PROGRAM EDUCATIONAL OBJECTIVES (PEO)

1. The graduates acquire ability to create environmental oriented models, design and analyze essential production operational skills, mechanism and automation system.

2. The graduates use their talent, self-confidence, knowledge and engineering practice which facilitate them to presume position of scientific and/or managerial leadership in their career paths towards green manufacturing.

3. The graduates apply their consciousness of moral, professional responsibilities and motivation to practice life-long learning in a team work environment.

PROGRAMME OUTCOMES (PO)

a. Graduate will demonstrate strong basics in mathematics, science and engineering which serve as the foundation for the Programme.

b. Graduate will demonstrate the ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.

c. Graduate will become familiar with modern engineering tools and analyze the problems within the domains of Green Manufacturing as the members of multidisciplinary teams.

d. Graduate will acquire the capability to identify, formulate and solve engineering problems related to production engineering.

e. Graduate will demonstrate an understanding of professional and ethical responsibility with reference to their career in the field of production engineering.

f. Graduate will be able to communicate effectively both in verbal and non verbal forms.

g. Graduate will be trained towards developing and understanding the impact of environmental oriented components on global, economic, and societal context.

h. Graduate will be capable of understanding the value for life-long learning.

i. Graduate will demonstrate knowledge of contemporary issues pertaining to the health and well being of desirable living forms inhabiting the environment.
j. Graduate will demonstrate the ability to use the techniques, skills and modern engineering tools necessary for engineering practice in the field of Production Engineering.

k. Graduate will be able to design and develop innovative/ manufacturable / marketable / environmental friendly products useful to the nation and the society.

l. Graduate will be able to manage any organization well and will be able to emerge as a successful entrepreneur.

### Mapping of PEOs with POs

<table>
<thead>
<tr>
<th>Programme Educational Objectives</th>
<th>Programme Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PO 1</td>
</tr>
<tr>
<td>I</td>
<td>✓</td>
</tr>
<tr>
<td>II</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>✓</td>
</tr>
</tbody>
</table>

- **PEO** stands for Programme Educational Objectives.
- **PO** stands for Programme Outcomes.
- The ✓ mark indicates that the programme educational objectives map onto the programme outcomes.
| YEAR 1 | SEM 1 | Green Manufacturing Design | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| YEAR 1 | SEM 1 | Green Manufacturing Practices | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| SEM 2 | Statistical Techniques for Green Manufacturing | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| SEM 2 | Environment Sustainability and Impact Assessment | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| YEAR 2 | SEM 3 | Quantitative Techniques for Green Manufacturing | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| YEAR 2 | SEM 3 | Green Supply Chain Management | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| YEAR 2 | SEM 3 | Lean Manufacturing System and Applications | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| YEAR 2 | SEM 3 | Case Studies in Green Manufacturing Practice | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| SEM 4 | Green Manufacturing Management | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| SEM 4 | Optimization Techniques for Green Manufacturing | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| SEM 4 | Computer Aided Modelling and Simulation Lab | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| YEAR 3 | SEM 5 | Project Phase – I | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| YEAR 3 | SEM 6 | Project Phase – II | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
### ANNA UNIVERSITY, CHENNAI
### UNIVERSITY DEPARTMENTS
### REGULATIONS – 2015
### CHOICE BASED CREDIT SYSTEM
### M.E. MANUFACTURING ENGINEERING (SPECIALIZATION WITH GREEN MANUFACTURING) (Part Time)

#### SEMESTER I

<table>
<thead>
<tr>
<th>S. No</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GR7101</td>
<td>Green Manufacturing Design</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>GR7102</td>
<td>Green Manufacturing Practices</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Elective I</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>9</td>
</tr>
</tbody>
</table>

#### SEMESTER II

<table>
<thead>
<tr>
<th>S. No</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GR7201</td>
<td>Environment Sustainability and Impact Assessment</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>GR7202</td>
<td>Statistical Techniques for Green Manufacturing</td>
<td>FC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Elective II</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>9</td>
</tr>
</tbody>
</table>

#### SEMESTER III

<table>
<thead>
<tr>
<th>S. No</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GR7301</td>
<td>Green Supply Chain Management</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>GR7302</td>
<td>Lean Manufacturing System and Application</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>GR7303</td>
<td>Quantitative Techniques for Green Manufacturing</td>
<td>FC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>GR7311</td>
<td>Case Studies in Green Manufacturing Practice</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>13</td>
<td>9</td>
<td>4</td>
<td>11</td>
</tr>
</tbody>
</table>

### PRACTICALS

<table>
<thead>
<tr>
<th>S. No</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>GR7311</td>
<td>Case Studies in Green Manufacturing Practice</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>13</td>
<td>9</td>
<td>4</td>
<td>11</td>
</tr>
</tbody>
</table>
### SEMESTER IV

