Department of Mechanical Engineering

Proposed Course Content for

M. Tech. in Manufacturing Engineering

From 1st Semester - 4th Semester

Finalized in BoS meeting held on 7th April, 2017
Vision

The vision of the Department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission

Imparting quality education, looking after the holistic development of students and conducting need-based research and extension activities.

Post Graduate Attributes

The Post Graduate Attributes are the knowledge skills and attitudes which the students have at the time of post-graduation. These Post Graduate Attributes identified by National Board of Accreditation are as follows:

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

### Program Educational Objectives

<table>
<thead>
<tr>
<th>PEO1</th>
<th>To train students with in-depth and advanced knowledge to become professional and capable of identifying, analyzing and solving complex problems in the areas of Manufacturing Engineering.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEO2</td>
<td>To enable post graduates to carry out innovative and independent research work, disseminate the knowledge in Academia/Industry/Research Organizations to develop systems and processes in the related field.</td>
</tr>
<tr>
<td>PEO3</td>
<td>To prepare the students to exhibit a high level of professionalism, integrity, effective communication skills and environmental and social responsibility.</td>
</tr>
<tr>
<td>PEO4</td>
<td>To provide an academic environment that gives adequate opportunity to the students to cultivate life-long independent learning ability for their successful professional career.</td>
</tr>
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</table>

### Program Outcomes

At the end of the program the student will be able to:

<table>
<thead>
<tr>
<th>PO1</th>
<th>Acquire, demonstrate and apply advanced knowledge in the area of manufacturing engineering.</th>
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</thead>
<tbody>
<tr>
<td>PO2</td>
<td>Identify problems in the field of manufacturing engineering, formulate them and solve by using advanced techniques.</td>
</tr>
<tr>
<td>PO3</td>
<td>Conduct independent research and generate new knowledge for the benefit of community, society Industry and country.</td>
</tr>
<tr>
<td>PO4</td>
<td>Apply various numerical methods, advanced software and engineering tools to model, analyze and solve manufacturing engineering problems.</td>
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<tr>
<td>PO5</td>
<td>Work effectively in interdisciplinary teams for solving real life problems in the related field.</td>
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<td>PO6</td>
<td>Apply engineering and scientific principles for the effective management of manufacturing systems.</td>
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<td>PO7</td>
<td>Effectively communicate through technical reports, presentations and scientific publications with the engineering community as well as society at large.</td>
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<tr>
<td>PO8</td>
<td>Demonstrate traits of management in handling engineering projects, related finance, and coordinate with workforce towards achieving goals.</td>
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<tr>
<td>PO9</td>
<td>Demonstrate high level of professional and intellectual integrity, ethics of research and scholarly standards.</td>
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<td>PO10</td>
<td>Examine critically the outcomes of one’s actions and make corrective measures subsequently.</td>
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<tr>
<td>PO11</td>
<td>Demonstrate the ability to work in team in the laboratory in achieving multidisciplinary tasks required for the project.</td>
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<tr>
<td>PO12</td>
<td>Engage in life-long reflective and independent learning with high level of enthusiasm and commitment.</td>
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## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>PEO</td>
<td>Program Educational Objectives</td>
</tr>
<tr>
<td>PO</td>
<td>Program Outcomes</td>
</tr>
<tr>
<td>CO</td>
<td>Course Outcomes</td>
</tr>
<tr>
<td>L</td>
<td>No. of Lecture (Per Week)</td>
</tr>
<tr>
<td>T</td>
<td>No. of Tutorial (Per Week)</td>
</tr>
<tr>
<td>P</td>
<td>No. of Practical (Per Week)</td>
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<td>C</td>
<td>Total number of credits</td>
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<tr>
<td>BSH</td>
<td>Basic Science and Humanity</td>
</tr>
<tr>
<td>BSC</td>
<td>Basic Sciences Course</td>
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<td>PCC</td>
<td>Program Core Course</td>
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<tr>
<td>OE</td>
<td>Open Elective</td>
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Department of Mechanical Engineering  
Master of Technology  
(Manufacturing Engineering)  
Syllabus effective from July 2017

**Semester-I**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMF101</td>
<td>Theory of Machining</td>
<td>03</td>
<td>1</td>
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<td>04</td>
</tr>
<tr>
<td>MMF102</td>
<td>CNC Technology</td>
<td>03</td>
<td>1</td>
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<td>04</td>
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<tr>
<td>MMF103</td>
<td>Advanced Joining Technology</td>
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<td>MMF104 A- MMF104N</td>
<td>Elective-I</td>
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<tr>
<td>MMF104 A- MMF104N</td>
<td>Elective-II</td>
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<td>03</td>
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<td>BH1101</td>
<td>Communication Skills</td>
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<tr>
<td>MMF105</td>
<td>PG Lab</td>
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**Total for Semester-I**  17 03 03 22

**List of Elective Courses**

**Elective (I &II) Semester I**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Course Code</th>
<th>Course Name</th>
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<tbody>
<tr>
<td>1.</td>
<td>MMF104A</td>
<td>Finite Element Method</td>
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<tr>
<td>2.</td>
<td>MMF104B</td>
<td>Machine Tool Design</td>
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<tr>
<td>3.</td>
<td>MMF104C</td>
<td>Sheet Metal Engineering</td>
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<tr>
<td>4.</td>
<td>MMF104D</td>
<td>Polymer Processing Technology</td>
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<td>5.</td>
<td>MMF104E</td>
<td>Advanced Tool Design</td>
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<tr>
<td>6.</td>
<td>MMF104F</td>
<td>Surface Engineering</td>
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<td>7.</td>
<td>MMF104G</td>
<td>Hydraulic, Pneumatic and Fluidic Control</td>
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<td>8.</td>
<td>MMF104H</td>
<td>Quality Control and Reliability</td>
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<td>9.</td>
<td>MMF104I</td>
<td>Processing of Advanced Materials</td>
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<td>10.</td>
<td>MMF104J</td>
<td>Management Information Systems</td>
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<tr>
<td>11.</td>
<td>MMF104K</td>
<td>Technology and Knowledge Management</td>
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<td>12.</td>
<td>MMF104L</td>
<td>Manufacturing Planning and Control</td>
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<tr>
<td>13.</td>
<td>MMF104M</td>
<td>Additive Manufacturing</td>
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<td>14.</td>
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### Semester-II

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<td>MMF202</td>
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<td>MMF203A – MMF203P</td>
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### List of Elective Courses

#### Elective (III and IV) Semester II

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<tr>
<td>1.</td>
<td>MMF203A</td>
<td>Ultra-Precision Machining</td>
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<td>MMF203B</td>
<td>Lean Manufacturing</td>
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<td>3.</td>
<td>MMF203C</td>
<td>Sensors for Intelligent Manufacturing and Monitoring</td>
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<tr>
<td>4.</td>
<td>MMF203D</td>
<td>Knowledge Based Systems in Manufacturing</td>
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<td>5.</td>
<td>MMF203E</td>
<td>World Class Manufacturing</td>
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<td>6.</td>
<td>MMF203F</td>
<td>Robotics</td>
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<td>MMF203I</td>
<td>Metrology and Computer Aided Inspection</td>
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<td>MMF203J</td>
<td>Mechatronics</td>
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<td>11.</td>
<td>MMF203K</td>
<td>Processing and Characterization Techniques</td>
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<td>MMF203L</td>
<td>Micro-Nano Engineering</td>
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<td>13.</td>
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<td>Numerical Methods and Computational Techniques</td>
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<td>16.</td>
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#### Elective-V (Open Elective) Semester-II

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<td>2.</td>
<td>MMF204 OE</td>
<td>Design of Experiments</td>
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<td>3.</td>
<td>MMF204 OE</td>
<td>Advanced Optimization Techniques</td>
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### Semester-III

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<tr>
<td>MMF301</td>
<td>Project Management and Intellectual Property Rights</td>
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<td>MMF302</td>
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**Total for Semester III**

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**Total for Semester IV**

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Semester-I
Theory of Machining

<table>
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<th>Continuous Assessment</th>
<th>End-Semester Exam</th>
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<td>Marks</td>
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<td>20</td>
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Pre-Requisites: Engineering mathematics-I
Course Outcomes: At the end of the course the student will be able to:

<table>
<thead>
<tr>
<th>CO1</th>
<th>Classify conventional and non-conventional machining processes.</th>
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</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Understand mechanism of metal cutting.</td>
</tr>
<tr>
<td>CO3</td>
<td>Determine force, stress, temperature, tool life, tool wear in metal cutting.</td>
</tr>
<tr>
<td>CO4</td>
<td>Identify method of cutting fluid delivery, surface integrity evaluation and minimum cost and production time in metal cutting.</td>
</tr>
<tr>
<td>CO5</td>
<td>Describe the mechanism and mechanics of grinding processes.</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand mechanism, application, limitations and benefits of various non-conventional machining processes.</td>
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</tbody>
</table>

Mapping of course outcomes with program outcomes

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
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<th>PO10</th>
<th>PO11</th>
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</table>

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit 1

Unit 2
- Mechanics of Metal Cutting: Introduction, terms and definitions, chip formation, forces acting on the cutting tool and their measurement, specific cutting energy, plowing force and the “size effect”, The apparent mean shear strength of the work material, chip thickness, friction in metal cutting.
- Temperature in Metal Cutting: Heat generation in metal cutting, heat transfer in moving material, temperature distribution in metal cutting, the measurement of cutting temperatures.

Unit 3
- Tool life and tool Wear: Introduction, progressive tool wear, forms of wear in metal
cutting, the tool material, the work material.

- Cutting Fluid and Surface roughness: Cutting fluids, the action of coolants, the action of lubricants, application of cutting fluids, surface roughness.

**Unit 4**
- Economics of Metal Cutting Operation: Introduction, choice of feed, choice of cutting speed, tool life for minimum cost and minimum production time, estimation of factors needed to determine optimum conditions, example off a constant-cutting-speed operation, machining at maximum efficiency, facing operations, operations with interrupted cuts, economics of various tool materials and tool designs, machinability data systems.

**Unit 5**
- Grinding: Introduction, the grinding wheel, effect of grinding conditions on wheel behavior, determination of the density of active grains, testing of grinding wheels, analysis of the grinding process, thermal effects in grinding, cutting fluids in grinding, grinding wheel wear, nonconventional grinding operations.

