PONDICHERRY ENGINEERING COLLEGE, PUDUCHERRY – 605 014

CURRICULUM AND SYLLABI FOR AUTONOMOUS STREAM

M.TECH. (PRODUCT DESIGN AND MANUFACTURING) COURSE
(FOR STUDENTS ADMITTED FROM ACADEMIC YEAR 2015-16 ONWARDS)

CURRICULUM

I SEMESTER

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subjects</th>
<th>Category</th>
<th>Periods</th>
<th>Marks</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ME162</td>
<td>Advanced Solid Mechanics</td>
<td>TY</td>
<td>3 1 -</td>
<td>40 60</td>
<td>100</td>
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<tr>
<td>ME163</td>
<td>Design Concepts and Technologies</td>
<td>TY</td>
<td>3 1 -</td>
<td>40 60</td>
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<tr>
<td>ME164</td>
<td>Newer Materials and Processing</td>
<td>TY</td>
<td>4 - -</td>
<td>40 60</td>
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<td>ME165</td>
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<td></td>
<td>Elective I</td>
<td>TY</td>
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<td>40 60</td>
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<tr>
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<td>Elective II</td>
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<td>40 60</td>
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<td>ME166</td>
<td>CAD Laboratory</td>
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Total Credits 26

II SEMESTER

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<tr>
<td>ME168</td>
<td>Robust Design and Quality Engineering</td>
<td>TCM</td>
<td>3 - 2</td>
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Total Credits 27
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<td>Professional Development Courses</td>
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<td>(Two one credit coursers)</td>
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<td><strong>Total Credits</strong></td>
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#CA – Continuous Assessment, SE – Semester Examination, TM - Total Marks

*TY – Theory, TCM – Theory with a Mini Project, LB – Laboratory, PR - Practice

A representative list of the **Professional Development Courses** is given below:

- a) Industrial Training (*Limited to one credit*)
- b) Specific Field Knowledge Training
- c) Seminar related with Directed Study
- d) Paper Publication in SCI Journal (*Limited to one credit*)
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<thead>
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<th>Subject Code</th>
<th>Subjects</th>
<th>Category</th>
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<tr>
<td>1</td>
<td>MEE68</td>
<td>Advances in Casting and Welding</td>
<td>TY</td>
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<tr>
<td>2</td>
<td>MEE69</td>
<td>Composite Materials Technology</td>
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<td>3</td>
<td>MEE70</td>
<td>Computer Aided Inspection and Quality Control</td>
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<td>4</td>
<td>MEE71</td>
<td>Design for Manufacture and Assembly</td>
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<td>5</td>
<td>MEE72</td>
<td>Finite Element Method</td>
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<td>6</td>
<td>MEE73</td>
<td>Pneumatic and Hydraulic Controls</td>
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<td>7</td>
<td>MEE74</td>
<td>Industrial Robotics Technology</td>
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<td>8</td>
<td>MEE75</td>
<td>Integrated Materials Management</td>
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<td>9</td>
<td>MEE76</td>
<td>Logistics and Supply Chain Management</td>
<td>TY</td>
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<td>10</td>
<td>MEE77</td>
<td>Principles of Maintenance of Safety Engineering</td>
<td>TY</td>
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<td>11</td>
<td>MEE78</td>
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<td>13</td>
<td>MEE80</td>
<td>Principles of Tribology</td>
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<td>14</td>
<td>MEE81</td>
<td>Product Reliability Engineering</td>
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<td>15</td>
<td>MEE82</td>
<td>Project Management</td>
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<td>16</td>
<td>MEE83</td>
<td>Rapid Prototyping</td>
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<td>17</td>
<td>MEE84</td>
<td>Surface Engineering in Tribology</td>
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<td>18</td>
<td>MEE85</td>
<td>World Class Manufacturing</td>
<td>TY</td>
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SYLLABUS (Core Subjects)
# Advanced Solid Mechanics

**Department:** Mechanical Engineering  
**Programme:** M.Tech. (Product Design and Manufacturing)  
**Semester:** One  
**Category:** TY  

<table>
<thead>
<tr>
<th>Subject code</th>
<th>Subject</th>
<th>Hours/week</th>
<th>Credit</th>
<th>Maximum marks</th>
</tr>
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<tbody>
<tr>
<td>ME162</td>
<td>Advanced Solid Mechanics</td>
<td>3 1 - 4 40 60 100</td>
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</tr>
</tbody>
</table>

**Prerequisite**

**Objectives**
- To analyse the stresses and deformations through advanced mathematical models.
- To estimate the design strength of various industrial equipment.

**Outcomes:**
- Apply mathematical knowledge to calculate the deformation behavior of simple structures.
- Critically analyse problem and solve the problems related to mechanical elements and analyse the deformation behavior for different types of loads.

## Unit I  
**Hours:** 09

## Unit II  
**Hours:** 09
Shear center: Bending axis and shear center-shear center unsymmetrical sections. Unsymmetrical bending: Bending stresses and deflections in Beams subjected to Nonsymmetrical bending.

## Unit III  
**Hours:** 09
Analysis of stresses in beams with large curvature – Stress distribution in curved beams – Stresses in crane hooks and C clamps – Contact Stresses – Hertz equation for contact stresses – applications to rolling contact elements.

## Unit IV  
**Hours:** 09
Torsion : Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section Hollow thin wall torsion members, Multiply connected Cross Section.

## Unit V  
**Hours:** 09
Mathematical modeling of plates with normal loads – Point and Distributed Loads – Support conditions – Rectangular plates - Stresses along coordinate axes– Plate deformations

<table>
<thead>
<tr>
<th>Total contact hours: 45</th>
<th>Total tutorials: 15</th>
<th>Total practical classes:</th>
<th>Total hours: 60</th>
</tr>
</thead>
</table>

**Text books:**

**Reference books:**
# Design Concepts and Technologies

**Department**: Mechanical Engineering  
**Programme**: M.Tech. (Product Design and Manufacturing)  
**Semester**: One  
**Category**: TY  
**Subject code**: ME163  
**Subject**: Design Concepts and Technologies  
**Hours/week**: 3  
**Credit**: 1  
**Maximum marks**: 40  
**Total contact hours**: 60  
**Total tutorials**: 15  
**Total practical classes**: 4  
**Total hours**: 60  

## Prerequisite

- Introduction to Product development cycle with methodology and factors to be considered for product design.
- Introducing basics of graphics, modeling, standards in CAD, Database arrangement.

