in PCB.

<table>
<thead>
<tr>
<th>PO</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
<th>CO5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>0.6</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.9</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.6</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>7</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES:

Attested

DIORCTOR
Centre for Academic Courses
Anna University, Chennai-600 025
COURSE OBJECTIVES:
- To impart knowledge on Metallurgy of welding.
- To be acquainted with Special welding processes.
- To elaborate gating system design and metallurgy.
- To provide knowledge on Special casting processes.
- To familiarize the students with automation and environmental aspects of welding and casting.

UNIT I  WELDING DESIGN  9

UNIT II  SPECIAL WELDING PROCESSES  9

UNIT III CASTING DESIGN  9
Introduction - Solidification shrinkage- - Pattern allowances- Design of gating System-Design of thin and unequal sections -Rapid solidification processing (RSP) - Melt spinning -Roll quenching - Vibratory solidification -Splat cooling - Thixoforming – Rheocasting - Single crystal growing- Casting defects, inspection, diagnosis and rectification – Case study on casting design.

UNIT IV SPECIAL CASTING PROCESSES  9

UNIT V  AUTOMATION AND ENVIRONMENTAL ASPECTS OF WELDING AND CASTING  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Use design knowledge to overcome defects in welding.
CO2: Select suitable welding process for the given applications.
CO3: Use design knowledge to produce quality casting.
CO4: Select suitable casting process for the given applications.
CO5: Implement automation principles with environment consciousness techniques in welding and casting plants.

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>CO2</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>CO3</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0.3</td>
</tr>
<tr>
<td>CO4</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>CO5</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.9</td>
</tr>
</tbody>
</table>
REFERENCES:

CI5003 PRECISION ENGINEERING

COURSE OBJECTIVES:
• To gain knowledge of the need for precision engineering and its application.
• To familiarize the importance of materials in precision engineering.
• To introduce latest topics in manufacturing like micro machining and MEMS in order to equip them to join core electronic manufacturing industries.
• To introduce the students with elements used in precision machines.

UNIT I INTRODUCTION

UNIT II MATERIALS FOR PRECISION ENGINEERING

UNIT III PRECISION MACHINING

UNIT IV ERRORS: CAUSES AND REMEDIES
Static stiffness - influence on machining accuracy - over all stiffness in a machine/instrument - errors due to variation of cutting forces - clamping forces - errors due to compliance while machining. Inaccuracy due to thermal effects: Heat sources and dissipation - Geometry of thermal deformation – Influence of forced is statics dimensional wear of elements - instruments; Machining tools and their influence on accuracy- error due to clamping and setting location.

UNIT V PRECISION MACHINE ELEMENTS

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Understand the need of precision engineering and its application.
CO2: Discuss process knowledge to use the light material / superior material as per the raising demands.
CO3: Discuss the advanced precision machining processes.
CO4: Explain the various errors, its causes and remedies to overcome these.
CO5: Describe elements used in precision machine tool.

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>0.9</td>
<td>0.6</td>
<td>0.3</td>
<td>0.3</td>
<td>CO3</td>
<td>0.9</td>
</tr>
<tr>
<td>CO2</td>
<td>0.9</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.6</td>
<td>CO4</td>
</tr>
<tr>
<td>CO3</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.3</td>
<td>0.3</td>
<td>CO5</td>
</tr>
<tr>
<td>CO4</td>
<td>0.9</td>
<td>0.3</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.3</td>
<td>0.3</td>
<td>0.9</td>
</tr>
</tbody>
</table>

REFERENCES:

MS5151 MANUFACTURING MANAGEMENT L T P C 3 0 0 3

OBJECTIVES
1. Students will be able to study the concepts in facility planning.
2. Students will be able to study types of plant layout and capacity planning methods.
3. Students will be able to study the concepts of Project management.
4. Students will be able to study the concepts and methods in production planning and control.
5. Students will be able to study the concepts in Inventory and maintenance management.

UNIT-I FACILITY PLANNING 9
Facility planning – Factors affecting selection of plant location, Factor rating analysis: Break – even analysis, Load distance model, closeness ratings – case study

UNIT-II CAPACITY & LAYOUT PLANNING 9
Types of plant layout, criteria for good layout, Process layout, Assembly line balancing. Computer based solutions to layout problems such as CRAFT, ALDEP, CORELAP and PREP. Capacity planning – Analysis of designed capacity, installed capacity, commissioned capacity, utilized capacity, factors affecting productivity and capacity expansion strategies.

UNIT-III PROJECT MANAGEMENT 9
Demand forecasting – Quantitative and qualitative techniques, measurement of forecasting errors, Project management – its role in functional areas of management, network representation of a project, CPM and PERT techniques – case study
UNIT-IV PRODUCTION PLANNING & CONTROL

Aggregate production planning, production planning strategies, Disaggregating the aggregate plan, Materials Requirement Planning (MRP), MRP-II, Supply chain management, Operation scheduling, prioritization.

UNIT-V INVENTORY AND MAINTENANCE MANAGEMENT

Introduction to EOQ models, Inventory control techniques – ABC, FSN, VED etc. Types of inventory control – Perpetual, two-bin and periodic inventory system – JIT, SMED, Kanban, Zero inventory, Maintenance strategies and planning, Maintenance economics: quantitative analysis, optimal number of machines. Replacement strategies and policies – economic service life, opportunity cost, replacement analysis using specific time period.