<table>
<thead>
<tr>
<th>S. No</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>GR7401</td>
<td>Green Manufacturing Management</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>GR7402</td>
<td>Optimization Techniques for Green Manufacturing</td>
<td>FC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Elective III</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>GR7411</td>
<td>Computer Aided Modelling Simulation Lab</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td>13</td>
<td>9</td>
<td>0</td>
<td>4</td>
<td>11</td>
</tr>
</tbody>
</table>

### SEMESTER V

<table>
<thead>
<tr>
<th>S. No</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td>Elective IV</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>Elective V</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Elective VI</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>GR7511</td>
<td>Project Work Phase I</td>
<td>EEC</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td>21</td>
<td>9</td>
<td>0</td>
<td>12</td>
<td>15</td>
</tr>
</tbody>
</table>

### SEMESTER VI

<table>
<thead>
<tr>
<th>S. No</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>GR7611</td>
<td>Project Work Phase II</td>
<td>EEC</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>12</td>
</tr>
</tbody>
</table>

**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF DEGREE = 67**
## FOUNDATION COURSES (FC)

<table>
<thead>
<tr>
<th>S. No</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GR</td>
<td>Statistical Techniques for Green</td>
<td>FC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manufacturing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>GR</td>
<td>Quantitative Techniques for Green</td>
<td>FC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manufacturing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>GR</td>
<td>Optimization Techniques for Green</td>
<td>FC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manufacturing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## PROFESSIONAL CORE (PC)

<table>
<thead>
<tr>
<th>S. No</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GR</td>
<td>Green Manufacturing Design</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>GR</td>
<td>Green Manufacturing Practices</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>GR</td>
<td>Environment Sustainability and Impact</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>GR</td>
<td>Green Supply Chain Management</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>GR</td>
<td>Lean Manufacturing System and Applications</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>GR</td>
<td>Green Manufacturing Management</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>GR</td>
<td>Modeling Simulation Lab</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>GR</td>
<td>Case Studies in Green Manufacturing</td>
<td>PC</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Practice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## PROFESSIONAL ELECTIVES (PE)

<table>
<thead>
<tr>
<th>S. No</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CI7251</td>
<td>Additive Manufacturing</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>GR7001</td>
<td>Design for Environment</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>GR7002</td>
<td>Energy Management</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>GR7003</td>
<td>Energy Saving Machinery and Components</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>GR7004</td>
<td>Green Building</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>GR7005</td>
<td>Green Chemistry</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

[Signature]
<table>
<thead>
<tr>
<th>S. No</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GR</td>
<td>Project Phase I</td>
<td>EEC</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>2.</td>
<td>GR</td>
<td>Project Phase II</td>
<td>EEC</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>12</td>
</tr>
</tbody>
</table>

**EMPLOYABILITY ENHANCEMENT COURSES (EEC)**
GR 7101  GREEN MANUFACTURING DESIGN  L T P C  3 0 0 3

OBJECTIVE:
- To introduce the concept of Green Manufacturing Design to the students

UNIT I  INTRODUCTION  9
Environmental effects of design – Environmental damage – In efficient energy use – Design for recycling.

UNIT II  ENVIRONMENTAL LIFE CYCLE ASSESSMENT  9

UNIT III  GREEN DESIGN METHODS  9

UNIT IV  DESIGN FOR ENVIRONMENT  9
Eco design – Industrial Ecology – Pollution prevention – Reduction of toxic emission.

UNIT V  SUSTAINABLE ECONOMIC ENVIRONMENT  9

TOTAL: 45 PERIODS

OUTCOMES:
- Students will understand the concepts of Green Manufacturing Design
- It will impart green design methods and to assess the life cycle of the product

REFERENCES:

GR7102  GREEN MANUFACTURING PRACTICES  L T P C  3 0 0 3

OBJECTIVE:
- To introduce the concept of Green Manufacturing to the students

UNIT I  AIR POLLUTION SAMPLING AND MEASUREMENT  4

UNIT II  NOISE POLLUTION & CONTROL  10
Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noise-Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.
UNIT III WATER DEMAND, WATER QUALITY
Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.

UNIT IV FIRE SAFETY

UNIT V SAFETY RADIATION PROTECTION
Radiation fundamentals-Types of radiation Ionizing and Non-ionizing radiation, their uses and biological effects. Radioactive waste disposal radioactive soil, water and air and their fate. Treatment and disposal Liquid and solid Radioactive wastes.

TOTAL: 45 PERIODS

OUTCOMES:
- It will create the awareness of air and noise pollution and methods of measurements and control
- It will impart the knowledge of fire safety and its protection

TEXT BOOKS:

REFERENCES:

GR 7201 ENVIRONMENT SUSTAINABILITY AND IMPACT ASSESSMENT L T P C
3 0 0 3

OBJECTIVE:
- To introduce the concepts of Environmental Sustainability & Impact Assessment to the students

UNIT I ENVIRONMENTAL ASSESSMENT - AN OVERVIEW
Environmental impact assessment objectives – Legislative development – European community directive – Hungarian directive.