## Objectives

- Know how to design a product.
- Able to program for basic transformation, simple curves, Develop own geometric modelling procedure.

## Outcomes

- Able to program for basic transformation, simple curves, Develop own geometric modelling procedure.

## Unit I

**Definition** - Design by Evolution and by Innovation - factors to be considered for product design - Production-Consumption cycle - The morphology of design - Primary design Phases and flow charting. Product strategies, Market research - identifying customer needs - Analysis of product – locating ideas for new products, product specification.


## Unit II


## Unit III


## Unit IV

**Total contact hours**: 45  
**Total tutorials**: 15  
**Total practical classes**: 4  
**Total hours**: 60  

## Text books:


## Reference books:


## Websites:

4. [http://nptel.ac.in/courses/Webcourse-contents/IIT](http://nptel.ac.in/courses/Webcourse-contents/IIT)
Department: Mechanical Engineering
Programme: M.Tech. (Product Design and Manufacturing)
Semester: One
Category: TY

Subject code | Subject | Hours/week | Credit | Maximum marks |
---|---|---|---|---|
ME164 | Newer Materials and Processing | 4 | 4 | 100 |

<table>
<thead>
<tr>
<th>Prerequisite</th>
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<table>
<thead>
<tr>
<th>Objectives</th>
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<tbody>
<tr>
<td>• Introduction to processing of composite and powder metallurgy products, testing and its real life application.</td>
</tr>
<tr>
<td>• Introduce knowledge about super plastic forming, Non-conventional machining, special metal joining process and special coating techniques.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Outcomes</th>
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<tbody>
<tr>
<td>• Familiarizing with composites and powder metallurgy products and its application in real life problems.</td>
</tr>
<tr>
<td>• Idea about utilization of super plastic forming, Non-conventional machining, special metal joining and special coating for real life problems.</td>
</tr>
</tbody>
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Unit I

<table>
<thead>
<tr>
<th>Hours: 12</th>
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Unit II

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Unit III

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<th>Hours: 12</th>
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Unit IV

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<th>Hours: 12</th>
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Unit V

<table>
<thead>
<tr>
<th>Hours: 12</th>
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</thead>
<tbody>
<tr>
<td>Surface Structure and properties – Surface coatings, Hard facing, Thermal spraying, Vapor deposition, Ion implantation, Hot dipping – Introduction to additive manufacturing.</td>
</tr>
</tbody>
</table>

Text books:


Reference books:


Websites:

1. http://nptel.ac.in/video.php?subjectId=113105057
**Department:** Mechanical Engineering  
**Programme:** M.Tech. (Product Design and Manufacturing)  
**Semester:** One  
**Category:** TY

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<tr>
<td>ME165</td>
<td>Design Optimization Techniques</td>
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<td>4</td>
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### Prerequisite
- To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
- To apply the mathematical models and numerical techniques for the optimization of design systems.
- The goal is to maintain a balance between theory, numerical computation, and problem setup for solution by optimization software, and applications to engineering systems.

### Objectives
- Ability to apply optimization techniques in problems of engineering and technology.

#### Unit I
**Hours:** 9  

#### Unit II
**Hours:** 9  
Multi variable unconstraint optimization- classical method-Optimization with Equality and Inequality constraints- Simplex search method – Conjugate gradient method – Variable-metric method. (Applications of these techniques in Design problems)

#### Unit III
**Hours:** 9  
Multi variable constraint optimization: Lagrange’s multipliers - Kuhn-Tucker conditions – Penalty function method – Frank-Wolfe method– Generalized projection method. (Applications of these techniques in Design problems)

#### Unit IV
**Hours:** 9  
Multi objective optimization: Conjugate gradient method - reduced Conjugate gradient method– Newton – Raphson method (Applications of these techniques in Design problems)  
Integer Programming – Branch and bound method, Introduction to Geometric programming and Dynamic programming.

#### Unit V
**Hours:** 9  

**Total contact hours:** 45  
**Total tutorials:** 15  
**Total practical classes:**  
**Total hours:** 60

### Text books:

### Reference books:

### Websites:
1. http://nptel.iitm.ac.in/courses.php
Department: Mechanical Engineering  
Programme: M.Tech. (Product Design and Manufacturing)  
Semester: One  
Category: LB

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<tr>
<td>ME166</td>
<td>CAD Laboratory</td>
<td>L T P C CA SE TM</td>
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</table>

Prerequisite

Objectives
- To teach various mechanical software in modeling and analysis.
- To teach the application of theory in the analysis of design problems.

Outcomes
- Ability to simulate real time modeling.
- Ability to model real time components.

I. Programming
Computer aided design of machine elements – Development of programs using FORTRAN/C language/ MATLAB for design, drawing & plotting of Machine Elements and Interfacing with packages like Auto CAD
  1. Shaft
  2. Couplings
Output of the program should create AutoCAD Script file. Run the Script file to show Design Drawing in the computer screen.

II. DRAFTING
Using AutoCAD Software draw
  1. Orthographic views of the given 3D blocks.
  2. 3D blocks for the given orthographic views.

III. MODELLING
Using any modelling Software like ProE/CATIA/IDEAS generate
  1. Solid modelling of given 3D blocks
  2. Assembly

IV. SIMULATION USING MATLAB
  1. Effect of damping on a single degree damped vibrating system.
  2. Transient heat transfer problem.

V. FE ANALYSIS
Using any FEA software packages like ANSYS/NISA etc solve for
  1. Plane Stress Analysis on tooth profile.
  2. 2D Asymmetric analysis to determine Hoop and longitudinal stress on thick cylinder

Total contact hours: -  
Total tutorials: -  
Total practical classes: 45  
Total hours: 45

WEBSITE:
2. https://sites.google.com/site/engineeringdrawingonline/cad-lab-manual
Department : Mechanical Engineering
Programme: M.Tech. (Product Design and Manufacturing)

Semester : Two
Category : TY

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<tr>
<td>ME167</td>
<td>Modern Manufacturing Techniques</td>
<td>4 L 4 T 4 P</td>
<td>4 C</td>
<td>40 CA 60 SE 100 TM</td>
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</table>

Prerequisite

Objectives
- To provide information about the various computer Aided manufacturing process and also the concept of various manufacturing techniques like Just in time, MRP I, MRP II etc.