TOTAL = 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to
1. Able to acquire knowledge on facility, and problems associated with it.
2. Ability to learn the various capacity and layout planning models
3. Understand the concepts of demand forecasting and project management with relevant case studies.
4. Able to understand the concepts of production planning and scheduling.
5. Understand the various inventory and maintenance management techniques.

REFERENCES:

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

S- Strong(0.9) ; M-Medium (0.6) ; L-Low(0.3)

CI5004 APPLIED MATERIALS ENGINEERING

<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:

- To provide knowledge in the areas of elastic and plastic behavior of materials.
- To understand the fracture behavior of materials.
- To elaborate the theories on plastic forming.
- To classify the different types of advanced materials.
- To select the material for specific industrial applications.
UNIT I  ELASTIC AND PLASTIC BEHAVIOUR  
Elastic, plastic and viscoelastic Behavior-Mechanism of Elastic and Plastic deformation, Shear strength of perfect and real crystals - Deformation by slip and twinning, strengthening mechanism, solid solution, grain boundary, poly phase mixture, precipitation, particle, fibre and dispersion strengthening, work hardening - Effect of temperature, strain and strain rate on plastic behavior

UNIT II  FRACTURE BEHAVIOUR
Types of fracture -Griffith’s theory, dislocation theory, ductile to brittle transition in steel - Stress intensity factor, fracture toughness and toughening mechanisms -High temperature fracture, creep - Larson-Miller Parameter - Deformation and fracture mechanism maps - Fatigue. Low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law, Effect of surface and metallurgical parameters on fatigue failure.

UNIT III  PLASTIC FORMING OF METALS
Fundamentals of metal working, mechanics of metal working, flow-stress distribution, residual stresses, temperature in metal working- Forging in plane strain, open and closed die forging - Forces and geometrical relationships in rolling, theories of cold and hot rolling, bending and stretch forming.

UNIT IV  ADVANCED MATERIALS

UNIT V  SELECTION OF MATERIALS AND TESTING
Motivation, cost basis and service requirements - Selection for mechanical properties, Selection for surface durability - Relationship between materials processing and selection - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Forgeability and castability test- NDT techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1.Discuss elastic plastic behavior of metals and its strengthening mechanisms.
CO2.Analyse the fracture behavior of metals and give solutions to avoid them.
CO3.Create processing techniques for controlling shape of the final product.
CO4.Select suitable materials for the specific industrial applications.
CO5.Able to work in R&D activity in the field of material science.

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO2</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO3</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>CO4</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.3</td>
</tr>
</tbody>
</table>

REFERENCES:
COURSE OBJECTIVES:
- To introduce Meso, Micro and Nano manufacturing and their respective applications.
- To familiarize the students with diamond, turn machining.
- To acquaint the students with advanced micro machining and nano finishing methods.
- To familiarize the students with synthesis of nanomaterials.
- To gain knowledge on the types of characterization techniques to be used.

UNIT I INTRODUCTION

UNIT II DIAMOND TURN MACHINING
Diamond turn machining-need, classification, components, material removal mechanisms, Tooling for diamond turning, Process parameters and optimization - Molecular Dynamic simulation to study nanoscale cutting-tool path strategies in surface generations- symmetric, asymmetric and freeform, applications of DTM products.

UNIT III ADVANCED MICROMACHINING / NANO FINISHING PROCESSES

UNIT IV SYNTHESIS OF NANOMATERIALS

UNIT V CHARACTERISATION TECHNIQUES

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Recognize the importance of Meso, Micro and Nano manufacturing and their respective applications.
CO2: Elaborate on Diamond turn machining process.
CO3: Describe the advanced micro machining and nano finishing methods.
CO4: Acquire knowledge on synthesis of nanomaterials.
CO5: Identify the type of characterization techniques to be used.

TOTAL: 45 PERIODS
<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>PSO</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>CO1</td>
<td>0.6</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>0.6</td>
<td>0.9</td>
<td>0.3</td>
<td></td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>0.9</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>0.6</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.3</td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES:

IL5084 SUPPLY CHAIN MANAGEMENT L T P C 3 0 0 3

COURSE OBJECTIVES:
- Explain the role of supply chain management in an organization.
- Identify the various aspects of supply chain management and the factors affecting them.
- Explain the relationship among various factors involved in planning, organising and controlling supply chain operations.
- Summarize the sourcing and inventory decisions involved in supply chain operations.
- Explain the use of information technology in supply chain management.

UNIT – I  INTRODUCTION SUPPLY CHAIN MANAGEMENT 9
Introduction, Types of supply chains with and examples, Evolution of SCM concepts, Supply chain performance, Strategic Fit, Drivers of Supply Chain Performance – key decision areas – External Drivers of Change. Supply contracts – centralized vs. decentralized system

UNIT – II  SUPPLY CHAIN NETWORK DESIGN 9
Need for distribution network design- Factors affecting, Design options for distribution network. Network design decisions - Framework, factors influencing, Models of facility location and capacity allocation. Role of Transportation in supply chain, modes of transportation Modal Selection, Classification of carriers, Carrier Selection, Transportation Execution and Control. Food Mile Concept., design options.