**Unit 6**
- Nonconventional Machining Processes: Introduction, range of nonconventional machining processes, ultrasonic machining, water-jet machining, abrasive-jet machining, chemical machining, electrochemical machining, electrolytic grinding, electrical discharge machining, wire electrical discharge machining, laser beam machining, plasma arc machining, comparative performance of cutting processes.
- Surface integrity: Effect of machining on surface/subsurface, various types of surface alterations, assessment of surface integrity, concept of engineered surfaces.

**TEXTS/REFERENCES:**

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| Semester-I  
<table>
<thead>
<tr>
<th>CNC Technology</th>
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<tbody>
<tr>
<td><strong>MMF 102</strong></td>
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<tr>
<td><strong>CNC Technology</strong></td>
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<tr>
<td>Class Test</td>
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<tr>
<td>20 Marks</td>
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</table>

**Pre-Requisites:** Engineering mathematics-I

**Course Outcomes:** At the end of the course the student will be able to:

- **CO1** Understand how the Cartesian coordinate system relates to CNC Routing, Turning and Milling operations
- **CO2** Write simple part programs for the two axis CNC lathe and router and milling machines
CO3  Be introduced to master cam's machining software program.

CO4  Calculate speeds and feeds for CNC machining operations and Debug a CNC part programming.

CO5  Identify cutting tools used for milling turning and wood cutting operations

CO6  Simulate part programs on CNC machining simulation software.

Mapping of course outcomes with program outcomes

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
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<tbody>
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Course Contents:

Unit 1
- Introduction to Numerical Control in computer aided manufacturing, components of a CNC system, types of CNC systems, open loop and closed loop control systems.

Unit 2
- Drives and controls, interpolators, feedback devices, CNC machine constructional features.

Unit 3
- CNC design considerations, CNC turret punch press, tooling for CNC, APC, ATC, CNC machine accessories, advanced features of CNC systems.

Unit 4
- CNC part programming for turning and milling, post processors, CNC part programming with CAD-CAM.

Unit 5
- Conversational and graphics based software, solids based part programming, free form surface machining, simulation and verification of CNC programs, computer assisted part programming.

Unit 6
- Maintenance and installation of CNC systems, utilization of CNC machines.

TEXTS / REFERENCES:
6. CNC Turning machines ACE MICROMATIC operation and programming manual.
7. CNC Milling machine HASS operation and programming manual.

**Semester-I**  
**Advanced Joining Technology**

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**Pre-Requisites: None**

**Course Outcomes:** At the end of the course the student will be able to:

<table>
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<tr>
<th>CO1</th>
<th>Students will understand the theoretical aspects of welding technology in depth.</th>
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<tbody>
<tr>
<td>CO2</td>
<td>Students will be able to intelligently select the appropriate Modern welding process for an application.</td>
</tr>
<tr>
<td>CO3</td>
<td>Students will be able to describe the basic metallurgy of the melted and heat-affected zone of a metal or alloy</td>
</tr>
<tr>
<td>CO4</td>
<td>Students will be able to choose or adjust welding parameters and techniques to optimize the weldment properties.</td>
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<tr>
<td>CO5</td>
<td>Completion of the course successfully will lead to an international or at least a national level certification endorsing the proficiency of the student in the Course area.</td>
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**Mapping of course outcomes with program outcomes**

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<th>Course Outcomes</th>
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**Course Contents:**

**Unit 1**
- Introduction to metal joining processes, heat sources for joining of metals.

**Unit 2**
- Modern welding processes like EBW, LBW, USW, diffusion bonding etc.

**Unit 3**
- Pulsed current welding processes, welding of ceramics, plastics, composites, joint design and design of weldments.
Unit 4
- Metallurgy of welding, heat treatment, residual stresses and stress relief methods.

Unit 5
- Failure of welds, NDT of welds, inspection codes for weldments.

Unit 6
- Introduction to adhesive bonding, soldering and brazing.

TEXTS / REFERENCES:

Semester-I
Finite Element Methods

<table>
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<th>MMF104A</th>
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Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

| CO1 | Understand the basics principle of FE method |
| CO2 | Identify mathematical model for solution of common problems |
| CO3 | Solve structural, thermal problem using FE in 1D Case |
| CO4 | Derive element stiffness matrix by different methods |
| CO5 | Understand the formulation for 2D and 3D case |
| CO6 | Recognize need for and engage in lifelong learning |

Mapping of course outcomes with program outcomes

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<th>Course Outcomes</th>
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12
Course Contents:

Unit 1
- 1-D Problems: Introduction to structural analysis and FEM, Introduction to approximate solutions and FEM, summary of linear elastic mechanics.

Unit 2
- 1-D Problems: Principles of linear elastic mechanics, principles of virtual displacements and minimum potential energy, Rayleigh Ritz method, exact v/s approximate solution, beam elements.

Unit 3
- 2-D Problems: Plane stress and plane strain conditions, triangular elements, constant strain triangle, linear strain triangle, Boundary conditions, body forces and stress recovery, quadrilateral elements.

Unit 4
- 2-D Problems: Lagrange and Serendipity shape functions, isoparametric formulation, numerical integration, modeling with isoparametric elements, requirements for convergence, patch test, nonconforming elements, reduced integration.

Unit 5
- 3-D Problems: Axisymmetric solids, governing equations, axisymmetric elements and their applications, mixed formulations, bending of flat plates (Kirchhoff Theory), continuity requirements and boundary conditions.

Unit 6
- 3-D Problems: Discrete Kirchhoff’s elements, thick plate elements, plate bending applications, shells as assemblage of flat plates, finite element formulation for dynamic problems, mass properties, introduction to elastic stability for frames and plates.

TEXTS / REFERENCES:
7. O.P., Goptha, Finite and Boundary Element Methods in Engineering; Oxford and IBH.
Semester-I
Machine Tool Design

<table>
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<th>MMF104B</th>
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Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

- CO1: Study kinematics of various machine tools.
- CO2: Understand principles of various machine tool feed and speed drives.
- CO3: Design power screws, sideways and machine tool spindle with bearings.
- CO4: Design structure and other auxiliary mechanism of machine tool.
- CO5: Apply modular design aesthetics and ergonomics for machine tool.
- CO6: Study acceptance test of machine tools and methods of machine tool condition.

Mapping of course outcomes with program outcomes

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Course Contents:

Unit 1
- Introduction to metal cutting machine tools- criteria for the selection of operating capacity and design parameters, kinematics of machine tools.

Unit 2
- Basic principles of machine tool design, estimation of drive power, machine tool drives, electrical, mechanical and fluid drives, stepped and step less speed arrangements and systems.

Unit 3
- Design of machine tool spindles and bearings, design of power screws, design of slide ways, selective and pre-selective mechanisms.

Unit 4
- Machine tool structures-beds, columns, tables and supports, stock feed mechanism, Measurement and control of machine tools, protective and safety devices, design of precision machine tools.
Unit 5
- Micro-feeding mechanisms, concept of modular design and integration of SPM’s, Concepts of aesthetic and ergonomics applied to machine tools.

Unit 6
- Acceptance tests standardization of machine tools, machine tool conditioning, latest trends in machine tool design, introduction to CAD techniques.

TEXTS / REFERENCES:

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Semester-I
Sheet Metal Engineering

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Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

| CO1 | Understand the applications of sheet metal processes |
| CO2 | Predict he spring back in metal forming products |
| CO3 | Understand the presses used in metal forming |
| CO4 | Describe the computer aided metal forming |
| CO5 | Draw the forming limiting diagrams |

Mapping of course outcomes with program outcomes

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Course Contents:

Unit 1
- Production of high quality sheet metal and control of its properties during processing.
Unit 2
- Basic applications: shearing processes like blanking, piercing, and punching.

Unit 3
- Drawing processes like shallow and deep drawing of cylindrical and rectangular bodies forming and bending including estimation and control of spring back.

Unit 4
- Computer applications in sheet metal with particular reference to nesting, tool selection and process planning, die design with special reference to compound and progressive dies.

Unit 5
- Equipment for sheet metal working: mechanical and hydraulic presses, design features and force diagrams.

Unit 6
- Formability studies: forming limit diagrams, their creation and use, soft tool processes: hydro-forming analysis and applications.

TEXTS / REFERENCES:

Semester-I
Polymer Processing Technology

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</table>

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

| CO1 | Classify various plastics and polymers for product design. |
| CO2 | Select suitable plastics using design requirements and mould flow analysis |
| CO3 | Understand plastics moulding mechanism in injection, blow, transfer, compression methods, |
| CO4 | Study plastics sheet and film manufacturing using extension and machining and |
joining methods.

CO5 Explain bending and forming of plastics part using unconventional processes

CO6 Identify various testing methods and finishing and decoration of polymer parts.

Mapping of course outcomes with program outcomes

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Course Contents:

Unit 1
- Properties of polymers: Physical, chemical, electrical and mechanical properties of plastics, thermal properties- types of plastics, thermosets and elastomers.
- Additives, fillers and reinforcement materials, liquid crystal polymers, engineering and mechanical plastics.

Unit 2
- Design of products: selection of plastics based on product requirement-reinforcing methods, aesthetic design, Stress strain in plastic components, design limitations-CAD/CAM application in product design by modeling, mold flow analysis.

Unit 3
- Molding of components: design of moulds, selection of material mould design for compression, injection and blow molding.
- Design of runner gate nozzle and cores, transfer molding coloring, texturing, rotational molding and casing of thermosets plastic molding machine injection, compression and blow molding machines.

Unit 4
- Extrusion of plastics: Design of extrude screw-barrel break plate die profile design pooling and take off equipment, PPE, sheet and film manufacture, thermoforming and thermoforming processes, Packaging applications
- Machining and joining of plastics: Machining of plastics by turning, drilling, milling and cutting parameters.