Outcomes
- To contribute the Industries, community through relevant high quality research, professional services and discrimination of knowledge . responsible to the evolving needs of stakeholders.

Unit I
Hours: 12

Unit II
Hours: 12

Unit III
Hours: 12

Unit IV
Hours: 12

Unit V
Hours: 12

Total contact hours: 60
Total tutorials: -
Total practical classes:-
Total hours: 60

Text books:

Reference books:

Websites:
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<tr>
<td>ME168</td>
<td>Robust Design and Quality Engineering</td>
<td>3 L - 2 T 4 P</td>
<td>50 CA</td>
<td>100 SE TM</td>
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**Prerequisite**

**Objectives**
- To understand and apply the statistical tools and techniques in product design.

**Outcomes**
- To design the products including the statistical theory.

**Unit I**
**Hours:** 9
Basic Concepts – Fundamentals of experimental design, Selection of an appropriate design, Criteria for evaluation, Factors and levels, Review of statistical inference – Importance of optimized design – Functional design – Parametric design.

**Unit II**
**Hours:** 9
Single factor experiments: Completely randomized design, Analysis of variance (ANOVA), Effect of total sum of Squares, Randomized block design, Randomized incomplete block design, Latin square design.

**Unit III**
**Hours:** 9

**Unit IV**
**Hours:** 9

**Unit V**
**Hours:** 9

At the end of the course, student(s) should submit a mini project report based on Experiments (or) Data from Journal Publications (or) using data obtained from industries

<table>
<thead>
<tr>
<th>Total contact hours:</th>
<th>Total tutorials:</th>
<th>Total practical classes:</th>
<th>Total hours:</th>
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**Text books:**

**Reference books:**

**Websites:**
2. [http://www.mne.psu.edu/simpson/courses/ie466/ie466.robust.handout.PDF](http://www.mne.psu.edu/simpson/courses/ie466/ie466.robust.handout.PDF)
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<tr>
<td>ME169</td>
<td>CAM Laboratory</td>
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</table>

**Prerequisite**

- To introduce Part Programs of simple machining operations in CNC lathe and Milling.
- To introduce Design Programs for casting and plastic components.
- To introduce Robot and FMS Programs.

**Objectives**

- Able to handle real world CNC Machining problems, Robot and FMS programs.
- Able to design casting and plastic components.

**Suggested list of Exercises:**

1. CNC part programming for simple turning operation
2. CNC part programming for box turning operation
3. CNC part programming for facing operation
4. CNC part programming for box facing operation
5. CNC part programming for step turning operation
6. CNC part programming for taper turning operation
7. CNC part programming for thread cutting operation
8. CNC part programming for end milling operation
9. CNC part programming for profile cutting in milling
10. CNC part programming for machining holes in milling
11. Generating G & M codes for the model created using solid edge package
12. Tool and die design for a plastic component
13. Pattern design for a casting component
14. Simple robot part programming for material handling
15. FMS programming for a simple layout

**Total contact hours:** -  **Total tutorials:** -  **Total practical classes:** 45  **Total hours:** 45
**Department:** Mechanical Engineering  
**Programme:** M.Tech. (Product Design and Manufacturing)

<table>
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<tr>
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<tbody>
<tr>
<td>ME159</td>
<td>Research Methodology</td>
<td>L T P C   CA SE TM</td>
<td></td>
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</tr>
</tbody>
</table>

| Prerequisite | -                      |

**Objectives**
- To educate students to methods of selection of research problems
- To expose students to different research methods

**Outcomes**
- Students will be capable to identify and narrow down to the area of research on the basis of the requirements of industrial and global requirements
- Students will exhibit the domain skill to choose suitable research methods to execute research effectively
- Students will possess knowledge to further their academic program, namely, Ph.D program.


- **Characteristics of research:** Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach.

- **Types of research:** Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches.

- **Research procedure:** Formulating the Research Problem, Literature Review, Developing the objectives, Preparing the research design including sample. Design, Sample size.

- **Considerations in selecting research problem:** Relevance, interest, available data, choice of data, Analysis of data, Generalization and interpretation of analysis.

- **Outcome of research:** Significance of report writing – Layouts of the research report – Types of reports – Oral presentation – Mechanics of writing research report – Precautions for writing research reports – Plagiarism and copy right violation – Patent writing and filing.

**Total contact hours:** -  
**Total tutorials:** -  
**Total practical classes:** 45  
**Total hours:** 45

**Reference books:**
1. Dawson, Catherine, Practical Research Methods, UBS Publishers and Distributors, New Delhi, 2002
<table>
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<th>Subject code</th>
<th>Subject</th>
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<th>Credit</th>
<th>Maximum marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME170</td>
<td>Project Work Phase-I</td>
<td>- - -</td>
<td>9</td>
<td>150 150 300</td>
</tr>
</tbody>
</table>

**Prerequisite**

- Students individually select a topic of interest in consultation with his project advisor.
- To guide a student to do an exhaustive literature survey in the broad area of interest.
- To guide to understand the scope and define the problem.
- To guide to find specific objectives and working methodology for project in two phases.
- To guide a student to design and fabricate the experimental setup/or simulate and modeling of problem with relevant software.
- To guide to plan for experiments or modeling.
- Analyze results of experiments or simulation.

**Objectives**

- Understand a problem and plan methodology to solve the problem effectively.
- Gains design and experimental skills.
- Understands various standards, codes and testing methods.
- Able to analyze results.

**Outcomes**

The project work is to acquaint the student in the analysis of problems posed to him, in the method of conducting a detailed literature survey and reviewing the state of art in the area of the problem. If the major project (Phase-I) which is not purely theoretical, student is also expected to design, conduct and develop skills of experimental work, in some of them and to analyse the results obtained.

<table>
<thead>
<tr>
<th>Total contact hours:</th>
<th>Total tutorials:</th>
<th>Total practical classes:</th>
<th>Total hours:</th>
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<tr>
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Department: Mechanical Engineering  
Programme: M.Tech. (Product Design and Manufacturing)

Semester: Four  
Category: PR

<table>
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</thead>
<tbody>
<tr>
<td>ME171</td>
<td>Project Work Phase-II</td>
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<table>
<thead>
<tr>
<th>Prerequisite</th>
</tr>
</thead>
</table>

Objectives

- To guide a student to do an exhaustive literature survey in the broad area of interest.
- To guide to understand the scope and define the problem.
- To guide to find specific objectives and working methodology for project in two phases.
- To guide a student to design and fabricate the experimental setup/or simulate and modeling of problem with relevant software.
- To guide to plan for experiments or modeling.
- Analyze results of experiments or simulation.