UNIT – III  DEMAND AND SUPPLY IN SUPPLY CHAIN 9
Forecasting in supply chain- Methods, Approach, Errors. Aggregate planning in supply chain- Problem, Strategies and Implementation. Predictable variability in supply chain, Managing supply and demand. Distribution strategies-direct shipment, traditional warehousing, cross docking, inventory pooling, transhipment, Choosing appropriate strategy, Milk Run Model.
UNIT – IV SOURCING AND INVENTORY DECISIONS IN SUPPLY CHAIN

Purchasing Vs Procurement Vs Strategic Sourcing, Item procurement importance matrix, Strategic Sourcing Methodology, Managing sourcing and procurement process, Supplier selection and evaluation, Bullwhip effect and its management, Economies of scale in supply chain - Cycle inventory, Estimation, Quantity discounts, Multiechelon cycle inventory. Uncertainty in supply chain - Safety inventory, Determination of appropriate level, Impact on uncertainty.

UNIT – V SUPPLY CHAIN AND INFORMATION SYSTEMS


COURSE OUTCOMES:

Students will be able to:

- To introduce the concepts and elements of supply chain management.
- Design supply chain various manufacturing and service sectors.
- To understand the principle of demand and supply in supply chain
- To gain knowledge on the sourcing and inventory decisions in supply chain.
- To understand the concepts of supply chain information systems.

<table>
<thead>
<tr>
<th>PO1</th>
<th>PO2</th>
<th>P03</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>P10</th>
<th>P11</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>
</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>
</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>
</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>
</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>
</tr>
</tbody>
</table>

REFERENCES


IL5077 LEAN MANUFACTURING AND SIX SIGMA

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

COURSE OBJECTIVES:

- Summarize the basics of Lean and Six Sigma.
- Describe the need and the process of integrating Lean and Six sigma.
- Identify and select the resources required for LSS Projects and selection of projects including Team building.
- Infer the DMAIC process and study the various tools for undertaking LSS projects.
- Relate how to institutionalize the LSS efforts.

Attended

DIRECTOR

Centre for Academic Courses
Anna University, Chennai-600 025
UNIT I  INTRODUCTION TO LEAN AND SIX SIGMA  9
Introduction to Lean- Definition, Purpose, Features of Lean ; Top seven wastes, Need for Lean
management, The philosophy of lean management, Creating a lean enterprise, Elements of Lean,
Lean principles, the lean metric, Hidden time traps. Introduction to quality, Definition of six sigma,
origin of six sigma, Six sigma concept and Critical success factors for six sigma; Case analysis.

UNIT II  INTEGRATION OF LEAN AND SIX SIGMA  9
Evolution of lean six sigma, the synergy of Lean and six sigma, Definition of lean six sigma, the
principles of lean six sigma, Scope for lean six sigma, Features of lean six sigma. The laws of lean
six sigma, Key elements of LSS, the LSS model and the benefits of lean six sigma. Initiation - Top
management commitment – Infrastructure and deployment planning, Process focus,
organizational structures, Measures – Rewards and recognition, Infrastructure tools, structure of
transforming event and Launch preparation; Case study presentations.

UNIT III  PROJECT SELECTION AND TEAM BUILDING  9
Resource and project selection, Selection of Black belts, Training of Black belts and Champions,
Identification of potential projects, top down (Balanced score card) and Bottom up approach –
Methods of selecting projects – Benefit/Effort graph, Process mapping, value stream mapping,
Predicting and improving team performance, Nine team roles and Team leadership; Case study
presentations.

UNIT IV  THE DMAIC PROCESS AND TOOLS  9
The DMAIC process – Toll gate reviews; The DMAIC tools; Define tools – Project definition form,
SIPOC diagram; Measure tools – Process mapping, Lead time/cycle time, Pareto chart, Cause and
Effect matrix, FMEA; Idea – generating and organizing tools – Brainstorming, Nominal group
technique, Multi-voting and Cause and effect diagram, Data collection and accuracy tools- Check
sheet, Gauge R&R; Understanding and eliminating variation- run charts, control charts and
process capability analysis; Analyze tools - Scattered plots, ANOVA, Regression analysis, Time trap
analysis; Improve tools – Mistake proofing, Kaizen, set up time reduction (SMED), TPM, DOE and
the pull system. Control tools – statistical process control.

UNIT V  INSTITUTIONALIZING AND DESIGN FOR LSS  9
Institutionalizing lean six sigma – improving design velocity, creating cycle time base line, valuing
projects, gating the projects, reducing product line complexity, Design for lean six sigma, QFD,
Theory of Inventive Problem solving (TRIZ), Robust design; Case study presentations.
TOTAL : 45 PERIODS

COURSE OUTCOMES:

- CO1: The students will be able to understand what is Lean and Six sigma and their
  importance in the globalised competitive world.
- CO2: The students will be able to understand the importance of integrating Lean and Six
  sigma and also the process of their integration.
- CO3: The students will be able to plan the Resources required to undertake the LSS projects
  and also acquire how to select the suitable projects and the teams.
- CO4: The students will be able apply DMAIC methodology to execute LSS projects and in
  this regard they will be acquainted with various LSS tools.
- CO5: The students will be able to understand the process of institutionalizing the LSS effort
  and also understand the Design for LSS.