UNIT II ENVIRONMENTAL DECISION MAKING
Strategic environmental assessment and sustainability appraisal – Socio economic impact assessment.

UNIT III ENVIRONMENTAL POLICY, PLANNING AND LEGISLATION
Regional spatial planning and policy – Cumulative effects assessment – Planning for climate change, uncertainty and risk.

UNIT IV TECHNICAL STUDIES AND METHODS
Casual network analysis – GIS and Expert systems in EIA.
UNIT V  SUSTAINABLE URBAN ECONOMIC DEVELOPMENT
Spatial economics – Knowledge economy and urban regions.

TOTAL: 45 PERIODS

OUTCOMES:
- It will introduce the concepts of Environment Sustainability, Environmental decision making
- It will impart the basics of environmental policy, planning and various legislation

REFERENCES:

GR 7202  STATISTICAL TECHNIQUES FOR GREEN MANUFACTURING

L T P C
3 0 0 3

OBJECTIVE:
- To train the students so that students will be able to design experimental designs and use these concepts for research design

UNIT I  PROBABILITY THEORY
Random variables – “probability density mass and distribution functions” – moment generating and characteristic functions – Binomial, Poisson, Normal distributions and their applications.

UNIT II  SAMPLING THEORY
Sampling distributions – Standard error – t, F, Chi square distributions – application.

UNIT III  ESTIMATION THEORY
Interval estimation for population mean, standard deviation, difference in means, ratio of standard deviations – point estimation.

UNIT IV  TESTING OF HYPOTHESIS
Hypothesis testing – Small samples – Tests concerning proportion, means, standard deviations – Tests based on chi square.

UNIT V  ANOVA
One, two factor models – Design of experiments

TOTAL: 45 PERIODS

OUTCOMES:
- It will train the students to understand the concepts of design of experiments
- It will deliver the knowledge of application of experiments towards research

TEXT BOOKS:

REFERENCES:
GR 7301  GREEN SUPPLY CHAIN MANAGEMENT  L  T  P  C
3  0  0  3

OBJECTIVE:
- To introduce the concepts of Green supply chain Management to the students.

UNIT I  NEED FOR GREEN SUPPLY CHAIN MANAGEMENT (GSCM)  9
Green supply Chains – Need for Green Supply Chains – Implications of modern supply chain management – The supply chain strategy – Ingredients of green supply chain strategy.

UNIT II  MEASURING AND MONITORING GREEN SUPPLY CHAINS  9
Evaluating the impact of GSCM activities on sustainability – Economic, Environmental and social impacts of GSCM Stages of GSCM - performance measurement.

UNIT III  MANAGING GREEN SUPPLY CHAIN MANAGEMENT  9

UNIT IV  SUPPLY NETWORK REDESIGNING  9

UNIT V  LOGISTICS AND GSCM  9

TOTAL: 45 PERIODS

OUTCOMES:
- It will provide the participants with a good knowledge on logistics and supply chain management
- It will teach how these topics can be related with the organization and their business needs.

TEXT BOOKS:
1. ‘Sustainable Supply Chain Management’ Balkan Cetinkaya and Richard Cuthbertson (2nd) – Springer 2011

REFERENCES:

GR 7302  LEAN MANUFACTURING SYSTEM AND APPLICATIONS  L  T  P  C
3  0  0  3

OBJECTIVES:
- To study the various tools for lean manufacturing (LM).
- To apply the above tools to implement LM system in an organization.

UNIT I  INTRODUCTION TO LEAN MANUFACTURING  7

UNIT II  CELLULAR MANUFACTURING, JIT, TPM  9
Cellular Manufacturing – Types of Layout, Principles of Cell layout, Implementation. JIT – Principles of JIT and Implementation of Kanban. TPM – Pillars of TPM, Principles and implementation of TPM.
UNIT III    SET UP TIME REDUCTION, TQM, 5S, VSM  10
Set up time reduction – Definition, philosophies and reduction approaches. TQM – Principles and implementation. 5S Principles and implementation - Value stream mapping - Procedure and principles.

UNIT IV    SIX SIGMA  9
Six Sigma – Definition, statistical considerations, variability reduction, design of experiments – Six Sigma implementation

UNIT V    CASE STUDIES  10
Various case studies of implementation of lean manufacturing at industries.  TOTAL: 45 PERIODS

OUTCOMES:
• It will impart the knowledge of cellular manufacturing, JIT and TPM
• It will teach how to reduce the manufacturing time by applying concepts of TQM, 5S and VSM

REFERENCES:
3. Rother M. and Shook J, 1999 ‘Learning to See: Value Stream Mapping to Add Value and Eliminate Muda’ , Lean Enterprise Institute, Brookline, MA.