Outcomes

- Gains design and experimental skills.
- Understands various standards, codes and testing methods.
- Able to analyze results.
- Able to understand the practical needs of the industries and society.

The student will take up the Major Project (Phase–II) in the fourth semester. This is aimed at exposing the students to analyze independently his project work. The work may be purely analytical or completely experimental or combination of both. In few cases, the project can also involve a sophisticated design work. The major project report is expected to show clarity of thought and expression, critical appreciation of the existing literature and analytical and/or experimental or design skill. The dissertation work should be of relevant nature for the current and the future needs of the country.

| Total contact hours: - | Total tutorials: - | Total practical classes: - | Total hours: - |
SYLLABUS (Elective Subjects)
<table>
<thead>
<tr>
<th>Subject code</th>
<th>Subject</th>
<th>Hours/week</th>
<th>Credit</th>
<th>Maximum marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEE68</td>
<td>Advances in Casting and Welding</td>
<td></td>
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<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Prerequisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Knowledge in metallurgy, basic casting and welding process.</td>
</tr>
<tr>
<td>• Knowledge in destructive and Non-destructive testing process.</td>
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</table>

<table>
<thead>
<tr>
<th>Objectives</th>
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</thead>
<tbody>
<tr>
<td>• To understand and analyse the different casting process.</td>
</tr>
<tr>
<td>• To understand and analyse the different welding process.</td>
</tr>
<tr>
<td>• To have knowledge about casting and welding product application.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• To work as successful engineers in product development and fabrication industries.</td>
</tr>
</tbody>
</table>

**Unit I** Hours: 12

Casting metallurgy and design - Heat transfer between metal and mould - Solidification of pure metal and alloys - Shrinkage in cast metals, progressive and directional solidification - Principles of grating and rising - Degasification of the melt - Design considerations in casting - Designing for directional solidification and minimum stresses - casting defects

**Unit II** Hours: 12

Special casting processes - Shell moulding, Precision investment casting, CO moulding, Centrifugal casting, Die casting and Continuous casting.

**Unit III** Hours: 12


**Unit IV** Hours: 12


**Unit V** Hours: 12

Recent advances in casting and welding - Layout of mechanised foundry - sand reclamation Material handling in foundry - pollution control in Foundry - Recent trends in casting – Computer Aided design of Castings, Low pressure die casting, Squeeze casting, and full mould casting process. Automation in welding - Welding robots - Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.

**Text books:**


**Reference books:**


**Websites:**

1. http://nptel.ac.in/courses/112107077/5
<table>
<thead>
<tr>
<th>Subject code</th>
<th>Subject</th>
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<tbody>
<tr>
<td>MEE69</td>
<td>Composite Materials Technology</td>
<td>4</td>
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</table>

| Prerequisite | Nil                             |

<table>
<thead>
<tr>
<th>Objectives</th>
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</thead>
<tbody>
<tr>
<td>• Introduce students to the concepts of modern composite materials; and equip them with knowledge on how to fabricate and carry out standard mechanical test on composites.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcomes</th>
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</thead>
<tbody>
<tr>
<td>• Identify and explain the types of composite materials and their characteristic features.</td>
</tr>
<tr>
<td>• Understand the differences in the strengthening mechanism of composite and its corresponding effect on performance and application.</td>
</tr>
<tr>
<td>• Understand and explain the methods employed in composite fabrication.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Unit I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition – Need – General Characteristics, Matrices – Polymer, Metal, Carbon and Ceramic Matrices, Reinforcement – Types – fibers, whiskers and particles, Reinforcement materials, Selection, advantages and limitations.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit II</th>
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</thead>
<tbody>
<tr>
<td><strong>Polymer Matrix Composites – Matrix Resins – Thermosetting resins, Thermoplastic resins, Polycrystalline polymers (PCL), Thermoplastic Polyimides (TPI), Polyacrylene Sulfide, Molecularly ordered liquid Crystals (MOLC), Polyblends Alloys, Fibers and Laminar Composites.</strong></td>
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<table>
<thead>
<tr>
<th>Unit III</th>
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<tbody>
<tr>
<td><strong>Metal Matrix Composites – Matrix selection, Reinforcement and reinforcement selection, Matrix reinforcement interface, Interaction zone, Interface bond strength.</strong></td>
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<table>
<thead>
<tr>
<th>Unit IV</th>
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</thead>
<tbody>
<tr>
<td><strong>Polymer Matrix Production Methods – Bag Moulding, Compression Moulding, Pultrusion, Filament Winding, Metal Matrix Composites - Fabrication methods – Solid State Techniques and Liquid State Techniques</strong></td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Unit V</th>
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<tbody>
<tr>
<td><strong>Micro mechanics and macro mechanics of composites, monotonic strength and fracture, Fatigue and Creep, Applications of composites. Composites Processing.</strong></td>
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<table>
<thead>
<tr>
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<table>
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<th>Reference books:</th>
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<tr>
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<tbody>
<tr>
<td>2. <a href="http://nptel.ac.in/courses/101104010/">http://nptel.ac.in/courses/101104010/</a></td>
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<tr>
<td>Subject code</td>
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<tr>
<td>MEE70</td>
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</table>

**Prerequisite:** Nil

**Objectives:**
- Imparting working knowledge about contact and non-contact computer aided measurement systems, optical measurement techniques and computer aided quality control techniques.

**Outcomes:**
- By familiarization able to select proper measurement system and quality control techniques and their computer aided execution.

**Unit I**

**Hours:** 12


**Unit II**

**Hours:** 12


**Unit III**

**Hours:** 12


**Unit IV**

**Hours:** 12


**Unit V**

**Hours:** 12

Computer Aided Quality Control–Objectives of CAQC- Computers in QC- CAQC Charts for Attributes and Variables – Study of CAQC Software like STAT- Introduction to six sigma - 6σMethods and Tools - 6σ for manufacturing - 6σ for product development.