Unit 5
- Bending and forming of plastic components, jigs used, joining of plastics-adhesives, Solvents-cements-elastomeric cements, thermosetting adhesives, hot gas welding, spin welding and induction welding
- Unconventional processing methods: ultrasonic welding, ultrasonic assembly, ultrasonic stacking, heat sealing, thermal heat sealing and dielectric sealing, testing and quality control: melt index test, spiral flow test, volume change test, differential scanning calorimetry.
Unit 6
- Thermo gravimetric analysis, thermo mechanical analysis, radiography, liquid penetrates, acoustics, photo elastic stress analysis.
- Finishing and decoration of plastic products: surface appearance, surface modification, washing, solvent cleaning and etching, chemical etching, screen printing, ink printing, laser marking, dying embossing and surface texturing, grinding and polishing.

TEXTS / REFERENCES:

Semester-I
Advanced Tool Design

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</table>

Pre-Requisites: None

Course Outcomes: At the end of the Course the student will be able to:

- CO1 Define tooling’s for different types of production systems.
- CO2 Understand jigs and fixture design and their elements.
- CO3 Design fixture for machining, welding and inspection using forces.
- CO4 Design special tooling’s for advanced manufacturing.
- CO5 Study cost analysis, maintenance and CAD of tools.
- CO6 Apply software knowledge for design of tools.

Mapping of course outcomes with program outcomes

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
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</table>
Course Contents:

Unit 1
- Influence of tooling on quality and productivity, requirement of tooling for flexible, small lot production with constraints on lead time.

Unit 2
- Jigs and fixtures: basic principles of locating, development of fixture using locating, clamping, indexing tool setting elements.

Unit 3
- Force analysis- standardization of elements, illustrative examples of machining, welding, assembly, and inspection fixtures.

Unit 4
- Design of special tooling (form cutters, broaches etc.) tooling for CNC, development of modular fixtures and tools, flexi tools, etc. innovative concepts like tooling or fragile parts, plastics for tooling etc.

Unit 5
- Manufacture and maintenance of tools, technology and management of a tool room, cost estimation and cost benefit analysis, CAD of tools: customization of CADD.

Unit 6
- Tool design software, parametric programming of tool libraries, mechanistic analysis, use of finite element methods, techniques for integration of part modeling, tool design and tool manufacture.

TEXTS / REFERENCES:

Semester-I
Surface Engineering

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Pre-Requisites: None
**Course Outcomes:** At the end of the course the student will be able to:

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**Mapping of course outcomes with program outcomes**

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**Course Contents:**

**Unit 1**
- **Introduction**
  Definition, Significance, Role of surface Engineering in creating high performance product, Functional characteristics of a surface, Nature of surfaces: Deformed layer, Beilby layer, chemically reacted layer, Physisorbed layer, Chemisorbed layer; Classification of Surface Engineering Techniques

**Unit 2**
- **Surface Preparation Techniques**
  Factors affecting selection of cleaning process, Significance of surface preparation, Classification of cleaning processes, Chemical cleaning processes; Mechanical Processes; Substrate considerations, Surface contaminants or soils: Various types and their removal, Tests for cleanliness.

**Unit 3**
- **Surface Integrity**
  Definition, Importance, Surface alterations, Factors in Surface Integrity: Visual, Dimensional Residual stress, Tribological, Metallurgical; Measuring Surface Integrity effects: Minimum and Standard data set, Macroscopic and microscopic examination.

**Unit 4**
- **Surface Modification Techniques**
  Classification, Thermal treatments: Laser and electron beam hardening, Mechanical treatments: Short peening: Peening action, surface coverage and peening intensity, Types and sizes of media, Control of process variables, equipment; Ion Implantation: Basic Principle, Advantages and disadvantages, equipment.
Unit 5
- **Surface Coating Techniques**
  Thermal Spraying: Types and applications; Chemical Vapor Deposition: Principles, Reactions, Types and applications; Physical Vapor Deposition: Basic principle, Evaporation, Sputtering, Ion Plating, Applications; Electroplating: Principle of working and applications; Types of Coatings: Hard, Soft, Single layer, Multi-layer.

Unit 6
- **Characterization of Coatings**

**TEXT/REFERENCES:**
1. ASM Handbook, Volume 5: Surface Engineering, ASM International
2. Budinski K. G.; Surface Engineering for Wear Resistance; Prentice Hall
5. ASM Handbook, Volume 16: Machining, ASM International

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**Semester-I**
**Hydraulic, Pneumatic and Fluidic Control**

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**Pre-Requisites:** None
**Course Outcomes:** At the end of the course, the student will be able to:

- **CO1** Understand the type of control system and their utility
- **CO2** Describe the hydraulic power generation
- **CO3** Design pneumatic and hydraulic circuits for a given application
- **CO4** Discuss steady state operating forces, transient forces and valve instability
- **CO5** Design of pure fluid digital elements, Lumped and distributed parameter fluid systems

**Mapping of course outcomes with program outcomes**

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21
### Course Contents:

**Unit 1**
- Introduction to control system, types of control system and their utility.

**Unit 2**
- Hydraulic power generation and transmission, valve control pressure flow relationship and constructions.

**Unit 3**
- Steady state operating forces, transient forces and valve instability.

**Unit 4**
- Circuit design, pneumatic valves, hydraulic and pneumatic drives, introduction to fluidic devices and sensors, servo hydraulics.

**Unit 5**
- Lumped and distributed parameter fluid systems, fluid mechanics of jets, wall attachment and vortex devices.

**Unit 6**
- Pure fluidic analog amplifiers, analog signal control techniques, design of pure fluid digital elements. Maintenance and trouble shooting.

### TEXTS / REFERENCES:

### Semester-I
**Quality Control and Reliability**

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**Pre-Requisites:** None

**Course Outcomes:** At the end of the course the student will be able to:

- CO1: Study various approaches of quality
- CO2: Understand kaizen, Deming and Juran’s quality control policies.
Mapping of course outcomes with program outcomes

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Course Contents:

Unit 1
- Introduction: New culture of TQM, TQM axioms, consequences of total quality managing, cost of total quality, valuable tools for quality, the Japanese factor.
- The Deming Approach to management: Historical background, Deming’s fourteen points for management, deadly sins & diseases, implementing the Deming’s philosophy, Deming on management.
- Juran on Quality: Developing a habit of quality, Juran’s quality trilogy, the universal breakthrough sequence, JuranVs Deming.

Unit 2
- Crosby & the Quality Treatment: Crosby diagnosis of a troubled company, Crosby’s quality vaccine, Crosby’s absolutes for quality management, Crosby’s fourteen steps for quality improvement.
- Imai’s Kaizen: The concept, Kaizen & innovation, the Kaizen management practices, Kaizen & Deming.

Unit 3
- Design & Analysis of Experiments: Introductions, factorial experiments, aliasing, constructing fractional designs, analysis of variance.

Unit 4
- Supporting of Quality Improvement Processes: Affinity diagram, bar chart, block diagram, brainstorming, cause and effect analysis, control charts, cost benefit analysis, customer-supplier relationship check list, decision analysis, flow charts, force field analysis, line graph/run charts, pareto analysis, quality costing, quality function development (QFD),
quality project approach & problem solving process, risk analysis scatter diagrams, Weibull analysis, 6 Sigma.

Unit 5
- Statistical Process Control: Introduction, data collection plan, variables charts, attributes, interpreting the control charts.
- Taguchi’s Approach to Experimental Design & Offline Quality Control: Introduction, background to the method, Taguchi’s recommended design techniques, from Deming to Taguchi & vice-versa.

Unit 6
- Reliability: Introduction, life cycle curves & probability distribution in modeling reliability, system reliability, operating characteristic curves, reliability and life testing plans.

TEXTS / REFERENCES:
1. N.Logothetis, Managing for Total Quality From Deming to Taguchi and SPC , Prentice Hall of India, New Delhi, 2005.

Semester-I
Processing of Advanced Materials

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Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

| CO1 | Understand the advanced materials and their applications |
| CO2 | Describe the manufacturing methods for GFRP composites |
| CO3 | Explain the manufacturing methods for MMC and CMC composites |
| CO4 | Identify the difficulties in machining of advanced materials |
| CO5 | Understand the application of High speed machining for advanced materials |

Mapping of course outcomes with program outcomes

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</table>
Detailed Syllabus:

Unit 1
- Advanced materials such as ceramics and glasses, polymers, composites, their properties and applications, non-ferrous alloys and their properties and applications, special alloys, shape memory alloys.

Unit 2
- Polymers and polymerization, structure and properties of thermoplastics and thermosets, engineering applications, property modifications, mechanical thermal behaviours, composites with polymer matrix, ceramics, glasses.

Unit 3
- Glass ceramics, fabrication methods, metal matrix and ceramic matrix composites,

Unit 4
- Machining (traditional and non-traditional) of composite materials such as MMC, GFRP, nickel alloys, refractory metals, powder metallurgy materials.

Unit 5
- Processing of polymers, fabrication of composites, processing of ceramics, super plastic forming.
  Application of non-traditional machining processes such as EDM, USM, AJM, AFM, LBM, EBM.

Unit 6
- Plasma machining, high speed machining etc. to the above advanced materials with special emphasis on mechanism of material removal, characteristic features and applications in each case. Recent trends and prospects.

TEXTS / REFERENCES:
Semester-I
Management Information Systems

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Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

| CO1 | Determine key terminologies and concepts including IT, marketing, management, economics, accounting, finance in the major areas of business. |
| CO2 | Design, develop and implement Information Technology solutions for business problems. |
| CO3 | Analysis of computing systems and telecommunication networks for business information systems. |
| CO4 | Understand ethical issues that occur in business, evaluate alternative courses of actions and evaluate the implications of those actions. |
| CO5 | Plan projects, work in team settings and deliver project outcomes in time. |

Mapping of course outcomes with program outcomes

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Course Contents:

Unit 1

Unit 2
Unit 3
• Telecommunication and Networks, Telecommunications and Networks, The Networked Enterprise, Telecommunications Network Alternatives

Unit 4

Unit 5
• Manufacturing and Service Systems Information systems for Accounting, Finance, Production and Manufacturing, Marketing and HRM functions, Enterprise Resources Planning (ERP), Choice of IT, Nature of IT decision, Managing Information Technology, Managing Global IT,

Unit 6
• Security and Ethical Challenges, Security and Ethical Challenges, Security and Ethical, and Societal Challenges of IT, Security Management of Information Technology, Enterprise and Global Management of Information Technology

TEXTS / REFERENCES

Semester-I
Technology and Knowledge Management

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Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

| CO1 | Define knowledge edge and classify drivers of knowledge management. |
| CO2 | Study the process of conversion from information to knowledge. |
| CO3 | Understand the different phases of knowledge management. |
| CO4 | Study different strategies to achieve successful knowledge management system. |
| CO5 | Explain infrastructural need and different layers for knowledge management. |
CO6 Study the measuring process of knowledge growth and failure and creating the knowledge management blueprint.