GR 7303    QUANTITATIVE TECHNIQUES FOR GREEN MANUFACTURING  L T P C
3 0 0 3

OBJECTIVE:
• To introduce the concepts of operations research to students so that these concepts, can be used in Green Manufacturing

UNIT I    LINEAR PROGRAMMING  10

UNIT II    TRANSPORTATION AND ASSIGNMENT METHODS  11

UNIT III    THEORY OF GAMES  9

UNIT IV    QUEUING THEORY AND SIMULATION  9

UNIT V    REPLACEMENT PROBLEMS  7
Replacement of equipment with increase of running cost with time – time value of money – Individual replacement policy – Group replacement policy - staffing problems.  TOTAL: 45 PERIODS

OUTCOMES
• The students will be able to study a given problem, formulate and model it suitably
The student will select an appropriate optimization technique, solve, find and implement the optimal solution.

**TEXT BOOKS:**

**REFERENCES:**

---

**GR 7311**  
**CASE STUDIES IN GREEN MANUFACTURING PRACTICE**  
**L T P C**  
0 0 4 2

**OBJECTIVES:**
To introduce the various live case studies from industries on Green Manufacturing to the students.

**OUTCOME:**
The students will be able to analyze in a systematic way the various case studies and offer solutions to problems related to Green Manufacturing.
Each student will identify a case study from industries related to Green Manufacturing practices and the case study will be presented by students with solutions to the other students.
Evaluation will be done by a panel of faculty members identified for this purpose.

**TOTAL:** 60 PERIODS

---

**GR 7401**  
**GREEN MANUFACTURING MANAGEMENT**  
**L T P C**  
3 0 0 3

**OBJECTIVES:**
- The students will be able to use these techniques while managing the manufacturing activity operations.

**UNIT I**  
**FORE CASTING**  

**UNIT II**  
**SCHEDULING AND SEQUENCING**  

**UNIT III**  
**INVENTORY CONTROL**  
Purpose or inventory – Basic EOQ model - Quantity discounts – P system – Q system – ABC analysis– MRP – Manufacturing batch size model – Multi item EOQ models with constraints – Aggregate planning.

**UNIT IV**  
**PROJECT MANAGEMENT**  
Project Network analysis – Critical path method (CPM) – Programme Evaluation and Review.
Technique (PERT) – Project Crashing.

UNIT V  PLANT ENGINEERING AND WORK STUDY  10

OUTCOMES:
- To implement the knowledge of forecasting, scheduling and sequencing the manufacturing product and processes
- It will develop the knowledge of inventory control, programme evaluation and plant engineering

TEXT BOOK:

REFERENCE:

TOTAL: 45 PERIODS

GR 7402  OPTIMIZATION TECHNIQUES FOR GREEN MANUFACTURING  L T P C
3 0 0 3

OBJECTIVES:
- To make use of the above techniques while modeling and solving the engineering problems of different fields.

UNIT I  INTRODUCTION  5

UNIT II  CLASSIC OPTIMIZATION TECHNIQUES  10

UNIT III  NON-LINEAR PROGRAMMING  9
Introduction – Lagrangeon Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming

UNIT IV  INTEGER AND DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES  12

UNIT V  ADVANCES IN SIMULATION  9
Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems

TOTAL: 45 PERIODS
OUTCOMES:
- The students will be able to study a given problem, formulate and model it suitably
- The student will select an appropriate optimization technique, solve, find and implement the optimal solution.

REFERENCES:

GR 7411 COMPUTER AIDED MODELLING AND SIMULATION LAB
OBJECTIVES:
- To train the students to make use of software for modeling and simulation various applications in the field of green manufacturing engineering.

MODELING LAB EXPERIMENTS
1. 2D drafting of automobile components like engine crank shaft, connecting rod etc.
2. 2D drafting of pin joints, cotter joints and bearings.
4. 3D modelling and Assembly of automobile components, Joints, Bearing, Couplings etc.

SIMULATION LAB EXPERIMENTS
1. One Dimensional FEA Problem.
   a. Truss structure analysis.
   b. Cantilever beam analysis.
   c. Temperature distribution problem.
2. Two Dimensional FEA Problems.
   a. Plane stress analysis.
   b. Axisymmetric analysis.
   c. Vibration Analysis.
3. Three Dimensional FEA Problem.
   a. 3D Shell Analysis.
   b. 3D Contact Analysis.
4. FEA Application in metal forming, Metal cutting, Casting process etc.
6. Simulation of simple mechanism using solid modeling software.

TOTAL: 60 PERIODS
OBJECTIVES
- A project topic may be selected based on the literature survey and the creative ideas of the students themselves in consultation with their project supervisor.
- The topic should be so chosen that it will improve and develop the skills to design, fabricate, analyse, test and research. Literature survey and a part of the project work be carried out in phase I.
- The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.
- A project report for phase I is to be submitted at the end.