<table>
<thead>
<tr>
<th>CO</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:

IL5071 ADVANCED OPTIMIZATION TECHNIQUES  

COURSE OBJECTIVES:
- Learn to solve integer programming problems
- To know how to solve the Dynamic programming problems
- Learn to solve non-linear programming problems with unconstrained optimization problems
- Understand to solve non-linear programming problems using KKT conditions, quadratic and separable programming
- To create awareness of Meta heuristic algorithms.

UNIT I INTEGER PROGRAMMING
- Branch and Bound technique – cutting plane algorithm method - Travelling Salesman problem - Traveling Salesman Problem - Branch and Bound Algorithms for TSP - Heuristics for TSP - Chinese Postman Problem - Vehicle Routeing Problem

UNIT II DYNAMIC PROGRAMMING

UNIT III NONLINEAR PROGRAMMING - I:
- Types of Nonlinear Programming Problems - One-Variable Unconstrained Optimization - Multivariable Unconstrained Optimization

UNIT IV NONLINEAR PROGRAMMING – II:

UNIT V NON-TRADITIONAL OPTIMIZATION

COURSE OUTCOMES:
- CO1: Know how to solve integer programming problems
- CO2: Able to solve Dynamic programming problems
- CO3: Familiar in solving unconstrained non linear optimization problems
- CO4: Familiar in solving constrained linear optimization problems
- CO5: Know how to solve non linear optimization problems using Meta heuristic algorithms

TOTAL: 45 PERIODS

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
COURSE OBJECTIVES:
- To make students familiar with various sensors in manufacturing and signal processing.
- To impart knowledge on sensors used in workpiece monitoring.
- To explain various sensors used in machine tool monitoring.
- To learn various sensors used in machining process monitoring.
- To brief the advanced and smart sensor technologies.

UNIT I  INTRODUCTION TO SENSORS
Role of sensors in manufacturing and condition monitoring – Principles – Classification Applications – Basic requirements of sensor – Signal processing and decision making.

UNIT II  SENSORS FOR WORKPIECE MONITORING
Mechanical, Electrical, Electro-mechanical, Opto-electrical, Optical, Pneumatic, Capacitance, Eddy- current and Magnetic sensors.

UNIT III  SENSORS FOR MACHINE TOOL MONITORING
Position measurements: Linear, angular and velocity sensors – Calibration of machine tools – Collision detection measurements.

UNIT IV  SENSORS FOR MACHINING PROCESSES

UNIT V  ADVANCED SENSORS

TOTAL: 45 Periods

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Recognize the importance of sensors and condition monitoring in manufacturing.
CO2: Identify suitable sensors for monitoring workpiece during machining operation.
CO3: Identify suitable sensors for monitoring machine tool during machining operation.
CO4: Identify suitable sensors in monitoring the machining process.
CO5: Perceive the usage and importance of advanced sensors in manufacturing industries.
<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>CO2</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO3</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO4</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.6</td>
</tr>
</tbody>
</table>

REFERENCES:

CI5007    FINITE ELEMENT ANALYSIS IN MANUFACTURING ENGINEERING    L T P C
                      3 0 0 3

COURSE OBJECTIVES:
- To equip students with fundamentals of finite element principles.
- To impart knowledge on computer implementation techniques.
- To develop finite element model for the plane elasticity problems.
- To introduce non-linear analysis and its computational methods.
- To emphasis on the finite element approach of production processes.

UNIT I    INTRODUCTION
Mathematical modelling of field problems in engineering - Basic concepts of the finite element method- Formulation methods: Variational and weighted residual methods - Element types: basic elements, Linear and higher order elements, isoparametric elements - Derivation of shape functions and stiffness matrices and force vectors - Assembly of matrices - problems on stress, and strain analysis.

UNIT II    COORDINATE TRANSFORMATION AND NUMERICAL INTEGRATION
Higher order elements - Natural co-ordinate systems - Coordinate transformation-isoparametric elements – Shape functions for isoparametric elements - Serendipity elements - Numerical integration and application - Jacobian of transformation - Order of convergence - example problems.

UNIT III    PLANE ELASICITY
Introduction to elasticity equations - stress strain relations, constitutive equations - Plane stress, plane strain and axisymmetric problems.

43
UNIT IV  NON-LINEAR ANALYSIS

UNIT V  ANALYSIS OF PRODUCTION PROCESSES
Application to Bulk forming, sheet metal forming, casting, metal cutting, welding- Features of software packages.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1.Explain the basic principles of the finite element technique.
CO2. Describe the computer implementation techniques of finite element model.
CO3. Analyze different types of plane elasticity problems.
CO4. Discuss the basics of non-linear finite element analysis.
CO5: Effectively use the FEA tools for solving problems in Manufacturing Engineering and Work in industrial R&D.