Mapping of course outcomes with program outcomes

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Course Contents:

Unit 1
- Introduction: Knowledge & necessity of Knowledge, KM’s value proposition, behind the buzz, assumptions about your company.
- The Knowledge Edge: A common theme, intellectual capital, knowledge, market value, and prosperity, the 24 drivers of KM, knowledge centric drivers, technology drivers, organizational structure based, drivers, personnel focused drivers, process drivers, economic drivers, creating the knowledge edge.

Unit 2
From Information to Knowledge: From data to information to knowledge, from data to knowledge, classifying knowledge, the three fundamental steps, knowledge management systems and existing technology, taming the tiger’s tail, business and knowledge.

Unit 3
- The 10-Step Knowledge Management Road Map: The 10 step knowledge management road map, phase1: infrastructural evaluation, phase2: knowledge management system analysis, design, and development, phase3: deployment, phase4: matrices for performance evaluation.

Unit 4
- The Leveraged Infrastructure: The approach leverage, leverage, leverage, leveraging the internet, enabling technologies for the knowledge management, technology framework, knowledge server.
- Aligning Knowledge management and Business Strategy: From strategic programming to strategic planning, codification or personalization, knowledge maps to link knowledge to strategy, strategic imperatives for a successful km system, assessing focus.

Unit 5
- Infrastructural Foundations: Technology components of the km architecture, the seven-layer km system architecture, foundation for the interface layer, the web or notes? collaborative intelligence and filtering layer, audit knowledge.
- Knowledge Audit and Analysis: Measuring knowledge growth, the knowledge audit team, choosing your company’s k-spots, sources of expertise, team composition and
selection criteria, team life span and sizing issues, the knowledge management project leader, the km team’s project space, points of failure.

Unit 6

- Creating Knowledge Management Blueprint: Analyzing lost opportunities, the knowledge management architecture, components of a knowledge management system, designing integrative and interactive knowledge applications, interoperability considerations, performance and scalability, user interface design consideration, a network view of the km architecture, future-proofing the knowledge management system

TEXTS / REFERENCES:


Semester-I

Manufacturing Planning and Control

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Pre-Requisites: Basic mechanical engineering, Engineering graphics

Course Outcomes: At the end of the course the student will be able to:

| CO1 | Apply the systems concept for the design of production and service systems. |
| CO2 | Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques. |
| CO3 | Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources. |
| CO4 | Understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand circumstances. |
| CO5 | Understand the lot sizing and production scheduling. |
| CO6 | Study about quality planning, cost planning and control. |
Mapping of course outcomes with program outcomes

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Course Contents:

Unit 1
- Overview of manufacturing systems and various issues of interest: assembly line, repetitive batch manufacturing.

Unit 2
- Cellular manufacturing, FMS, JIT, CIM, preplanning: forecasting, economic analysis, aggregate planning, capacity planning, inventory planning.

Unit 3
- Decision making in design of manufacturing systems: group technology, line balancing, plant layout.

Unit 4
- Operations planning: MRP, MRP II, hierarchical planning systems, JIT systems.

Unit 5
- FMS Operation and control: lot sizing decisions, production scheduling, line of balance.

Unit 6
- Quality planning and control, cost planning and control, Simulation analysis of manufacturing systems, case studies.

TEXTS / REFERENCES:
Semester-I
Additive Manufacturing

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Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

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<td>CO4</td>
<td>Understand the applications of AM</td>
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<td>Apply the AM Processes bio-medical applications</td>
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Mapping of course outcomes with program outcomes

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Course Contents:

Unit 1
- **Introduction**

Unit 2
- **Geometric Model & Reverse Engineering**

Unit 3
**Liquid Based and Solid Based Additive Manufacturing Systems**

Unit 4
- **Powder Based Additive Manufacturing Systems**

Unit 5
• Rapid Casting and Segmental Object Manufacturing, Visible Slicing Implementation
  Rapid casting using wax patterns, acrylic patterns, dense polystyrene patterns - Expanded polystyrene process – Rapid manufacturing of metallic objects.

Unit 6
• Medical and Bio-Additive Manufacturing
  Customized implants and prosthesis, Design and production, Bio-Additive Manufacturing – Computer Aided Tissue Engineering (CATE) – Case Studies.

TEXT/REFERENCES:

Semester-I
Soft Computing Techniques

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Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

| CO1 | Classify different optimization and evolutionary algorithms. |
| CO2 | Apply optimization techniques to real life problems. |
| CO3 | Learn and apply neural network prediction algorithm to solve engineering problems. |
| CO4 | Understand and apply fuzzy based logic function for predicting results. |
| CO5 | Acquire and use knowledge of genetic algorithm to optimize real life problems. |
| CO6 | Study different hybrid soft computing methods and its applications. |

Mapping of course outcomes with program outcomes

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32
Unit 1
- **INTRODUCTION**
  Artificial Intelligence: Introduction, Various types of production systems, characteristics of production systems, breadth first search, depth first search techniques, other Search Techniques like hill Climbing, Best first Search, A* algorithm, AO* Algorithms and various types of control strategies. Knowledge representation issues, Prepositional and predicate logic, monotonic and non-monotonic reasoning, forward Reasoning, backward reasoning.

Unit 2
- **OPTIMIZATION CONCEPTS**
  Objective functions, constraints, Search space, local optima, global optima, fitness functions, search techniques, etc.

Unit 3
- **NEURAL NETWORKS**

Unit 4
- **FUZZY LOGIC**
Unit 5
• **GENETIC ALGORITHM**

Unit 6
• **HYBRID SOFT COMPUTING TECHNIQUES & APPLICATIONS**

**TEXTS/REFERENCES:**

**Semester-I**
Communication Skills

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**Pre-Requisites:** None

**Course Outcomes:** At the end of the course, the student will be able to:

- CO1: Students are found to be confident while using English
- CO2: Engage in analysis of speeches or discourses and several articles
- CO3: Identify and control anxiety while delivering speech
- CO4: Write appropriate communications(Academic/Business)
- CO5: Prepared to take the examinations like GRE/TOFEL/IELTS
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**Course Contents:**

**Unit 1:**
- **Communication and Communication Processes**
  Introduction to Communication, Forms and functions of Communication, Barriers to Communication and overcoming them, Verbal and Non-verbal Communication, Ways of Effective Communication.

**Unit 2:**
- **Oral Communication**

**Unit 3:**
- **Study of Sounds in English**
  Introduction to phonetics, Study of Speech Organs, Study of Phonemic Script, Articulation of Different Sounds in English, Stress Mark.

**Unit 4:**
- **English Grammar**
  Grammar: Forms of Tenses, Articles, Prepositions, Use of Auxiliaries and Modal Auxiliaries, Synonyms and Antonyms, Common Errors, Sentence Formation and Sentence Structures, Use of Appropriate Diction.

**Unit 5:**
- **Writing Skills**

Unit 6:
- **Reading Skills & Listening Skills**
  - **Reading**: Introduction to Reading, Barriers to Reading, Types of Reading: Skimming, Scanning, Fast Reading, Strategies for Reading, Comprehension.
  - **Listening**: Importance of Listening, Types of Listening, Barriers to Listening.

**TEXTS/REFERENCE:**

---

**Semester-I**

**Manufacturing Engineering Laboratory**

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**Pre-Requisites:** None

**Course Outcomes:** At the end of the course, the student will be able to:

- CO1: Measure cutting forces in turning, milling and drilling operations
- CO2: Modelling of machine components using software like ANSYS, LSDYNA
- CO3: Experiment on EDM, PCM, Wire EDM
- CO4: Design a Pneumatic circuit for a given application
- CO5: Optimize the machining processes
- CO6: Experiment on CMM, Robotics and PROCAST

**Mapping of course outcomes with program outcomes**

<table>
<thead>
<tr>
<th>Course Outcomes</th>
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<td>CO6</td>
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**Continuous Assessment:** 25 Marks

**Exam:** 25 Marks

**Total:** 50 Marks
Course Contents:
- Cutting force determination using force dynamometer in CNC Milling operation
- Cutting force determination using force dynamometer in CNC Turning operation
- Experimental study in micromachining using photo chemical machining
- Solid modeling of structural components using modeling software
- Solid modeling of machine components using modeling software
- Analysis of machine components using ANSYS, LSDyna etc. software
- Use of statistical quality control software for process optimization
- Study of EDM/Wire EDM for metal machining.
- Metal casting simulation using PROCAST.
- Sequencing of cylinders using pneumatic trainer kit.
- Modeling of component and determination of mass properties.
- Inspection of an engineering component using CMM.
- Simulation of robot.

Semester-II
Metal Forming Processes

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<td>Course Outcomes: At the end of the course, the student will be able to:</td>
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<tr>
<td>CO1</td>
<td>Understand theory of plasticity and yield criteria</td>
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<tr>
<td>CO2</td>
<td>Do the mathematical modeling of metal forming processes</td>
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<tr>
<td>CO3</td>
<td>Analyze metal forming processes</td>
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<tr>
<td>CO4</td>
<td>Design rolls for rolling, forging and extrusion</td>
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<tr>
<td>CO5</td>
<td>Describe the latest trends in metal forming</td>
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Mapping of course outcomes with program outcomes

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<td>CO5 3 1 1</td>
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</table>

Course Contents:

Unit 1
- Introduction to basic concepts, theory of plasticity, yield criteria (isotropic).
Unit 2
- Hot, cold, and warm working, bulk forming like rolling.

Unit 3
- Forging, extrusion and wire drawing, analytical techniques like upper bound equilibrium (slab).

Unit 4
- Slip line field analysis, forming tools, tools and dies for forging.

Unit 5
- Design of rolls for forging, design of rolls for rolling, extrusion dies.

Unit 6
- Latest trends: forming from mashy stage, isothermal forging, near-net-shape manufacturing.