**Total contact hours:** 60  **Total tutorials:** -  **Total practical classes:** -  **Total hours:** 60

**Text books:**

**Reference books:**

**Websites:**


**Department**: Mechanical Engineering  
**Programme**: M.Tech. (Product Design and Manufacturing)

<table>
<thead>
<tr>
<th>Semester</th>
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<tr>
<th>Subject code</th>
<th>Subject</th>
<th>Hours/week</th>
<th>Credit</th>
<th>Maximum marks</th>
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<tbody>
<tr>
<td>MEE71</td>
<td>Design for Manufacture and Assembly</td>
<td>4</td>
<td>-</td>
<td>40 60 100</td>
</tr>
</tbody>
</table>

**Prerequisite**

- Study the various factors influencing the manufacturability of components and the use of tolerances in manufacturing.
- Apply this study to various forging, casting, welding and machining processes.
- Study about the various assembly methods and processes and design for assembly guidelines.

**Objectives**

- Apply knowledge of mathematics, science, and engineering.
- 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.
- Study the various factors influencing the manufacturability of components.
- Study the use of tolerances in manufacturing.

**Outcomes**

- Apply knowledge of mathematics, science, and engineering.
- 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.
- Study the various factors influencing the manufacturability of components.
- Study the use of tolerances in manufacturing.

**Unit I**

*Hours: 12*

General design principles, Effect of material properties on design, Effect of manufacturing process on design, mechanisms selection, evaluation method, Process capability.

**Unit II**

*Hours: 12*

Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.

**Unit III**

*Hours: 12*


**Unit IV**

*Hours: 12*

Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores.

**Unit V**

*Hours: 12*

Feature tolerances - Geometric tolerances - Assembly limits – Datum features - Tolerance stacks Introduction to design for assembly, General approach to design for assembly- case studies.

**Total contact hours**: 60  
**Total tutorials**: -  
**Total practical classes**: -  
**Total hours**: 60

**Text books:**

2. Robert Matousek- Engineering Design-A systematic approach, Blackie&SonsLtd.1963.

**Reference books:**

2. Swift K.G. -Knowledge based design for manufacture, Koga Page Ltd., 1987

**Websites:**

<table>
<thead>
<tr>
<th>Subject code</th>
<th>Subject</th>
<th>Hours/week</th>
<th>Credit</th>
<th>Maximum marks</th>
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<tbody>
<tr>
<td>MEE72</td>
<td>Finite Element Method</td>
<td>L 3  T 1  P -</td>
<td>C 4  CA 40  SE 60  TM 100</td>
<td></td>
</tr>
</tbody>
</table>

**Prerequisite**: Nil

**Objectives**
- Introduction to concept and method of Finite element method and its application in 1D, 2D structural and thermal analysis (only static problems).

**Outcomes**
- Able to develop own FE code applied for static problems in 1D, 2D structural and thermal analysis.

**Unit I**
**Hours: 9**
Basic Concept of FEM, discretisation, comparison with finite difference method, advantages and disadvantages, history of development, application. Variational and Weighted Residual Formation: Boundary value problems, approximated methods of solution, review of variational calculus, geometric and natural boundary condition, method of Weighted residuals, Rayleigh Ritz and Galerkin methods of finite element formulations and convergence criteria, weak formulation - simple problems.

**Unit II**
**Hours: 9**
One dimensional second order equations, discretisation of domain into elements, derivation of element equations, assembly of element equation, imposition of boundary conditions, solution of equations - post processing, Direct stiffness method (DSM): Fundamental steps in DSM, Plane Truss, Calculation of Reaction, Internal forces and stresses. Extension of fourth order equations and their solutions – examples from solid mechanics, heat transfer.

**Unit III**
**Hours: 9**
Classification of C0, C1 continuous problems- Parameter functions, its properties- completeness and compatibility condition, One-dimensional elements, Global coordinates Two-dimensional elements, three nodded triangular elements and four nodded quadrilateral elements. Natural coordinate systems – Lagrangian Interpolation Polynomials- Serendipity Formulation – Difference between Superparametric, Subparametric and Isoparametric Elements, Isoparamatric Elements Formulation, length coordinates – 1D bar elements, C0 continuous shape function, beam elements, C1 continuous shape function - 2D Triangular elements, Rectangular elements. – Area coordinates- Numerical integration – simple Problems using Gauss quadrature technique.

**Unit IV**
**Hours: 9**

**Unit V**
**Hours: 9**

**Total contact hours: 45**
**Total tutorials: 15**
**Total practical classes:-**
**Total hours:60**

**Text books:**

**Reference books:**
1. http://nptel.ac.in/courses/112104115/
<table>
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<tr>
<th>Subject code</th>
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<th>T</th>
<th>P</th>
<th>C</th>
<th>CA</th>
<th>SE</th>
<th>TM</th>
<th>Hours/week</th>
<th>Credit</th>
<th>Maximum marks</th>
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<tbody>
<tr>
<td>MEE73</td>
<td>Pneumatic and Hydraulic controls</td>
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<td></td>
<td></td>
<td></td>
<td>4</td>
<td>40</td>
<td>60</td>
<td>100</td>
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</tbody>
</table>

**Prerequisite** Nil

**Objectives**

- This course is aimed at making an Engineer with appropriate experience; a qualified designer of Industrial automation systems with the use of PLCs, PACs, Industrial Field Instruments, Industrial PCs, SCADA/HMI, Data-acquisition boards, Machine vision, robots, Microprocessor based instruments, and related Software.

**Outcomes**

- Qualified automation engineers to meet the requirements of designing appropriate industrial automation systems.

**Unit I**

Hours: 12

Principles of automatic controls: Basic concepts of open and closed loop feedback control systems, block diagram representation of physical system, spring mass system, torsion system, hydraulic system, transfer function from block diagram for mechanical, electro-mechanical and hydraulic system. Controls and sensors used in machine tools.