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO2</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO3</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>CO4</td>
<td>0.9</td>
<td>0.3</td>
<td>0.3</td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td>0.9</td>
<td>0.3</td>
<td>0.9</td>
<td>0.6</td>
</tr>
</tbody>
</table>

REFERENCES:

CI5008  SYSTEM SIMULATION FOR MANUFACTURING ENGINEERS

COURSE OBJECTIVES:
- To discuss the importance and advantages of applying simulation techniques related to different organizations.
- To teach various random number generation techniques, its use in simulation, tests and Validity of random numbers for its use in development of simulation models, verification, validation and analysis.
- To explain the applications of random probability distributions in real time environments.
- To train students to solve discrete event problems using software.
- To train students on Simulation models using a simulation software.
UNIT I  INTRODUCTION  9
Systems, general systems theory, concept of simulation, Stochastic activities, Types of Models, Principles used in Modeling, simulation as a decision making tool, types of simulation, Advantages and disadvantages of simulation, Steps in simulation model building

UNIT II  RANDOM NUMBERS  9
Methods of generating random numbers, Pseudo random numbers and random variates, discrete and continuous random probability distributions, tests for random numbers.

UNIT III  DESIGN OF SIMULATION  9
Problem formulation, data collection and reduction, time flow mechanism, key variables, logic flow chart, starting condition, run size, experimental design consideration, output analysis and interpretation, validation. Monte Carlo method of simulation, Manual simulation techniques-based on tag numbers; based on probability distributions.

UNIT IV  SIMULATION SOFTWARE  9
Study and selection of simulation languages, Use of any one of the simulation software for simulation model building. Creation of database, Data handling - import and export of data, injecting and extraction of information in the model blocks, Collection of model history and information, Dealing with statistics of the models and analysis - Interpretation of results

UNIT V  CASE STUDIES IN SIMULATION  9
Ear deaf Analysis-Development of simulation models for Manufacturing and production systems, inventory optimization techniques, Advanced Sequencing and Scheduling problems, queuing systems - Problems, Heuristics for scheduling - Single pass heuristics, multipass heuristics, Evolutionary Optimization techniques-Tabu search, Simple Genetic algorithm, Ant Colony algorithm, Particle Swarm optimization - Case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:

CO1: Discuss various types of systems and identify different elements of a system to build simulation models and to use them.

CO2: Generate, test and use random numbers in different ways.

CO3: Explain various steps in building simulation models and how to run them for effective analysis of real life scenarios and obtain superior results.

CO4: Develop capabilities of taking up consultancy projects.

CO5: Describe various cases in system simulation and its approaches.

<table>
<thead>
<tr>
<th>CO1</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>0.3</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CO2</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>0.9</td>
<td>0.3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CO3</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CO4</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CO5</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.3</td>
<td>0.3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES:
COURSE OBJECTIVES:

- Gain knowledge of innovation in Product design and development.
- Summarize the development of new products through conceptualization, design and development phases.
- Associate various aspects of product development with industrial design and manufacturing.
- Interpret the fundamental concept of Rapid Prototyping.
- Generate products which are suitable for the needs of the society.

UNIT I  PRODUCT DEVELOPMENT AND CONCEPT SELECTION  9

UNIT II  PRODUCT ARCHITECTURE  9
Product architecture – Implication of the architecture – Establishing the architecture – Related system level design issues.

UNIT III  INDUSTRIAL AND MANUFACTURING DESIGN  9
Need for industrial design – Impact of industrial design – Industrial design process. Assessing the quality of industrial design- Human Engineering consideration -Estimate the manufacturing cost – Reduce the component cost – Reduce the assembly cost – Reduce the support cost – Impact of DFM decisions on other factors

UNIT IV  PROTOTYPING AND ECONOMIC ANALYSIS  9

UNIT V  MANAGING PRODUCT DEVELOPMENT PROJECTS  9
Sequential, parallel and coupled tasks - Baseline project planning – Project Budget- Project execution – Project evaluation- patents- patent search-patent laws-International code for patents.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: The students should be able to understand the basic concept of product development.
CO2: Design and develop new products in a systematic using the studied tools and techniques.
CO3: To associate various aspects of product development with industrial design and manufacturing.
CO4: To understand the fundamental concept of Rapid Prototyping.
CO5: To be able to design products which are suitable for the needs of the society.

<table>
<thead>
<tr>
<th>CO</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>P10</th>
<th>P11</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

REFERENCES:
COURSE OBJECTIVES:

- To expose students on the areas of competitive environment, the best manufacturing practices in the world.
- To impart the concepts of group technology and flexible manufacturing systems.
- To gain knowledge in simulation techniques of flexible manufacturing systems.
- To outline computer software and database of flexible manufacturing systems.
- To familiarize the principles of just in time manufacturing systems.

UNIT I MANUFACTURING IN A COMPETITIVE ENVIRONMENT

UNIT II GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS

UNIT III SIMULATION OF FLEXIBLE MANUFACTURING SYSTEMS

UNIT IV COMPUTER SOFTWARE AND DATABASE OF FLEXIBLE MANUFACTURING SYSTEMS

UNIT V JUST IN TIME MANUFACTURING SYSTEMS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:

- CO1: Describe the areas of Competitive Environment and the best Manufacturing Practices in the World.
- CO5: Explain Just in Time Manufacturing Systems.
CI5010 INDUSTRIAL ROBOTICS AND INTELLIGENT SYSTEMS

UNIT I ELEMENTS OF ROBOT

UNIT II KINEMATICS OF SERIAL AND PARALLEL MANIPULATORS

UNIT III DYNAMICS OF SERIAL AND PARALLEL MANIPULATORS
Introduction - Lagrangian formulation- Examples of Equations of Motion- Inverse Dynamics & Simulation of Equations of Motion- Recursive Formulations of Dynamics of Manipulators-Articulated-body algorithm– Dynamic Simulation.