TEXTS / REFERENCES:

**Semester-II**
*Casting and Moulding Technology*

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**Pre-Requisites:** None

**Course Outcomes:** At the end of the course the student will be able to:

| CO1      | Identify suitable casting processes and their working principles to manufacture products. |
| CO2      | Design and analyze the melt flow in mould gating and rise ring system. |
| CO3      | Understanding casting solidification phenomenon and identify various casting defects and their remedies. |
| CO4      | Classify different mould types for plastics product and understood polymerization and synthesis techniques. |
| CO5      | Understand different plastics processing methods and their working principles. |
| CO6      | Determine the plastic flow in mould, gating layout and cooling using analysis software. |
Mapping of course outcomes with program outcomes

<table>
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<th>Course Outcomes</th>
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**Course Contents:**

**Unit 1**
- Metal casting processes part and tool materials, foundry layout and equipment, patterns and cores.

**Unit 2**
- Melt flow: Flow in gating channels and mold cavity, fluidity, gating systems, flow analysis.

**Unit 3**
- Solidification: Heat transfer, shrinkage, feeding, growth structures, simulation, casting defects type: attributes, causes and remedies, inspection techniques, expert system.

**Unit 4**
- Plastics for molding types, chemical composition and structures, polymerization, synthesis techniques.

**Unit 5**
- Processing methods: calendaring, injection, compression, blow, extrusion and transfer molding, casting and reaction injection molding.

**Unit 6**
- Plastic flow in mold pressure and shear stress distribution, gating layout, cooling analysis, CAD/CAM for casting and molding: review of existing packages.

**TEXTS / REFERENCES:**
### Semester-II
#### Ultra-Precision Machining

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**Pre-Requisites:** None

**Course Outcomes:** At the end of the course the student will be able to:

| CO1 | Define ultra-precision machining, Nano-mechanical, Nano-chemical, Nano-physical and electro-chemical machining. |
| CO2 | Understand mechanism of Nano machining in atomic bit and cluster, Nano indentation and scratching. |
| CO3 | Study and understand mechanism of directional photon, electron, plasma, molecular beam processing. |
| CO4 | Explain mechanism of diamond turning and ultra-precision polishing and grinding |
| CO5 | Understand Nano physical and electrochemical processes. |
| CO6 | Study mechanical and optical measuring system for Nano machining. |

### Mapping of course outcomes with program outcomes

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### Course Contents:

**Unit 1:**

- **Introduction:** Definition of ultra-precision machining; Taniguchi curves of evolution of accuracy in the twentieth century; definition of Nanotechnology; Positional accuracy of today’s manufacturing processes and equipment; Deviational and scattering errors in achieving nanometric resolution. Atomic-bit and atomic cluster processing methods: Nano-mechanical, nano-physical and nano-chemical and -electrochemical processes, their capabilities and advantages.

**Unit 2:**

- **Mechanism of nano-mechanical processing of atomic clusters:** Processing stress, breaking stress and processing energy density; Concept of size effect in mechanical processing; thresholds of specific energy; Nano-machining, abrasive and adhesive processing, theories of nanometric processing of ductile and brittle materials, and polymers; Failure and fracture under uniform and localized loading; Atomic-bit processing and lattice defect density, theories of nano-indentation and scratching.
Unit 3:
- **Mechanism of nano-physical and -chemical processing of atomic-bits**: Scanning tunneling effect, directional photon, electron and ion beam processing, plasma surface processing, molecular beam processing; Principles of chemical and electro-chemical processing, equilibrium of chemical and electro-chemical reactions.

Unit 4:
- **Nano-processing systems (Nano-mechanical processing) - Diamond turning**: Soft metal single-point diamond turning technology, the ultra-precision CNC machine, plane and spherical mirrors machining; Nano-grinding: technology and requirements, concept of critical depth of cut, size-effect in form and fine grinding, Elid grinding, Elastic emission grinding; mechano-chemical polishing of Si wafers, principles and models; Ultra-precision polishing: Principles of ultra-precision polishing of block gauges, balls and aspherical lenses.

Unit 5:
- **Nano-processing systems (Nano-physical and -electrochemical processing)**: Photo beam processing: Thermal and chemical processes in photon beam ablation; Electron and ion beam processing: removal mechanism in electron and ion beam processing, abilities and limitations; scanning tunneling microscope (STM) processing; Chemically reactive milling and etching processes, Chemically reactive deposition and consolidation, electrochemical machining and deposition processes.

Unit 6:
- **Nano-measuring systems**: In-situ processes, mechanical and optical measuring systems, Scanning probe and image processing systems.

**TEXTS/REFERENCES:**

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### Semester-II

#### Lean Manufacturing

<table>
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**Pre-Requisites**: Machine design and Manufacturing processes-II

**Course Outcomes**: At the end of the course the student will be able to:

<table>
<thead>
<tr>
<th>CO1</th>
<th>Define lean manufacturing and Lean thinking concepts.</th>
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<tbody>
<tr>
<td>CO2</td>
<td>Understand philosophy and culture of Toyota production system.</td>
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</table>
CO3 | Learn value stream mapping in Lean manufacturing.
CO4 | Study various tools and techniques in lean manufacturing.
CO5 | Discuss the importance of problems in change process and training.
CO6 | Write the various applications of lean manufacturing process and follow-ups.

Mapping of course outcomes with program outcomes

<table>
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<td>CO6</td>
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</table>

Course Contents:

Unit 1.
- What is lean production? – Introduction, background, and lean thinking.

Unit 2.
- Importance of philosophy, strategy, culture, alignment, focus and systems view. Discussion of Toyota Production System.

Unit 3.

Unit 4.

Unit 5.

Unit 6.
- Startup of lean processes and examples of applications. Sustaining improvement and change, auditing, follow-up actions.

TEXTS/REFERENCES:
Semester-II
Sensors for Intelligent Manufacturing and Monitoring

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<tr>
<td>20 Marks</td>
<td>20 Marks</td>
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</table>

**Pre-Requisites:** Machine design and Manufacturing processes-II

**Course Outcomes:** At the end of the course the student will be able to:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Course Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the importance and need of sensors</td>
</tr>
<tr>
<td>CO2</td>
<td>Classify sensors based on different criterion</td>
</tr>
<tr>
<td>CO3</td>
<td>Know about the different sensor and its applications.</td>
</tr>
<tr>
<td>CO4</td>
<td>Apply knowledge of sensors in manufacturing process and condition monitoring</td>
</tr>
</tbody>
</table>

**Mapping of course outcomes with program outcomes**

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>PO1 2 PO2 1 PO3 1 PO4 1 PO5 1 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 1</td>
</tr>
<tr>
<td>CO2</td>
<td>PO1 2 PO2 1 PO3 1 PO4 1 PO5 1 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 1</td>
</tr>
<tr>
<td>CO3</td>
<td>PO1 2 PO2 1 PO3 1 PO4 1 PO5 1 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 1</td>
</tr>
<tr>
<td>CO4</td>
<td>PO1 2 PO2 1 PO3 1 PO4 1 PO5 1 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 1</td>
</tr>
</tbody>
</table>

**Course Contents:**

**Unit 1**
- Introduction-role of sensors in manufacturing automation.

**Unit 2**
- Principles of different sensors, electrical, optical, acoustic, pneumatic, magnetic, electro-optical and vision sensors.

**Unit 3**
- Condition monitoring of manufacturing systems: principles, sensors for monitoring force, vibration and noise.

**Unit 4**
- Selection of sensors and monitoring techniques, acoustic emission: principles and applications, concepts of pattern recognition.

**Unit 5**
- Sensors for CNC machine tools: linear and angular position and velocity sensors, Automatic identification techniques for shop floor control.

**Unit 6**
- Bar code scanners, radio frequency systems, optical character and machine vision sensors, smart/intelligent sensors, integrated sensors, adaptive control of machine tools.
TEXTS / REFERENCES:

Semester-II
Knowledge Based Systems in Manufacturing

<table>
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<th>MMF203B</th>
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<tr>
<td>20 Marks</td>
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<td>60 Marks</td>
<td>100 Marks</td>
<td></td>
</tr>
</tbody>
</table>

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

| CO1 | Define various knowledge bases and data bases for manufacturing. |
| CO2 | Study knowledge representing paradigms. |
| CO3 | Understand fuzzy logic and neural based systems in manufacturing. |
| CO4 | Study methods of knowledge acquisition and model in manufacturing. |
| CO5 | Design manufacturing application using expert coding languages. |
| CO6 | Analyze defect in processes planning and scheduling in manufacturing. |

Mapping of course outcomes with program outcomes

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1 2 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12</td>
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<tr>
<td>CO2 2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12</td>
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<td>CO3 2 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12</td>
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<td>CO4 2 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12</td>
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<td>CO5 2 PO6 PO7 PO8 PO9 PO10 PO11 PO12</td>
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<tr>
<td>CO6 2 PO7 PO8 PO9 PO10 PO11 PO12</td>
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</tbody>
</table>

Course Contents:

Unit 1
- Introduction, development of databases and knowledge bases.

Unit 2
- Knowledge representing paradigms-rule based, logic based, object oriented, semantic nets and frames.
Unit 3
- Uncertainty, fuzzy logic, neural nets, inference mechanisms: goals, control strategies, forward and backward chaining.

Unit 4
- Conflict resolution, explanation, blackboard model, implementation issues: knowledge acquisition.

Unit 5
- Coding, expert system shells, PROLOG and LISP, Selected applications in manufacturing, product design.

Unit 6
- Process planning and scheduling, robot movement, factory layout, defect analysis, diagnostic maintenance, quality control, etc.