**Unit II**

Hours: 12


**Unit III**

Hours: 12


**Unit IV**

Hours: 12


**Unit V**

Hours: 12


**Total contact hours:** 60  **Total tutorials:** -  **Total practical classes:** -  **Total hours:** 60

**Text books:**


**Reference books:**


**Websites:**

1. [http://nptel.ac.in/courses/108105062/](http://nptel.ac.in/courses/108105062/)
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<th>Credit</th>
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<td>P</td>
<td>C</td>
<td>CA</td>
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<tr>
<td>MEE74</td>
<td>Industrial Robotics Technology</td>
<td>4</td>
<td>-</td>
<td>40</td>
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</tbody>
</table>

**Prerequisite**: Nil

**Objectives**
- Introducing knowledge about different types of robots and its components, programming language and its applications in industries sites.

**Outcomes**
- By knowing programming language, control the robots in different industries application.

**Unit I**
Hours: 12

**Unit II**
Hours: 12

**Unit III**
Hours: 12

**Unit IV**
Hours: 12
Robot cell layouts – multiple Robots and machine interface, consideration in work cell design, interlocks, error detection and recovery, Robot cycle time analysis, simulation of Robot work cells.

**Unit V**
Hours: 12
Applications of robots in material transfer, machine loading and unloading, welding, assembly and inspection, safety, training, maintenance and quality aspects, Economics and social aspects of robotics

**Total contact hours**: 60  
**Total tutorials**: -  
**Total practical classes**: -  
**Total hours**: 60

**Text books**:

**Reference books**:

**Websites**:
1. http://nptel.ac.in/courses/112101099/3
Department: Mechanical Engineering  
Programme: M.Tech. (Product Design and Manufacturing)

<table>
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<th>Credit</th>
<th>Maximum marks</th>
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<tbody>
<tr>
<td>MEE75</td>
<td>Integrated Materials Management</td>
<td>4 T - 4</td>
<td>40</td>
<td>100</td>
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</tbody>
</table>

Prerequisite: Nil

Objectives
- Understand how materials management should be considered for profitability and how to establish the best methods of inventory analysis and create performance measures.

Outcomes
- Student gains knowledge on effective utilization of materials in manufacturing and Service organizations.

Unit I
Hours: 12

Unit II
Hours: 12

Unit III
Hours: 12
Inventory Control : inventory models - purchase model with instantaneous replenishment and without shortages, manufacturing model without shortages, purchase model with shortage and manufacturing model with shortages – operation of inventory systems – quantity discounts - P & Q systems of inventory replenishment – multiple item model with shortage limitation –determination of stock level of perishable items under probabilistic condition – MRP I and II.

Unit IV
Hours: 12

Unit V
Hours: 12

Total contact hours: 60
Total tutorials: -
Total practical classes:-
Total hours: 60

Text books:
**Reference books:**


**Websites:**

<table>
<thead>
<tr>
<th>Department: Mechanical Engineering</th>
<th>Programme: M.Tech. (Product Design and Manufacturing)</th>
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<td>Subject code</td>
<td>Subject</td>
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<tr>
<td>MEE76</td>
<td>Logistics and Supply Chain Management</td>
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</table>

### Prerequisite

- Understanding the importance of major decisions in supply chain management for gaining competitive advantage.
- Ability to build and manage a competitive supply chain using strategies, models, techniques, and information technology.

### Outcomes

- Understanding the importance of major decisions in supply chain management for gaining competitive advantage.
- Ability to build and manage a competitive supply chain using strategies, models, techniques, and information technology.

#### Unit I

**Hours: 12**


#### Unit II

**Hours: 12**


#### Unit III

**Hours: 12**


#### Unit IV

**Hours: 12**

Managing the Supply Chain: creating logistics vision — problems with conventional organizations — developing logistics organizations - logistics as a vehicle for change — need for integration — managing supply chain as a network — process integration and ECR — co-makership and logistics partnerships — supplier development. Role of Information Systems and Technology in SCM : importance of information in an integrated SCM environment — interorganizational information systems (IOIS) — information requirements determination for a supply chain IOIS — information and technology applications of SCM.

#### Unit V

**Hours: 12**


### Text books:


### Reference books:

1. Ayers, J B - Handbook of Supply Chain Management, St. Lencie Press, 2000

### Websites:

2. [www.youtube.com/watch?v=Nrl0CtS1m8Y](http://www.youtube.com/watch?v=Nrl0CtS1m8Y)
Department: Mechanical Engineering  
Programme: M.Tech. (Product Design and Manufacturing)

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<th>Hours/week</th>
<th>Credit</th>
<th>Maximum marks</th>
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<tbody>
<tr>
<td>MEE77</td>
<td>Principles of Maintenance and Safety Engineering</td>
<td>4 L - 4 T</td>
<td>4 C</td>
<td>40 CA 60 SE 100 TM</td>
</tr>
</tbody>
</table>

Prerequisite

- To understand the concepts of safety and maintenance.
- To familiarize the safety procedures.
- To derive the shortest route to minimize the maintenance and hazardous.

Objectives

- At the end of the subject Student can understand the various theories of precautions.
- Student can able to analyze the problem easily.
- Can measure the time of working period.

Outcomes

- To understand the concepts of safety and maintenance.
- To familiarize the safety procedures.
- To derive the shortest route to minimize the maintenance and hazardous.

Unit I  

Unit II  
Predictive Maintenance - vibration and noise as maintenance tool - wear debris analysis - Condition monitoring concepts applied to industries - Total Productive Maintenance (TPM) –Evaluation of O.E.E- Economics of Maintenance-Case studies.

Unit III  
Importance of maintenance management-types of maintenance organization- maintenance of stores and spare parts management – ABC analysis – Value analysis – Computer aided maintenance.

Unit IV  

Unit V  

Total contact hours: 60  
Total tutorials: -  
Total practical classes:-  
Total hours: 60

Text books:


Reference books:


Websites:

<table>
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<tr>
<th>Department</th>
<th>Programme</th>
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<td>M.Tech. (Product Design and Manufacturing)</td>
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<td>C</td>
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<tr>
<td>MEE78</td>
<td>Micro-Electro-Mechanical Systems</td>
<td>4</td>
<td>-</td>
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</tbody>
</table>

**Prerequisite**

**Objectives**

- Educating about PLC and its applications in robotics and manufacturing systems,
- Development of micro-electro-mechanical components and micro machining techniques.

**Outcomes**

- Ability to replace the conventional controller with PLC miniaturised micro-electro-mechanical devices and ability to select proper micro machining techniques to develop miniaturised micro-mechanical components.