UNIT IV ROBOT CELL DESIGN AND APPLICATION
UNIT V  ROBOT INTELLIGENCE


TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
- CO1: Apprehend the preliminary concepts that comprise a robotic system.
- CO2: Acquire knowledge on robot kinematic system.
- CO3: Acquire knowledge on robot dynamic system.
- CO4: Create a typical robot work cell for a problem.
- CO5: Recognize the importance of robot intelligence in all applications.

<table>
<thead>
<tr>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td>0.3</td>
</tr>
<tr>
<td>CO2</td>
<td>0.6</td>
</tr>
<tr>
<td>CO3</td>
<td>0.6</td>
</tr>
<tr>
<td>CO4</td>
<td>0.6</td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
</tr>
</tbody>
</table>

REFERENCES:

CI5071  DESIGN FOR MANUFACTURING AND ASSEMBLY  L T P C
3 0 0 3

COURSE OBJECTIVES:
- To impart the knowledge in design for manufacturing and assembly (DFM/A) principles.
- To be acquainted with the use of DFM/A tools.
- To elaborate DFM/A system architecture.
- To outline product model and interfacing.
- To discuss system implementation by considering various manufacturing constraints.
UNIT I  INTRODUCTION
Implementation of concurrent engineering- Issues involved in introducing design for manufacturing and assembly (DFM/A)-DFM/A principles and techniques - Current state of commercial DFM/A packages- Requirements for a new generation of DFM/A Systems -Knowledge-based approaches to DFM/A-Interfacing design (CAD) and DFM/A Systems, Case studies.

UNIT II  DFM/A METHODOLOGIES
Total design Environment-Tools: Quality function deployment, Failure modes and effects analysis (FMEA)- Design for manufacturing and assembly principles: Mechanical Assembly-General DFA principles- DFA guidelines: General mechanical, General electro-mechanical - Design for manual assembly- Design for electronics Assembly-Design for Testability-Machining-Currently available manufacturability analysis tools- Integrating DFM/A into different design regimes - Case studies

UNIT III  DFM/A SYSTEM ARCHITECTURE

UNIT IV  PRODUCT MODEL AND CAD INTERFACING
Product Model - Structure and object - Oriented Approach-Classes and objects - Polymorphism and inheritance - Modelling concepts- Product model structure overview- Detailed product model-Storage of object-Oriented product models - Features in CAD-DFM integration - Feature representation methodologies- Classification of features -Hierarchical structure of the features - Interfacing with different CAD systems - Interface mechanisms for applications-knowledge engineering and inferencing

UNIT V  SYSTEM IMPLEMENTATION
System for design for PCB assembly, small parts assembly, mechanical assembly, machining Generic architecture operational aspects- Architecture realization- Control module

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the End of the Course, the students will be able to
CO1: Describe the design for manufacturing principles.
CO2: Implement DFM/A principles in the required applications.
CO3: Use DFM/A tools.
CO4: Select appropriate DFM/A system architecture with the given manufacturing aspects.
CO5: Create Product model.

<table>
<thead>
<tr>
<th>PO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>PSO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES:

IL5076 INDUSTRIAL AUTOMATION AND ROBOTICS

L T P C
3 0 0 3

COURSE OBJECTIVES:
- Justify the high cost of investment in automation through production economics concepts.
- Summarize the fundamental concepts and elements of computer-integrated manufacturing.
- Articulate various aspects of automated manufacturing such as fixed automation and programmable automation.
- Familiarize the automated material handling and storage systems
- Discover computerized planning, lean and agile systems.

UNIT I AUTOMATION
Types of production – Functions – Automation strategies – Production economics – Costs in manufacturing – Break-even analysis.

UNIT II AUTOMATED FLOW LINES
Transfer mechanism - Buffer storage – Analysis of transfer lines - Automated assembly systems.

UNIT III NUMERICAL CONTROL AND ROBOTICS

UNIT IV AUTOMATED HANDLING AND STORAGE
Automated material handling systems – AGV- AS/RS – carousel storage – Automatic data capture – bar code technology- RFID

UNIT V MANUFACTURING SUPPORT SYSTEMS
Product design and CAD, CAD/CAM and CIM, Computer aided process planning- variant and generative approaches, Concurrent engineering and design for manufacture, Lean production, Agile manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Select automated equipment based on break-even quantity and compute cost per component.
CO2: Analyze an automated flow line without and with buffer for its performance measures.
CO3: Acquire knowledge in Numerical control programming.
CO4: Identify the elements of manufacturing automation; these include CNC, Robotics, automated assembly and material handling.
CO5: Understand manufacturing planning and control systems.