TEXTS / REFERENCES:

Semester-II
World Class Manufacturing

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<th>Elective</th>
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</table>

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

| CO1 | Define challenges in world class manufacturing |
| CO2 | Study various world class manufacturing strategies. |
| CO3 | Understand total quality and employee involvement in manufacturing. |
| CO4 | Discuss different world class information system for change management. |
| CO5 | Identify various methods and processes for WCM using brain storming. |
| CO6 | Describe method to monitor performance in WCM. |

Mapping of course outcomes with program outcomes

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>PO1</th>
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<table>
<thead>
<tr>
<th>Pre-Requisites: None</th>
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</table>

Course Outcomes: At the end of the course the student will be able to:

| CO1 | Define challenges in world class manufacturing |
| CO2 | Study various world class manufacturing strategies. |
| CO3 | Understand total quality and employee involvement in manufacturing. |
| CO4 | Discuss different world class information system for change management. |
| CO5 | Identify various methods and processes for WCM using brain storming. |
| CO6 | Describe method to monitor performance in WCM. |

Mapping of course outcomes with program outcomes

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<tr>
<th>Course Outcomes</th>
<th>PO1</th>
<th>PO2</th>
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</table>
Course Contents:

Unit 1.

Unit 2.

Unit 3.

Unit 4.

Unit 5.
- Typical characteristics of WCM companies: Performance indicators – what is world class Performance – Six Sigma philosophy

Unit 6.
- Indian Scenario: Leading Indian companies towards world class manufacturing – Task Ahead.

TEXTS / REFERENCES:
1. World Class Manufacturing - Strategic Perspective - B.S. Sahay ,KBC Saxena , Ashish Kumar(Mac Millan)
3. The Toyota Way - Jeffrey K.Liker – (Tata Macgraw Hill )
4. Operations Management for Competitive Advantage – Chase
5. Making Common Sense Common Practice – Moore
6. Managing Technology & Innovation for Competitive Advantage – Narayanan
7. Just In Time Manufacturing – M.G.Korgaonkar
Semester-II
Robotics

<table>
<thead>
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</table>

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

- **CO1**: Study the manipulators and its kinematics.
- **CO2**: Classify the actuators and study their characteristics.
- **CO3**: Understand the motions of robots and its control.
- **CO4**: Determination of the solution to inverse kinematics and trajectory planning in robot movements.
- **CO5**: Acquire the knowledge of sensors used in robots.
- **CO6**: Write a program for robot motion and control.

Mapping of course outcomes with program outcomes

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>PO1</th>
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</table>

Course Contents:

**Unit 1**
- Introduction, construction of manipulators, advantages and disadvantages of various kinematic structures.

**Unit 2**
- Applications, actuators, pneumatic, hydraulic and electric, characteristics and control, non servo robots.

**Unit 3**
- Motion planning; feed back systems, encoders, servo control PTP and CP, Kinematics.

**Unit 4**
- Homogeneous so ordinates, solution of the inverse kinematic problem, multiple solutions, Jacobian, work envelopes, trajectory planning.
Unit 5
- Manipulator dynamics and force control, sensors: vision, ranging, laser, acoustic, tactile, developments in sensor technology.

Unit 6
- Sensory control, programming language: VAL, RAIL, AML. Mobile robots, walking robots, walking devices, robot reasoning.

TEXTS / REFERENCES:

Semester-II
Manufacturing Automation

<table>
<thead>
<tr>
<th>Course Code</th>
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<td>End-Semester Exam 60 Marks</td>
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</table>

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>PO1 3 PO2 2 PO3 2 PO4 2 PO5 1</td>
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<tr>
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<td>PO1 1 PO2 3 PO3 3 PO4 2</td>
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<td>CO3</td>
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</tr>
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<td>PO1 2 PO2 3 PO3 3</td>
</tr>
<tr>
<td>CO5</td>
<td>PO1 3 PO2 2 PO3 1 PO4 1</td>
</tr>
</tbody>
</table>

Mapping of course outcomes with program outcomes

Course Contents:

Unit 1
- Product cycle, manufacturing functions, types of automation, degree of automation, technical, economic and human factors in automation.
Unit 2
- Technologies- mechanical, electrical, hydraulic, pneumatic, electronic, hybrid systems, comparative evaluation.

Unit 3
- Development of small automation systems using mechanical devices, synthesis of hydraulic circuits.

Unit 4
- Circuit optimization techniques, illustrative examples of the above types of systems.

Unit 5
- Industrial logic control systems logic diagramming, programmable controllers.

Unit 6
- Applications, designing for automation, cost-benefit analysis.

TEXTS / REFERENCES:

Semester-II
Total Productive Maintenance

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Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>To increase the productivity of plant and equipment with a modest investment in maintenance.</td>
</tr>
<tr>
<td>CO2</td>
<td>Enhance knowledge of key operational activities of the quality management system</td>
</tr>
<tr>
<td>CO3</td>
<td>To know the causes for accelerated deterioration while production.</td>
</tr>
<tr>
<td>CO4</td>
<td>To identify then prioritize and eliminate the causes of the losses.</td>
</tr>
<tr>
<td>CO5</td>
<td>Employing consultants to create this culture is common practice.</td>
</tr>
</tbody>
</table>

Mapping of course outcomes with program outcomes

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
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</table>

49
Course Contents:

Unit 1
- Outline of TPM. Maintenance Concepts, Objectives and functions, Tero technology, Reliability Centered, Maintenance, (RCM), maintainability prediction, availability and system, effectiveness, organization for maintenance.

Unit 2
- TPM-challenging limits, maximizing equipment effectiveness, Maintenance Models, Minimal repair, maintenance types, balancing preventive maintenance, and breakdown maintenance, preventive maintenance schedules: deviations on target values, preventive maintenance schedules: functional characteristics, replacement models.

Unit 3
- Organizing for TPM implementation, PM Concepts, Importance of TPM, Zero breakdown concepts, Zero Defects and TPM, maximizing equipment effectiveness, autonomous maintenance program, five pillars of TPM, TPM Small group activities.

Unit 4
- TPM implementation and stabilization, TPM Planning and Implementation, Organization for TPM, management decision, awareness and training for TPM, establishment of basic policies and goals, formation of master plan, TPM implementation, Ongoing global trends in TPM.

Unit 5
- TPM small group activities, Maintenance Logistics, Human factors in maintenance, maintenance manuals, maintenance staffing methods, queuing applications, simulation, spare parts management, maintenance planning and scheduling.

Unit 6

TEXTS / REFERENCES:
1. Nahchi-Fujikoshi Corporation, Training For TPM, Japan Institute of Plant Maintenance, 1990.
Semester-II
Metrology and Computer Aided Inspection

<table>
<thead>
<tr>
<th>MMF203I</th>
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<th>Elective</th>
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<tr>
<td>20 Marks</td>
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</table>

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1 Explain high precision measurement requirements of industry and select instruments for high precision.</td>
<td>PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12</td>
</tr>
<tr>
<td>CO2 Using various measuring standards and instruments for different applications.</td>
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</tr>
<tr>
<td>CO3 Calibrate basic metrology instruments used in machine shop, and Identify techniques to minimize the errors in measurement.</td>
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</tr>
<tr>
<td>CO4 Employing limits and design gauges</td>
<td></td>
</tr>
<tr>
<td>CO5 Explain the different instruments used for linear and angular measurements, surface finish and form features of a component</td>
<td></td>
</tr>
<tr>
<td>CO6 Identify the advanced measurement principles with ease and operate sophisticated measurement machines.</td>
<td></td>
</tr>
</tbody>
</table>

Mapping of course outcomes with program outcomes

Course Contents:
Unit 1
- Metrological concepts, Abbe's principle, need for high precision measurements, problems associated with high precision measurements.

Unit 2
- Standards for length measurement, shop floor standards and their calibration, light interference, method of coincidence.
Unit 3
- Slip gauge calibration, measurement errors, various tolerances, and their specifications, gauging principles.

Unit 4
- Selective assembly, comparators, angular measurements, principles and instruments, gear and thread measurements.

Unit 5
- Surface and form metrology, computer aided metrology, principles and interfacing, software metrology, laser metrology, CMM, types, probes used applications.

Unit 6
- Non-contact CMM using electro-optical sensors for dimensional metrology, non-contact sensors for surface finish measurements, image processing and its applications in metrology.

TEXTS / REFERENCES:

Semester-II
Mechatronics

<table>
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<th>Elective</th>
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</table>

Pre-Requisites: Basic Electronics

Course Outcomes: At the end of the course, the student will be able to:

| CO1 | Define sensor, transducer and understand the applications of different sensors and transducers |
| CO2 | Explain the signal conditioning and data representation techniques |
| CO3 | Design pneumatic and hydraulic circuits for a given application |
| CO4 | Write a PLC program using Ladder logic for a given application |
| CO5 | Understand applications of microprocessor and micro controller |
| CO6 | Analyze PI, PD and PID controllers for a given application |

Mapping of course outcomes with program outcomes

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
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</thead>
<tbody>
<tr>
<td><strong>PO1</strong></td>
<td><strong>PO2</strong></td>
</tr>
<tr>
<td><strong>CO1</strong></td>
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</table>
Course Contents:

Unit 1
- Introduction to Mechatronic systems, elements, advantages and practical examples of Mechatronic systems.
- **Sensors and Transducers:**
  Various types of sensors and transducers used in Mechatronic system such as pressure sensors, temperature sensors, velocity sensors, Acceleration sensors, proximity sensors, position sensors, force sensors, Optical encoders, Capacitive level sensor, tactile sensors, Selection of sensors.

Unit 2
- **Signal Conditioning and Data Representation**
Types of electronic signals, Need for signal processing, Operational amplifiers: Types, classification and applications, Opto-isolators, Protection devices, Analogue to Digital and Digital to Analog Converters, Interfacing devices, Electro-magnetic Relays, Data representation systems, Displays, Seven segment displays, LCD displays, Printers, Data loggers, Data Acquisition Cards/Systems

Unit 3
- **Drives:**
- **Electrical Drives:** Types of Electrical Motors, AC and DC motors, DC servomotors, Stepper motors, linear motors, etc.
- **Pneumatics and Hydraulics**
  Hydraulic cylinders, design of cylinder, Design of Piston and piston rod, Valves, poppet valve, house pipes and design of tubing, Meter-in and Meter-out circuits.

Unit 4
- **Microprocessor and Microcontroller**
- 8085 microprocessor, architecture, various types of registers and their functions in 8085µP, Instruction sets, interfacing, applications. 8081 microcontroller, architecture, Instruction sets, various pins and their functions interfacing, applications.
- **Programmable Logic Controller**
  Introduction, Architecture, Types of inputs/outputs, Specifications, guidelines for Selection of PLCs, Programming: Ladder logic and FBD

Unit 5
- **Control Systems**
  Open and closed loop system; block diagram manipulation/reduction, Transfer function, modeling of Mechanical Systems using spring, Dashpot and Masse quivalence.