**Unit I**

**Hours:** 12


**Unit II**

**Hours:** 12


**Unit III**

**Hours:** 12

Dry Etching- Definitions- Plasmas or Discharges- Ion Etching or Sputtering and Ion-Beam Milling- Plasma Etching (Radical Etching) - Physical Etching. Wet Isotropic And Anisotropic Etching- Alignment Patterns- Chemical Etching Models- Etching with Bias And/or Illumination Of The Semiconductor- Etch-Stop Techniques- Problems.

**Unit IV**

**Hours:** 12

Physical and Chemical Vapour Deposition- Silk-Screening or Screen-Printing- Sol-Gel Deposition Technique, Doctors' Blade or Tape Casting, Plasma Spraying-Deposition and Arraying Methods of Organic Layers in BIOMEMS- Thin versus Thick Film Deposition- Selection Criteria for Deposition Method. Introduction to LIGA and Micro moulding- LIGA Background – LIGA and LIGA like process steps.

**Unit V**

**Hours:** 12


**Total contact hours:** 60

**Total tutorials:** -

**Total practical classes:** -

**Total hours:** 60

**Text books:**


**Reference books:**


**Websites:**

1. http://nptel.ac.in/video.php?subjectId=117105082
**Department:** Mechanical Engineering  
**Programme:** M.Tech. (Product Design and Manufacturing)  

**Semester:**  
**Category:** TY  

<table>
<thead>
<tr>
<th>Subject code</th>
<th>Subject</th>
<th>Hours/week</th>
<th>Credit</th>
<th>Maximum marks</th>
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<tbody>
<tr>
<td>MEE79</td>
<td>Nanotechnology</td>
<td>4</td>
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**Prerequisite**

| Objectives |  
|---|---|
| • To promote the responsible development of nanotechnology by highlighting the innovation and sustainable application and improve awareness of societal benefits of nanotechnology.  
• To support the development of appropriate, science and risk based regulations nomenclature and definitions for nanotechnology that foster safety and innovation. |

| Outcomes |  
|---|---|
| • Help to support research needed to assess and manage potential health and environment risks associated with Nano scale materials. |

**Unit I**  
**Hours:** 12  
General principles of Machine Tool Design-Parameters defining working motions of a machine tool- Machine tool drives- mechanical and hydraulic transmission and its elements- engineering design process applied to machine tools.

**Unit II**  
**Hours:** 12  
Regulation of speed and feed rates – design of gear box – design of feed box – special cases of gear box design – classification of speed and feed boxes – determining the number of teeth of gears.

**Unit III**  
**Hours:** 12  
Design of machine tool structures – design criteria for machine tool structures – materials for machine tool structures- design of beds, columns, housings, bases and tables, cross rails, arms, saddles and carriages, rams.

**Unit IV**  
**Hours:** 12  

**Unit V**  
**Hours:** 12  

**Total contact hours:** 60  
**Total practical classes:** -  
**Total hours:** 60  

**Text books:**  

**Reference books:**  

**Websites:**  
<table>
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<td>MEE80</td>
<td>Principles of Tribology</td>
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**Prerequisite**

- Understand tribology's role in business and the importance of Tribology as a way of creating value in an organization.
- Identify and create the conditions in which tribology projects can be proposed, commissioned and promoted.

**Outcomes**

- Identify the surface related problems which lead to failure of the components.
- Come up with ideas to design against tribological problems.

**Unit I**

<table>
<thead>
<tr>
<th>Hours:12</th>
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</thead>
<tbody>
<tr>
<td>Introduction to tribology-Factors influencing Tribological phenomena-Engineering surfaces Surface characterization, Computation of surface parameters. Surface measurement techniques Apparent and real area of contact. Introduction to nano tribology.</td>
</tr>
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**Unit II**

<table>
<thead>
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<th>Hours:12</th>
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<tbody>
<tr>
<td>Genesis of friction-Various laws and theory of friction-friction in contacting rough surfaces sliding and Rolling friction-frictional heating and temperature rise.</td>
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**Unit III**

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<th>Hours:12</th>
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**Unit IV**

<table>
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<th>Hours: 12</th>
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**Unit V**

<table>
<thead>
<tr>
<th>Hours :12</th>
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</thead>
<tbody>
<tr>
<td>Surface modification techniques-Improving wear resistance-Surface coating techniques such as electrochemical depositions, anodizing, thermal spraying, Chemical Vapour Deposition (CVD),Physical Vapour Deposition (PVD), etc. and their applications.</td>
</tr>
</tbody>
</table>

**Total contact hours: 60**

**Total tutorials: -**

**Total practical classes:-**

**Total hours:60**

**Text books:**


**Reference books:**


**Websites:**

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</table>

**Prerequisite**

- To apply the reliability theory and reliability estimation in product design and manufacturing.

**Outcomes**

- To design and manufacture the products based reliability techniques.

**Unit I**


**Unit II**


**Unit III**

- Reliability tests – types – Component reliability from test data – reliability models for series, parallel, stand by and k-out-of-m systems.

**Unit IV**


**Unit V**

- Significance of availability and maintainability concepts in reliability evaluation – Importance of maintainability in design and manufacturing – reliability and associated costs – economics of reliability - reliability management.

**Total contact hours: 60**  
**Total tutorials: -**  
**Total practical classes:-**  
**Total hours: 60**

**Text books:**


**Reference books:**


**Websites:**

<table>
<thead>
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<td>MEE82</td>
<td>Project Management</td>
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**Prerequisite**

**Objectives**
- Understand about a project, its various stages, evaluation of projects, sources of finance, implementation and control of projects.

**Outcomes**
- Ability to select most desirable projects, apply appropriate approaches to plan a new project, develop a suitable budget for a new project, identify important risks facing a new project and apply suitable techniques to assess on-going project performance.

**Unit I**
**Hours: 12**

Indian project management scenario, Projects - Project ideas and preliminary screening.

Developments - Project planning to Project completion - Pre-investment phase, Investment phase, operational phase - Governmental Regulatory framework. Capital Budgeting: Capital cost-time value (CTV) system, managing project resources flow.

**Unit II**
**Hours: 12**

Stages - Opportunity studies - General opportunity studies, specific opportunity studies, prefeasibility studies, functional studies or support studies, feasibility study expansion projects, data for feasibility study. Market and Technical Appraisal: Market and Demand analysis, Market Survey, Demand forecasting. Technical analysis - Materials and inputs, Choice of Technology, Product mix, Plant location, capacity, Machinery and equipment.