<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>CO1</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>
</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>
</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>
</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>
</tr>
</tbody>
</table>
REFERENCES:

CI5011 MANUFACTURING INFORMATION SYSTEMS

COURSE OBJECTIVES:
- To impart knowledge on databases and its application in manufacturing systems.
- To elaborate with order policies, data base terminologies, designing, manufacturing considerations.
- To outline modules involved in inventory, process flow and shop floor control.
- To be acquainted with integration of the modules to function as a single application that aids different departments of the factory.
- To introduce the concepts of the shop floor data capturing systems, Industry 4.0 and smart factories.

UNIT I DATABASE 9

UNIT II DATABASE DESIGN 9

UNIT III MANUFACTURING CONSIDERATION 9

UNIT IV INFORMATION SYSTEM FOR MANUFACTURING 9

UNIT V INDUSTRY 4.0 AND SMART FactORIES 9

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Perceive the data base concepts, terminologies, trends and its application in manufacturing field.
CO2: Discuss common types of databases, normalization and its importance, and operations involved in database management.
CO3: Elaborate various sub modules involved in inventory, process flow and shop floor control.
CO4: Acquire knowledge in integration of the modules to function as a single application that aids different departments of the factory.
CO5: Recognize the importance of data integration in advanced manufacturing environments like industry 4.0 and smart factory systems.

<table>
<thead>
<tr>
<th></th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td>CO2</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO3</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>CO4</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td>CO5</td>
<td>0.3</td>
<td>0.9</td>
</tr>
</tbody>
</table>

REFERENCES:

CI5072 SUSTAINABLE MANUFACTURING

COURSE OBJECTIVES
- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

UNIT I ECONOMIC SUSTAINABILITY 9

UNIT II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9
Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability
UNIT III  SUSTAINABILITY PRACTICES
Sustainability awareness - Measuring Industry Awareness - Drivers and barriers - Availability of sustainability indicators - Analysis of sustainability practicing - Modeling and assessment of sustainable practicing - Sustainability awareness - Sustainability drivers and barriers - Availability of sustainability indicators - Designing questionnaires - Optimizing Sustainability Indexes - Elements – Cost and time model

UNIT IV  MANUFACTURING STRATEGY FOR SUSTAINABILITY
Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs

UNIT V  TRENDS IN SUSTAINABLE OPERATIONS
Principles of sustainable operations - Life cycle assessment manufacturing and service activities - Influence of product design on operations - Process analysis - Capacity management - Quality management - Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
- CO1: Discuss the importance of economic sustainability.
- CO2: Describe the importance of sustainable practices.
- CO3: Identify drivers and barriers for the given conditions.
- CO4: Formulate strategy in sustainable manufacturing.
- CO5: Plan for sustainable operation of industry with environmental, cost consciousness

REFERENCE:

COURSE OBJECTIVES:
- Describe an idea about ERP
- Creating awareness of core and extended modules of ERP
- Extract knowledge of ERP implementation cycle
- Gaining knowledge about effects of ERP after its implementation.
- Understanding the emerging trends on ERP

UNIT I  INTRODUCTION
Overview of enterprise systems – Evolution - Risks and benefits - Fundamental technology - Issues to be consider in planning design and implementation of cross functional integrated ERP systems.

UNIT II  ERP SOLUTIONS AND FUNCTIONAL MODULES
Overview of ERP software solutions- Small, medium and large enterprise vendor solutions, BPR, and best business practices - Business process Management, Functional modules.

UNIT III  ERP IMPLEMENTATION

UNIT IV  POST IMPLEMENTATION
Maintenance of ERP- Organizational and Industrial impact; Success and Failure factors of ERP Implementation.

UNIT V  EMERGING TRENDS ON ERP

TOTAL : 45 PERIODS

REFERENCES
COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Selecting the different machine tool mechanisms.
2. Designing the Multi speed Gear Box and feed drives.
3. Designing the machine tool structures.
4. Designing the guideways and power screws.
5. Designing the spindles and bearings.

UNIT-I  INTRODUCTION TO MACHINE TOOL DESIGN  9

UNIT-II  REGULATION OF SPEEDS AND FEEDS  9
Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design

UNIT-III  DESIGN OF MACHINE TOOL STRUCTURES  9

UNIT-IV  DESIGN OF GUIDEWAYS AND POWER SCREWS  9
Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slide ways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws

UNIT-V  DESIGN OF SPINDLES AND SPINDLE SUPPORT  9

TOTAL  = 45 PERIODS

COURSE OUTCOMES:
On Completion of the course the student will be able to
1. Select the different machine tool mechanisms.
2. Design the Multi speed Gear Box and feed drives.
3. Design the machine tool structures.
4. Design the guideways and power screws.
5. Design the spindles and bearings.