Unit 6
• **Stability of Systems**
  On/Off controller, Proportional Control, Integral control, Derivative Control; PI, PD and PID Controllers, Introduction to control using state variable system models, Bode Plots and stability criteria.

**TEXTS / REFERENCES:**

## Semester-II
**Processing and Characterization Techniques**

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**Pre-Requisites:** Materials Engineering

**Course Outcomes:** At the end of the course, the student will be able to:

- **CO1** Enhance knowledge on processing for different material.
- **CO2** To know the characteristic and properties after processing of material.
- **CO3** To know about latest characterization technique.
- **CO4** Enhance knowledge of thermal analysis technique
- **CO5** To examine fine detail using microscope

### Mapping of course outcomes with program outcomes

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<th>Course Outcomes</th>
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**Course Contents:**

**Unit 1**
- Processing: melting and casting, heat treatment, thermo-mechanical processing, sheet metal forming and welding.
Unit 2
- Structural characterization: phase transformation, electron microscopy, crystallography by using modern techniques. Properties: mechanical properties (like fatigue, fracture toughness, integrity assessment) relating to structure and processing, corrosion evaluation.

Unit 3
- Characterization Techniques: X-ray diffraction, crystal structure and phase identification, residual stress measurement and other applications.

Unit 4
- Outline of thermal analysis technique, description of DTA/DSC/TGA techniques and instrumentation, applications and case studies.

Unit 5

Unit 6

TEXTS / REFERENCES:
Semester-II
Micro - Nano Engineering

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**Pre-Requisites:** None

**Course Outcomes:** At the end of the course, the student will be able to:

- **CO1** To expose the students to the evolution of Nano systems, to the various fabrication techniques.
- **CO2** To impart knowledge to the students about nano materials and various nano measurements techniques.
- **CO3** To develop the student’s skills and knowledge in micro and nano-engineering.
- **CO4** To investigate molecular surface structures and their electronic properties.
- **CO5** To discuss the different modeling concepts of micro and nanostructures.

**Mapping of course outcomes with program outcomes**

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</table>

**Course contents:**

**Unit 1**

- **Introduction to micro and nano fabrication**
  Basic concepts of micro and Nanotechnology – Quantum wire – Quantum well – Quantum dot – fullerenes, Nanofabrication

- **Characterization of micro and nanostructures**

- **Zero and three dimensional micro and nanostructures**
  Nanoparticles through homogeneous nucleation growth- kinetically confined synthesis of nanoparticles-Classification of Nanoparticle Synthesis Techniques - Solid-State Synthesis of Nanoparticles

- **Fabrication of arrays of Si micro / nano structures based on atom lithography**
  Introduction to Atom Lithography based on Metastable atoms beam (MAB) and Self Assembled

- **Micro and nanostructure modeling**
  Studies on microstructure systems using atomistic and mesoscale simulations – Solid liquid phase-Graphene – Carbon nanotubes – Material processing by chemical vapor deposition and physical vapor deposition- applications of nanomaterials.
Unit 2
- Photolithography and its limitation-Electron-beam lithography (EBL)- Nanoimprint – Softlithography patterning.

Unit 3
- Tunneling Microscope (STM)-Surface enhanced Raman spectroscopy (SERS)- X-ray Photoelectron Spectroscopy (XPS)

Unit 4
- Mechanical alloying and mechanical milling - Vapor-Phase Synthesis of Nanoparticles - Inert Gas Condensation of Nanoparticles - Plasma-Based - Flame-Based - Spray Pyrolysis based Synthesis of Nanoparticles - Solution Processing of Nanoparticles - Sol-Gel Processing - Solution Precipitation

Unit 5
- Monolayer structures (SAMs) – Principle and procedure - Mechanism of forming SAMs on Si substrates.

Unit 6

TEXTS / REFERENCES:

Semester-II
Modeling and Simulation

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</table>
Course Contents:

Unit 1
- Introduction to systems and modeling – discrete and continuous system - Limitations of simulation, areas of application - Monte Carlo Simulation.

Unit 2
- Discrete event simulation and their applications in queueing and inventory problems.

Unit 3
- Random number generation and their techniques - tests for random numbers. Random variable generation.

Unit 4
- Analysis of simulation data. - Input modeling – verification and validation of simulation models – output analysis for a single model.

Unit 5
- Simulation languages and packages - FORTRAN, C, C++, GPSS, SIMAN V, MODSIM III, ARENA, QUEST, VMAP - Introduction to GPSS – Case studies.

Unit 6
- Simulation of manufacturing and material handling system, Case studies.

TEXTS / REFERENCES:
Semester-II
Numerical Methods & Computational Techniques

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**Pre-Requisites:** None

**Course Outcomes:** At the end of the course, student should be able to:

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**Mapping of course outcomes with program outcomes**

**Course Contents:**

**Unit 1**
- Introduction to Numerical Analysis: Objectives, Mathematical Modeling, Programming Concepts, MATLAB, Computational Accuracy, Precision, Truncation Errors, Taylor Series
- Curve fitting and Regression, Interpolation, Fourier Series concepts

**Unit 2**
- Roots of equations: Bisection, False position, Fixed Point Iteration, Newton-Raphson, Secant methods, Roots of polynomials
- Linear Algebraic Equations, Gauss Elimination

**Unit 3**
- Non-linear Systems of Equations, Gauss-Jordan, LU Decomposition and Matrix Inversion, Gauss-Seidel, Optimization concepts
Unit 4
- Numerical Integration: Trapezoidal and Simpson’s Rules, Gaussian Quadrature
- Numerical Differentiation and finite-difference approximations

Unit 5
- Ordinary Differential Equations: Euler’s and Runge-Kutta Methods, Boundary-Value, Eigen value and Eigen vector Problems

Unit 6
- Partial Differential Equations: Elliptic Equations, Laplace Equation and Boundary Conditions, Control Volume Approach, Parabolic Equations, Explicit and Implicit Methods, Crank-Nicolson, Introduction to Finite Element Methods

TEXTS / REFERENCES:

Semester-II
CAD-CAE

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Course Pre-requisites: Numerical Methods & Computational Techniques (PC3), Structured or Object Oriented Programming (FORTRAN / C / C++ / Java / VB )

Course Outcomes: At the end of the course, student should be able to:

CO1 Demonstrate - Polynomial and spline interpolation, Bezier curves, B-splines to surfaces representation, patches and composite surfaces.
CO2 Design and create Solid model assembly of thermal and fluid engineering system in CAD software.
CO3 Analyse simple Engineering problem by selecting appropriate Mesh generation.
## Mapping of course outcomes with program outcomes

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<th>Course Outcomes</th>
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</table>

### Course Contents:

**Unit 1**
- Overview of CAD Applications, Curves - Polynomial and spline interpolation, Bezier curves, B-splines, Introduction to surfaces representation, patches and composite surfaces
- Solid Modeling: Representation of Solids, Topology, Wireframe, Boundary representation (B-Rep), CSG, Solid modeling operations

**Unit 2**
- Computer Graphics: Mathematical principles for 2D and 3D visualization, Matrix transformations, Modeling, viewing, projection and rendering, OpenGL graphics library
- Meshing – Mesh topology, Data structures, Introduction to Mesh generation algorithms, Surface meshes, Element types and quality criteria

**Unit 3**
- CAD data formats and exchange, Hands-on lab sessions: Modeling and Meshing of Thermal and Fluid Flow equipment

**Unit 4**
- Computer Aided Engineering: Lab simulations for Thermal and Heat Transfer

**Unit 5**
- Computational Fluid Dynamics: Lab simulations for Fluid Flow

**Unit 6**
- Computer Aided Manufacturing - CAD/CAM data exchange, CAD/CAM integration,

### TEXTS / REFERENCES:
5. Peter Shirley, Michael Ashikhmin and Steve Marschner, Fundamentals of Computer
7. Hartmut Prautzsch and Wolfgang Boehm, Geometric Concepts for Geometric Design, A
K Peters/CRC Press, 1993
8. Computational Geometry for Design and Manufacture, Faux I. D. and Pratt M. J., Ellis
Horwood, 1980

Semester-II
Machine Learning Techniques

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Pre-Requisites: None
Course Outcomes: At the end of the course, student should be able to:

<table>
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<th>Course Outcomes</th>
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<tr>
<td>CO1 Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.</td>
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<tr>
<td>CO2 Perform evaluation of learning algorithms and model selection.</td>
<td>PO1 1 PO2 1 PO3 2 PO4 1 PO5 1 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 1</td>
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<tr>
<td>CO3 Apply knowledge representation, reasoning, and machine learning techniques to real-world problems</td>
<td>PO1 1 PO2 1 PO3 2 PO4 1 PO5 1 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 1</td>
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<td>CO4 Proficiency with a variety of classifier methods including decision trees, neural networks, naïve bayes learning, nearest neighbor methods.</td>
<td>PO1 1 PO2 1 PO3 2 PO4 1 PO5 1 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 1</td>
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<tr>
<td>CO5 Illustrate hybrid learning methods involving domain theories and adaptive learning methods, and create algorithm by using this.</td>
<td>PO1 1 PO2 1 PO3 2 PO4 1 PO5 1 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 1</td>
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<td>CO6 Apply this techniques to control and teach something to robot.</td>
<td>PO1 1 PO2 1 PO3 2 PO4 1 PO5 1 PO6 1 PO7 1 PO8 1 PO9 1 PO10 1 PO11 1 PO12 1</td>
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Mapping of course outcomes with program outcomes

Course Contents:
Unit 1
- **FOUNDATIONS OF LEARNING**
  9 Components of learning – learning models – geometric models – probabilistic models –

Unit 2
• **LINEAR MODELS 9**

Unit 3
• **DISTANCE-BASED MODELS 9**

Unit 4
• **TREE AND RULE MODELS 9**

Unit 5
• **REINFORCEMENT LEARNING 9**

**TEXTS/REFERENCES:**
Semester-II
Research Methodology

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Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

- CO1 Understand and Describe importance of research.
- CO2 Classify and select appropriate resources for Research.
- CO3 Analyze the contents of literature and identify further scope.
- CO4 Formulate a Research Problem.
- CO5 Develop effective written and oral Presentation skills.