**Unit III**
**Hours: 12**


**Unit IV**
**Hours: 12**


**Unit V**
**Hours: 12**

Forms of Project Organization, Project Planning, Implementation, and Control – Network construction, CPM, PERT, Development of Project schedule, Crashing of Project Network, Scheduling based on the availability of Resources (Manpower and Release of Funds). Introduction to Foreign collaboration projects - Governmental policy framework, Need for foreign technology, Royalty payments, Foreign investments and procedural aspects.

**Total contact hours: 60**
**Total tutorials: -**
**Total practical classes:-**
**Total hours: 60**

**Text books:**

**Reference books:**
2. UNIDO - Series on Project Management.

**Websites:**
<table>
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<tr>
<td>MEE83</td>
<td>Rapid Prototyping</td>
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</table>

**Prerequisite**

- Introducing Knowledge about different Rapid prototyping techniques and its application and its limitation.

**Objectives**

- Ability to select proper Rapid prototyping techniques for the real life design model problems.

**Outcomes**

- Introducing Knowledge about different Rapid prototyping techniques and its application and its limitation.

**Unit I**


**Unit II**

Product Development Cycle – Data requirements, Modeling, Data representation, part orientation and support, from CAD / CAM, STL format, Slicing, Post Processing.

**Unit III**

Engineering Manufacturing, Overview of existing technologies of prototyping and tooling, General features and classification of Generative Manufacturing process (GMP) for Rapid Prototyping.

**Unit IV**

Two-Dimensional Layer – by Layer Techniques - Steriolithography (SL), Solid Foil Polymerization (SFP), Selective Laser Sintering (SLS), Selective Powder Building (SPB), Ballistic Particle Manufacturing (PM), Fused Deposition Modelling (FDM), Laminated Object Manufacturing (LOM), Solid Ground curing (SGC).

**Unit V**

Direct three Dimensional Techniques – Beam Interference Solidification (BIS), Ballistic Particle Manufacturing, Programmable Moulding, Comparison of GMP characteristics, considerations for adopting RP technology.

| Total contact hours: 60 | Total tutorials:-- | Total practical classes:-- | Total hours: 60 |

**Text books:**

1. Radhakrishnan, P. Subramanaya, S and Raju.v - CAD/CAM/CIM, New age international (P) Ltd.,

**Reference books:**

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<tr>
<td>MEE84</td>
<td>Surface Engineering in Tribology</td>
<td>4</td>
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Prerequisite

Objectives
- Understand tribology’s role in business and the importance of tribology as a way of creating value in an organization.
- Identify and create the conditions in which tribology projects can be proposed, commissioned and promoted.

Outcomes
- Identify the surface related problems which lead to failure of designed components.
- Create designer surfaces so as to exploit the tribological advantages.

Unit I

Unit II
Introduction- surface roughness- sampling length- asperities- quantification of roughness parameters- traditional and latest surface parameters- standardized methods of measurement- various roughness measurement techniques- statistical analysis of surfaces- PDF-ACF-Spectral density-fractal-BAC etc.

Unit III
Introduction- geometry of non-conforming surfaces in contact- surface and subsurface stresses-surface traction- contact of rough surface- surface temperature in sliding- apparent and real area of contact- frictional heating – an idealized rough surface- a realistic rough surface.

Unit IV
Adhesion- fundamentals- solid to solid contacts- bonding between surface- types of bonding- free surface energy theory of adhesion- liquid mediated contact.

Unit V

Text books:

Reference books:

Websites:
### Subject: World Class Manufacturing

**Course Code:** MEE85  
**Category:** TY  

<table>
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<th>Subject</th>
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<tr>
<td>World Class Manufacturing</td>
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**Prerequisite:**
- To introduce students with WCM concepts and emphasize the necessary steps for the journey toward becoming a World class manufacturing organization with a perspective approach of effectively interfacing functional areas to derive better results.

**Objectives:**
- Implementation of WCM principles covers almost all the management techniques like manufacturing strategy, lean manufacturing, TPM, TQM in unison which eventually reduce lead times, speed time-to-market, cut operations costs, exceed customer expectations, manage the global enterprise, streamline outsourcing processes and finally improves business performance visibility.

**Outcomes:**
- Implementation of WCM principles covers almost all the management techniques like manufacturing strategy, lean manufacturing, TPM, TQM in unison which eventually reduce lead times, speed time-to-market, cut operations costs, exceed customer expectations, manage the global enterprise, streamline outsourcing processes and finally improves business performance visibility.

---

**Unit I**  
**Hours:** 12  
Introduction to World-Class Manufacturing (WCM): Manufacturing Excellence and Competitiveness, Meaning of World-class, Competing in World markets, WCM Techniques, Review of frameworks for WCM, Justification of WCM; An overview of manufacturing strategy: concepts, manufacturing strategy formulation and implementation, Manufacturing strategy – examples from the industry (Indian and international context).

**Unit II**  
**Hours:** 12  

**Unit III**  
**Hours:** 12  
Total Productive Maintenance (TPM) - An overview of various maintenance systems, Evolution of TPM, Productivity and TPM, OEE, TPM and TQC, Small Group Activities, Pillars of TQM, Kobetsu-Kaizen (Continuous Improvement), Jishu-Hozen (Autonomous maintenance), Planned Maintenance System, Skill upgrade training, Initial control (Equipment Life cycle management), Hinshitsu-Hozen (Quality Maintenance), Office TPM, Total safety management, Implementation, 5s, Case Studies.

**Unit IV**  
**Hours:** 12  
Total Quality Management (TQM) - Definition, Understanding quality, Evolution of TQM, Framework for TQM, Commitment and leadership, Customer satisfaction, Employee involvement, Continuous process improvement, Supplier partnership, Performance measures, Formulation and implementation of TQM, Case Studies.

**Unit V**  
**Hours:** 12  
Salient features of WCM - Supply Chain Management & key issues in SCM, Role of Information system in WCM, Knowledge management - Introduction, Benefits, Tools and techniques, Study of various performance measures in world class organization, Human Resource Dimensions in WCM.

**Total contact hours:** 60  
**Total tutorials:** -  
**Total practical classes:** -  
**Total hours:** 60

**Text books:**

**Reference books:**

**Websites:**