REFERENCES:
1. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 2010
<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>

0.3- Low
0.6- Medium
0.9- High
OPEN ELECTIVE COURSES (OEC)

OE5091  BUSINESS DATA ANALYTICS  L T P C  3 0 0 3

COURSE OBJECTIVES:
- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I  OVERVIEW OF BUSINESS ANALYTICS  9

Suggested Activities:
- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:
- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II  ESSENTIALS OF BUSINESS ANALYTICS  9

Suggested Activities:
- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:
- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III  MODELING UNCERTAINTY AND STATISTICAL INFERENCE  9

Suggested Activities:
- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai 600 025
Suggested Evaluation Methods:
- Assignments on hypothesis testing.
- Group presentation on real-time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV      ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK

Suggested Activities:
- Practical – Install and configure Hadoop.
- Practical – Use web-based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:
- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V      OTHER DATA ANALYTICAL FRAMEWORKS
Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:
- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:
- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the student will be able to:
- Identify the real-world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real-world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce.
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

OE5092                         INDUSTRIAL SAFETY                        L T P C
COURSE OBJECTIVES:
- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION
9
Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING
9
Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION
9

UNIT IV FAULT TRACING
9
Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE
9
maintenance of mechanical and electrical equipment, advantages of preventive maintenance.
Repair cycle concept and importance

COURSE OUTCOMES:
CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

OE5093 OPERATIONS RESEARCH

COURSE OBJECTIVES:
- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9
Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9
Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9
Transportation problems - Northwest corner rule, least cost method, Voges’s approximation method - Assignment problem - Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9
Shortest path problem: Dijkstra’s algorithms, Floyds algorithm, systematic method - CPM/PERT

UNIT V NETWORK ANALYSIS – III 9
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS
COURSE OUTCOMES:
CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

<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:

OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS

COURSE OBJECTIVES:
- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS
Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning, Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS
Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL
Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9
Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

COURSE OUTCOMES
CO1 – Understand the costing concepts and their role in decision making
CO2 – Understand the project management concepts and their various aspects in selection
CO3 – Interpret costing concepts with project execution
CO4 – Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 – Become familiar with quantitative techniques in cost management

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

REFERENCES:
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988

OE5095 COMPOSITE MATERIALS L T P C 3 0 0 3

COURSE OBJECTIVES:
- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9
Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCMENTS 9
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES

UNIT V STRENGTH
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

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

REFERENCES:

OE5096 WASTE TO ENERGY
L T P C
3 0 0 3

COURSE OBJECTIVES:
- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE
Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors
UNIT II  BIOMASS PYROLYSIS

UNIT III  BIOMASS GASIFICATION

UNIT IV  BIOMASS COMBUSTION
Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation – Operation of all the above biomass combustors.

UNIT V  BIO ENERGY
Properties of biogas (Calorific value and composition), Biogas plant technology and status – Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

COURSE OUTCOMES:
CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

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

REFERENCES:
AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING

COURSE OBJECTIVES:
- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS

UNIT III TITLE WRITING SKILLS
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES:
CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

<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
AX5092  DISASTER MANAGEMENT  L T P C

COURSE OBJECTIVES:

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I  INTRODUCTION  6
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II  REPERCUSSIONS OF DISASTERS AND HAZARDS  6

UNIT III  DISASTER PRONE AREAS IN INDIA  6
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV  DISASTER PREPAREDNESS AND MANAGEMENT  6
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V  RISK ASSESSMENT  6
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

<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>
</tbody>
</table>
REFERENCES

AX5093  SANSKRIT FOR TECHNICAL KNOWLEDGE

COURSE OBJECTIVES:
- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I   ALPHABETS
Alphabets in Sanskrit

UNIT II   TENSES AND SENTENCES
Past/Present/Future Tense - Simple Sentences

UNIT III  ORDER AND ROOTS
Order - Introduction of roots

UNIT IV   SANSKRIT LITERATURE
Technical information about Sanskrit Literature

UNIT V   TECHNICAL CONCEPTS OF ENGINEERING
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

COURSE OUTCOMES:
- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

<table>
<thead>
<tr>
<th>CO1</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></td>
<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>

Director of
Centre for Academic Courses
Anna University, Chennai-600 025
REFERENCES
1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2.  “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbhashastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

COURSE OBJECTIVES:
Students will be able to
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

UNIT II

UNIT III

UNIT IV

TOTAL: 30 PERIODS

COURSE OUTCOMES:
Students will be able to
- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING

AX5095 CONSTITUTION OF INDIA L T P C 2 0 0 0

COURSE OBJECTIVES:
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional 
Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
• To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

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

UNIT V LOCAL ADMINISTRATION:

UNIT VI ELECTION COMMISSION:
Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:
Students will be able to:
• Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
• Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
• Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
• Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING
1. The Constitution of India, 1950 (Bare Act), Government Publication.

AX5096 PEDAGOGY STUDIES
COURSE OBJECTIVES
Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

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

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

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

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

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

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:
Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING
AX5097  STRESS MANAGEMENT BY YOGA  L T P C  2 0 0 0

COURSE OBJECTIVES
- To achieve overall health of body and mind
- To overcome stress

UNIT I
Definitions of Eight parts of yoga.(Ashtanga)

UNIT II
Yam and Niyam - Do’s and Don’t’s in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III
Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects - Types of pranayam

TOTAL: 30 PERIODS

COURSE OUTCOMES
Students will be able to:
- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING
1. “Yogic Asanas for Group Tarining-Part-I”:Janardan Swami Yoga bhyasi Mandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098  PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS  L T P C  2 0 0 0

COURSE OBJECTIVES:
- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I
Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont’s) - Verses- 71,73,75,78 (do’s)

UNIT II
Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III
Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-
COURSES OUTCOMES:
Students will be able to
- Study of Shrimad-Bhagavad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING
1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari’s Three Satakam, Niti-sringar-vairagya, New Delhi, 2010