Mapping of course outcomes with program outcomes

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Course contents:

Unit 1

Unit 2

Unit 3
- Hypothetical proposals for future development and testing, selection of Research task.

Unit 4
Unit 5

TEXTS/REFERENCES

Semester-II
Design of Experiments

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</table>

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

| CO1 | Define Taguchi, factorial experiments, variability, orthogonal array, quality loss. |
| CO2 | Plan and design the experimental investigations efficiently and effectively. |
| CO3 | Understand strategy in planning and conducting experiments. |
| CO4 | Evaluate variability in the experimental data using ANOVA. |
| CO5 | Practice statistical software to achieve robust design of experiments. |

Mapping of course outcomes with program outcomes

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Course Contents:

Unit 1
- Introduction: Modern quality control, quality in engineering design, history of quality engineering.
- The Taguchi Approach to quality: Definition of quality, loss function, off-line and on-line quality control, Taguchi’s quality philosophy.
Unit 2
- Full Factorial Designs: Experimentation as learning process, traditional scientific experiments, three factor design, replicating experiments, factor interactions, normal plots of estimated effects, mechanical plating experiments, two factor design, four factor design, Taguchi design and western design.

Unit 3
- Fractional Factorial Design: Fractional factorial design based on eight run experiments, folding over an eight run experimental design, Fractional factorial design in sixteen run, folding over an sixteen run experimental design, blocking two level designs, other two level designs.

Unit 4
- Evaluating Variability: Necessity to analyze variability, measures of variability, the normal distribution, using two level designs to minimize variability, signal-to-noise ratio, minimizing variability and optimizing averages.
- Taguchi Inner and Arrays: Noise factors, experimental designs for control and noise factors, examples.

Unit 5
- Experimental Design for Factors at Three and Four level: Necessity to use more than two level, factors at four levels, factors at three levels.
- Analysis of Variance in Engineering Design: Hypothesis testing concepts, using estimated effects as test statistics, analysis of variance for two level designs, when to use analysis of variance.

Unit 6
- Computer Software for Experimental Design: Role of computer software in experimental design, summery of statistical packages, example of use of software packages.
- Using Experiments to improve Processes: Engineering design and quality improvement, steps to implementing use of engineering design.

TEXTS / REFERENCES:
Semester-II
Advanced Optimization Techniques

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<td>End-Semester Exam</td>
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</table>

Prerequisite: None

Course Outcomes: At the end of the course the student will be able to:

| CO1 | Enables to acquire mathematical methods and apply in engineering disciplines. |
| CO2 | Apply methods of optimization to solve a linear, non-linear programming problem by various methods |
| CO3 | Optimize engineering problem of nonlinear-programming with/without constraints, by using this techniques |
| CO4 | Use of dynamic programming problem in controlling in industrial managements. |
| CO5 | Simulate Thermal engineering system problem. Understand integer programming and stochastic programming to evaluate advanced optimization techniques. |

Mapping of course outcomes with program outcomes

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Course Contents:

Unit 1
SINGLE VARIABLE NON-LINEAR UNCONSTRAINED OPTIMITION: One dimensional Optimization methods, Uni-modal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

Unit 2

Unit 3
DYNAMIC PROGRAMMING: Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic
programming, production inventory. Allocation, scheduling replacement.

**Unit 4**
**LINEAR PROGRAMMING**: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints.


**Unit 5**
**INTEGER PROGRAMMING**: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

**STOCHASTIC PROGRAMMING**: Basic concepts of probability theory, random variables distributions – mean, variance, Correlation, co variance, joint probability distribution stochastic linear, dynamic programming.

**TEXTS/REFERENCES:**
1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan & Kumar/Springar
4. Operation Research/H.A. Taha/TMH
5. Optimization in operations research/R.L Rardin
6. Optimization Techniques/ Benugundu & Chandraputla/Person Asia
7. Optimization Techniques / Benugundu & Chandraputla / Pearson Asia

**Semester-III**
**Project Management and Intellectual Property Rights**

<table>
<thead>
<tr>
<th>MMF301</th>
<th>Project Management and Intellectual Property Rights</th>
<th>PCC</th>
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<td>End-Semester Exam 50 Marks</td>
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</table>

**Pre-Requisites: None**

**Course Outcomes**: At the end of the course the student will be able to:

<table>
<thead>
<tr>
<th>CO1</th>
<th>Enumerate and demonstrate fundamental terms such as copy-rights, Patents, Trademarks etc.,</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration Processes to register own project research.</td>
</tr>
<tr>
<td>CO3</td>
<td>exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms’ commercial strategies.</td>
</tr>
<tr>
<td>CO4</td>
<td>Develop awareness at all levels (research and innovation) of society to develop patentable technologies.</td>
</tr>
<tr>
<td>CO5</td>
<td>Apply trade mark law, copy right law, patent law and also carry out intellectual property audits</td>
</tr>
</tbody>
</table>
CO6 | Manage and safeguard the intellectual property and protect it against unauthorized use

Mapping of course outcomes with program outcomes

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
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<td>CO6</td>
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</table>

Course Contents:

A. Project Management:

Unit-1

Unit-2
- Developing Project Plan (Baseline), Project cash flow analysis, Project scheduling with resource constraints: Resource Leveling and Resource Allocation. Time Cost Trade off: Crashing Heuristic.

Unit-3

B. IPR:

Unit-4
- Introduction to IPR; Overview & Importance; IPR in India and IPR abroad; Patents ;their definition; granting; infringement ;searching & filing; Utility Models an introduction;

Unit-5
- Copyrights ; their definition; granting; infringement ;searching & filing, distinction between related and copy rights; Trademarks ,role in commerce ,importance , protection, registration; domain names;

Unit-6
- Industrial Designs ; Design Patents; scope; protection; filing infringement; difference between Designs & Patents' Geographical indications , international protection; Plant varieties; breeder's rights, protection; biotechnology& research and rights managements;
licensing, commercialization; legal issues, enforcement; Case studies in IPR.

TEXT BOOKS/REFERENCES:
1. Shtub, Bardand Globerson, Project Management: Engineering, Technology, and Implementation, Prentice Hall, India

Semester -II
Seminar-I

<table>
<thead>
<tr>
<th>MMF205</th>
<th>Seminar-I</th>
<th>PCC</th>
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<td>50</td>
<td>50 Marks</td>
<td>Total 100 Marks</td>
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</table>

Pre-Requisites: Previously studied courses.
Course Outcomes: At the end of the course the student will be able to:

| CO1 | Identify and compare technical and practical issues related to the area of course specialization. |
| CO2 | Outline annotated bibliography of research demonstrating scholarly skills. |
| CO3 | Prepare a well organized report employing elements of technical writing and critical thinking. |
| CO4 | Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting. |

Mapping of course outcomes with program outcomes

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
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<tbody>
<tr>
<td>CO1</td>
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<td>CO3</td>
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</table>

Objective:
To assess the debating capability of the student to present a technical topic. Also, to impart training to a student to face audience and present ideas and thus creating self-esteem, self-confidence and courage that are essential for an engineer.

Individual students are required to choose a topic of their interest from Manufacturing Systems Management related topics preferably from outside the M.Tech syllabus or an extension of syllabus and give a seminar on that topic for about 30 minutes. The Seminar can also be a case study from a manufacturing organization. A committee consisting of at least three faculty members shall assess the presentation of the seminar and award marks to the
students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

**Semester-II**

**Mini Project**

<table>
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**Pre-Requisites:** Previously studied courses.

**Course Outcomes:** At the end of the course the student will be able to:

- CO1: Identify methods and materials to carry out experiments/develop code.
- CO2: Reorganize the procedures with a concern for society, environment and ethics.
- CO3: Analyze and discuss the results to draw valid conclusions.
- CO4: Prepare a report as per recommended format and defend the work.
- CO5: Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

**Mapping of course outcomes with program outcomes**

<table>
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<tr>
<th>Course Outcomes</th>
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**Objectives:**

To train students in identification, analysis, finding solutions and execution of live engineering and managerial problems. It is also aimed to enhance the capabilities of the students for group activities.

Individual students are required to choose a topic of their interest. The course content of the mini project shall be from emerging / thrust areas, topics of current relevance having research aspects or shall be based on industrial visits. Students can also choose live problems from manufacturing organisations as their mini project. At the end of the semester, the students should submit a report duly authenticated by the respective guide, to the head of the department.

Mini Project will have internal marks 50 and Semester-end examination marks 50.

Internal marks will be awarded by respective guides as per the stipulations given below.
Attendance, regularity of student (20 marks)
Individual evaluation through viva voce / test (30 marks)
Total (50 marks)

Semester end examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, before the committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.
Report = 25 marks
Concept/knowledge in the topic = 15 marks
Presentation = 10 marks
Total marks = 50 marks

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**Semester-III**

**Masters Research Project (Phase – I)**

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**Pre-Requisites:** Previously studied courses.

**Course Outcomes:** At the end of the course the student will be able to:

- **CO1** Identify methods and materials to carry out experiments/develop code.
- **CO2** Reorganize the procedures with a concern for society, environment and ethics.
- **CO3** Analyze and discuss the results to draw valid conclusions.
- **CO4** Prepare a report as per recommended format and defend the work
- **CO5** Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

**Mapping of course outcomes with program outcomes**

<table>
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<tr>
<th>Course Outcomes</th>
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**Objective:**
To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.
The project work can be a design project, experimental project, computer simulation project or an empirical study involving data collection and analysis from manufacturing organisations. The topic should be on Manufacturing Systems Management or any of the topics related with Manufacturing stream. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute. If found essential they may be permitted to continue their project outside the parent institute subject to the conditions of M.Tech regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members. The student is required to undertake the masters research project phase-I during the third semester and the same is continued in the 4th semester (Phase-II). Phase-I consists of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester.

Semester-IV
Masters Research Project (Phase – II)

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Pre-Requisites: Previously studied courses.
Course Outcomes: At the end of the course the student will be able to:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
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Mapping of course outcomes with program outcomes
Objectives:
To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Masters Research project phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre-qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.