EVALUATION
- Project work evaluation is based on the Regulations of the Credit system for the Post graduate programmes of Anna University

TOTAL: 90 PERIODS

OUTCOME
The students would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated in their project work phase – II.

OBJECTIVES
- To continue the work from phase I and complete the project work in order to meet the stated objectives of the topic chosen.
- The progress of the project is evaluated based on a minimum of three reviews.
- The review committee may be constituted by the Head of the Department.
- A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Division based on oral presentation and the project report
- To improve the research and development activities of the students.

EVALUATION
- Project work evaluation is based on the Regulations of the Credit system for Post graduate programmes of Anna University

TOTAL = 180 PERIODS

OUTCOME
The students’ would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated project outcome of the aimed work.

OBJECTIVE:
- To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and industrial applications.
UNIT I INTRODUCTION:

UNIT II REVERSE ENGINEERING AND CAD MODELING:

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS:

UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS:
Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

TOTAL: 45 PERIODS

OUTCOME:
- On completion of this course, they will learn about a variety of Additive Manufacturing (AM) technologies, their potential to support design and manufacturing, case studies relevant to mass customized manufacturing, and some of the important research challenges associated with AM and its data processing tools

REFERENCES:
OBJECTIVES:
- To make the students to understand the importance of Design for Environment with respect to existing and future world.
- To make the students to understand the life cycle, concurrent and information obtained from nature.
- To understand the guidelines and rules for various forms of design
- To make the students to realize the decision making with respect to Environmental design
- To understand the applications and implementation of Design & Environment

UNIT I  THE GREEN MOVEMENT  10

UNIT II  THE ART AND SCIENCE OF DESIGN FOR ENVIRONMENT  10

UNIT III  DESIGN RULES AND GUIDELINES  10

UNIT IV  ANALYSIS METHODS FOR DESIGN DECISIONS  8

UNIT V  THE REAL WORLD PRACTISE OF DESIGN FOR ENVIRONMENT  7
Consumer products industries – Kimberly Clark: Getting serious about DFE – Procter and Gamble: Ensuing a better quality.

TOTAL: 45 PERIODS

OUTCOMES:
- It will impart the knowledge of decision making with respect to environmental design

TEXT BOOKS:
REFERENCES:

GR 7002 ENERGY MANAGEMENT

OBJECTIVES:
- To introduce the concepts of Energy conservation and management to the students.

UNIT I ENERGY AND ENVIRONMENT

UNIT II ENERGY CONSERVATION

UNIT III ENERGY TECHNOLOGIES

UNIT IV ENERGY MEASUREMENT AND MANAGEMENT

UNIT V ECONOMICS AND FINANCE

TOTAL: 45 PERIODS

OUTCOMES:
- It will develop the concepts of energy conservation and management to students

TEXT BOOKS:

REFERENCES:
GR 7003 ENERGY SAVING MACHINERY AND COMPONENTS

OBJECTIVES:
- To introduce the various energy saving machineries and components to the students for the purpose of conserving energy.

UNIT I BASICS OF ELECTRICAL ENERGY USAGE

UNIT II TRANSFORMERS & MOTORS

UNIT III FANS / PUMPS / COMPRESSORS
Basics – Selection – Performance Evaluation – Cause for inefficient operation – scope for energy conservation – methods (General & Latest) adopted for effecting ENCON – Economics of ENCON adoption in all the 3 utilities

UNIT IV ILLUMINATION AND ENERGY EFFICIENCY DEVICES

UNIT V CASE STUDIES & CO2 MITIGATION
Case Study Evaluation for 3 / 4 Typical Sectors – PAT Scheme (an introduction) – CO2 Mitigation & Energy Conservation & Cost Factor

TOTAL: 45 PERIODS

OUTCOMES:
- It will introduce the various energy saving machinery and components among students
- It will teach the students various methods of conserving energy

REFERENCES
1. Hamies, Energy Auditing and Conservation; Methods Measurements, management and Case
5. Peters et al. Sustainable Energy, beta – test – draft Kraushaar and Ristenen, Energy and

GR 7004 GREEN BUILDING

OBJECTIVES:
- To introduce the concepts of green building management.
UNIT I GREEN CONCEPTS IN BUILDINGS 9
Green Building concepts and definition – Environmental implications of buildings on water, energy, waste disposal and carbon emissions – Building materials, sources, methods of production, embodied energy, maintenance and environmental implications.

UNIT II WATER MANAGEMENT IN BUILDINGS 9
Water utilisation in buildings – Management of Sullage water sewage – Methods of waste water treatment and recycling – Low energy approaches to water management.

UNIT III ENERGY MANAGEMENT IN BUILDINGS 9
Energy requirements of building – Optimising the energy utility – Low energy concepts in lighting, ventilation and transportation of men and materials in buildings – Utility of energy efficient devices for lighting, heating and cooling – Methods of utilisation solar and wind energy.

UNIT IV THERMAL MANAGEMENT OF BUILDINGS 9

UNIT V MANAGEMENT OF SOLID WASTE AND BIOMASS 9
Low energy approaches in collection, storage, transport, recycling and disposal of solid wastes – Biomass resources for buildings – Green cover and built environment – Concepts of green composites.

TOTAL: 45 PERIODS

OUTCOMES:
- It will impart the knowledge of management of water, energy, power and wastes in buildings

TEXT BOOKS:
2. Low energy Cooling for sustainable buildings, John Wiley & Sons, 2009
3. Dennis C Brewer, Green My Home: 10 steps to lowering energy costs and reducing your carbon footprint, Kaplam Publishing Ltd., 2008.

REFERENCES:

GR 7005 GREEN CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:
- The idea behind an elective is to expose the students to a green chemistry on cutting edge technology.
- To enable the students to understand key aspects and applications of green chemistry in academic and industries and in modern research and developments.
- To enable students understand the products and its interaction with the environments. To enable students understand the basic building blocks of green chemicals.
- To enable the students to understand Green chemical reactions and manufacture green materials for a safer world.

21
UNIT I  INTRODUCTION TO GREEN CHEMISTRY


UNIT II  INTERACTION OF ENVIRONMENTAL SPHERES


UNIT III  BASIC BUILDING BLOCKS OF GREEN CHEMICALS

Elements – atoms and atomic theory – hydrogen – helium – lithium – the second period of the periodic table – the special significance of eight outer shell electrons for green chemical synthesis – the brief periodic table to stable chemicals and sustainable development.

UNIT IV  GREEN CHEMICAL REACTIONS


UNIT V  SAFER MATERIALS FOR A SAFER WORLD


OUTCOMES:

- It will create an exposure towards understanding the key aspects and application of green chemistry towards modern research and developments

TEXTBOOK:


REFERENCES:


GR 7006  GREEN ELECTRONICS MANUFACTURING

OBJECTIVES:

- This course aims to provide students with knowledge on theories, eco-design concepts, methods and relevant hands-on experience for designing a range of sustainable green...
electronic products.

- It is expected that students will develop their ability to address relevant issues on environmental impact; product design, operating life on lead-free electronics assembly.

UNIT I  INTRODUCTION OF GREEN ELECTRONICS

Environmental concerns of the modern society – Overview of electronics industry and their relevant regulations in China, European Union and other key countries. Restriction of Hazardous substances (RoHs) – Waste Electrical and electronic equipment (WEEE) – Energy using Product (EUP) and Registration Evaluation, Authorization and Restriction of Chemical substances (REACH).

UNIT II  GREEN ELECTRONICS MATERIALS AND PRODUCTS


UNIT III  GREEN ELECTRONICS ASSEMBLY AND RECYCLING


UNIT IV  FLIP-CHIP ASSEMBLY AND BONDING FOR LEAD-FREE ELECTRONICS


UNIT V  CASE STUDIES


TOTAL: 45 PERIODS

OUTCOMES:

- To expose the students with knowledge on theories, eco-design concepts, methods and relevant hands on experience for designing a range of sustainable green products
- It will create the awareness on environmental impact, product design, operating life of electronics assembly

TEXT BOOKS:

GR 7007 GREEN ENERGY SYSTEM L T P C 3 0 0 3

OBJECTIVES:
- To introduce the concept of green energy generation systems.

UNIT I ENERGY SOURCES 9
Energy sources; coal oil, natural gas; nuclear energy; hydro electricity, other fossil fuels; geothermal; supply and demand; depletion of resources; need for conservation; uncertainties; national and international issues.

UNIT II FORECASTING TECHNIQUES 9
Forecasting techniques, energy demand, magnitude and pattern, input and output analysis, energy modeling and optimal mix of energy sources. Energy - various forms, energy storage, structural properties of environment.

UNIT III GREEN CYCLES 9
Bio-geo-chemical cycles; society and environment population and technology. Energy and evolution, growth and change, patterns of consumption in developing and advances countries, commercial generation of power requirements and benefit.

UNIT IV GREEN PROCESSES 9
Chemical industries, classification, conservation in unit operation such as separation, cooling tower, drying, conservation applied to refineries, petrochemical, fertilizers, cement, pulp and paper, food industries, chloro alkali industries, conservation using optimization techniques.

UNIT V ANALYSIS OF ENERGY RESOURCES 9
Sources of continuous power, wind and water, geothermal, tidal and solar power, MHD, fuel cells, hydrogen as fuel. Cost analysis, capacity; production rate, system rate, system cost analysis, corporate models, production analysis and production using fuel inventories, input-output analysis, economics, tariffs.

TOTAL : 45 PERIODS

OUTCOMES:
- The students will learn to identify the green energy generation systems and will be able to introduce green energy system

REFERENCES

GR 7008 HAZARDOUS MANAGEMENT L T P C 3 0 0 3

OBJECTIVES:
- To impart the knowledge on different kinds of waste and their management

UNIT I HAZARDOUS WASTES 9
Hazardous waste definition terminology and classification – Sources of hazardous wastes – Need for hazardous waste management – Handling of hazardous waste, methods of collection, storage and transport – Sampling and analysis of hazardous materials.
UNIT II  CHEMICAL AND BIOMEDICAL WASTES, TOXIC MATERIALS  9

UNIT III  NUCLEAR AND RADIATION WASTES  9

UNIT IV  E-WASTES  9

UNIT V  SCIENTIFIC LAND FILL  9
Concept and definition – Site selection and approval – Acceptable wastes for landfill – Design and construction – Liners, clay, geomembrane, HDPE, geonet, geotextile – Treatment and disposal of leachate – combined and separate treatment, site remediation – Remedial techniques.

TOTAL: 45 PERIODS

OUTCOMES:
- It will impart the knowledge of a various types of waste and their significance and effects on the environment
- It will develop the skill to deal with various issues due to wastes

TEXT BOOKS:

REFERENCES:

GR 7009  LEGAL ASPECTS OF ENVIRONMENTAL ENGINEERING  L T P C
3 0 0 3

OBJECTIVES:
- To impart knowledge on the policies, legislations, institutional frame work and enforcement mechanisms for environmental management in India.

UNIT I  INTRODUCTION  9

UNIT II  WATER (P&CP) ACT, 1974  8
Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to
prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT III AIR (P&CP) ACT, 1981
Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT IV ENVIRONMENT (PROTECTION) ACT 1986
Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorization – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards

UNIT V OTHER TOPICS
Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC - Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases.

TOTAL: 45 PERIODS

OUTCOMES:
- It adds the knowledge of various laws related to environmental and legal aspects

REFERENCES:
1. CPCB, “Pollution Control acts, Rules and Notifications issued there under “Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.

GR 7010 QUALITY MANAGEMENT IN GREEN MANUFACTURING

OBJECTIVES:
- To provide the students with the knowledge of theory of quality tools, principles, management and quality systems

UNIT I INTRODUCTION

UNIT II QM PRINCIPLES
Leadership – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – PDSA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.
UNIT III QM TOOLS & TECHNIQUES I 9

UNIT IV QM TOOLS & TECHNIQUES II 9

UNIT V QUALITY SYSTEMS 9

TOTAL : 45 PERIODS

OUTCOMES:
- It will make the students to understand the various quality principles, tools and control techniques and to construct the various quality control charts
- It will develop design concepts for reliable system by implementing quality systems in industries.

TEXT BOOKS:

REFERENCES:

GR 7011 RECYCLIC PACKAGING SYSTEMS L T P C 3 0 0 3

OBJECTIVES:
- To introduce the concept of recycling, recycling techniques and recycling of various kinds of materials

UNIT I INTRODUCTION 9

UNIT II RECYCLING TECHNIQUES / METHODS 9
Recycling rate, material recovery facilities – Integrating recycling with landfills – Processing equipments.

UNIT III RECYCLING OF PAPER 9
Paper board / solid waste - Recycling of papers, pulp, construction and demolition of debris, house hold wastes.
UNIT IV  RECYCLING OF METALS  9
Recycling of Aluminium cans, scrap metals and steel cans, ferrous metals, non-ferrous metals

UNIT V  RECYCLING OF PLASTICS AND GLASS  9
Recycling of tyres, batteries, glass beverage bottles, textiles, plastic bottles, rubber materials and
tires.

TOTAL 45 PERIODS

OUTCOMES:
- It will impart the concepts of recycling, recycling techniques
- It will teach the students to decide the appropriate method for recycling of various kind of
  materials

REFERENCES:

GR 7012  SAFETY ENGINEERING  L T P C  3 0 0 3

OBJECTIVES:
- To impart the basic knowledge of safety aspect in engineering industries

UNIT I  SAFETY IN METAL WORKING AND WOOD WORKING MACHINES  9
General safety rules, principles, maintenance, Inspections of turning machines, boring machines,
milling machine, planning machine and grinding machines, CNC machines, Wood working
machinery, types, safety principles, electrical guards, work area, material handling, inspection,
standards and codes- saws, types, hazards.

UNIT II  PRINCIPLES OF MACHINE GUARDING  9
Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding
of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock
guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing-
guard construction- guard opening. Selection and suitability: lathe-drilling-boring-milling-grinding-
shaping-sawing-shearing-presses-forges hammer-flywheels-shafts-couplings-gears-sprockets
wheels and chains-pulleys and belts-authorized entry to hazardous installations-benefits of good
guarding systems.

UNIT III  SAFETY IN WELDING AND GAS CUTTING  9
Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards,
personal protective equipment, training, safety precautions in brazing, soldering and metalizing –
explosive welding, selection, care and maintenance of the associated equipment and instruments
– safety in generation, distribution and handling of industrial gases-colour coding – flashback
arrester – leak detection-pipe line safety-storage and handling of gas cylinders.

UNIT IV  SAFETY IN COLD Farming AND HOT WORKING OF METALS  9
Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and
cutting mechanism, hand or foot-operated presses, power press electric controls, power press set
up and die removal, inspection and maintenance-metal sheers-press brakes. Hot working safety in
forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes , hazards
and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health
hazards, work environment, material handling in foundries, foundry production cleaning and
finishing foundry processes.
UNIT V  SAFETY IN FINISHING, INSPECTION AND TESTING  9
Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry - industrial waste disposal.

TOTAL: 45 PERIODS

OUTCOMES:
• It will impart the knowledge of safety in industrial practices

REFERENCES
5. Indian Boiler acts and Regulations, Government of India.

GR 7013    SOLID WASTE MANAGEMENT  L T P C 3 0 0 3

OBJECTIVES:
• To introduce the concepts of storage, collection and safe disposal of solid wastes.

UNIT I  INTRODUCTION  9

UNIT II  WASTE QUANTITIES AND CHARACTERISTICS  9
Sources of solid waste – Quantities and composition – Physical, Chemical and Biological characteristics.

UNIT III  STORAGE AND COLLECTION  9
Storage - Collection for low-rise detatched houses - Collection from low and medium rise apartments - Collection from high rise apartments - Vehicles for collection - Transfer and Transport.

UNIT IV  MATERIALS RECOVERY  9

UNIT V  REUSE AND RECYCLING  9
Composting – Road making – Stabilization – Deactivation – Metal removal and recovery – Aqueous treatment – Biological technologies.

TOTAL: 45 PERIODS

OUTCOMES:
• It will develop the concepts of storage, collection and safe disposal of solid wastes

REFERENCES:
GR 7014  SUSTAINABILITY PRACTICE

OBJECTIVES:
- To introduce the various concepts of sustainability and its practices

UNIT I  INTRODUCTION

UNIT II  MAIN STREAM SUSTAINABLE DEVELOPMENT

UNIT III  ENVIRONMENT, DEGRADATION AND SUSTAINABILITY
Environmental degradation, over population and intensification – overgrazing and new range ecology - Environmental costs of development – Dams, People and resettlement.

UNIT IV  ECOLOGY OF SUSTAINABILITY
Poverty, environment and degradation - Forest clearance and forest people - Ecology of conversation - Famine - Deforestation - Tropical deforestation

UNIT IV  SUSTAINABILITY AND RISK SOCIETY

TOTAL 45 PERIODS

OUTCOMES:
- It will develop the skills to create various sustainable development practices

REFERENCES:

GR7015  SUSTAINABLE MANUFACTURING SYSTEM

OBJECTIVES:
- To introduce the various concepts associated with Manufacturing and Design for sustainability.

UNIT I  SUSTAINABILITY AND DEVELOPMENT CHALLENGES
UNIT II  PRINCIPLES AND FRAME WORK

UNIT III  SUSTAINABLE LIVELIHOOD

UNIT IV  SUSTAINABLE SOCIO-ECONOMIC SYSTEMS

UNIT V  ASSESSING PROGRESS AND WAY FORWARD

TOTAL: 45 PERIODS

OUTCOMES:
- The students will be able to develop various sustainable development practices

REFERENCES:
GR 7016  WASTE STREAM MAPPING  L T P C  3 0 0 3

OBJECTIVES:
- To introduce various concepts of waste stream mapping.

UNIT I  MECHANICAL PROCESSING FOR MATERIAL RECYCLING  10

UNIT II  BIOLOGICAL PROCESSING FOR RESOURCE RECOVERY  10
Mechanisms of Biological Processing – Aerobic Processing of Organic fraction - Composting methods and processes- factors affecting- Design of Windrow Composting Systems- In Vessel Composting- Compost Quality Control- Vermiculture: definition, scope and importance - common species for culture - Environmental requirements - culture methods- Applications of vermiculture- Potentials and constraints for composting in India- Largescale and decentralized plants.

UNIT III  BIO-CHEMICAL CONVERSION OF WASTE TO ENERGY  9

UNIT IV  THERMO-CHEMICAL CONVERSION OF WASTE TO ENERGY  8

UNIT V  CASE STUDIES ON WASTE RECYCLING  8

TOTAL: 45 PERIODS

OUTCOMES:
- The students will be able to identify various waste streams and reduce wastages

REFERENCES:
3. Chiumenti, Chiumenti, Diaz, Savage, Eggerth, and Goldstein, Modern Composting Technologies JG Press October 2005