Swami Ramanand Tirth Marathwada University, Nanded

Proposed Teaching/Examination Scheme for the degree of Master of Engineering (Mechanical Engineering)

w. e. f. Academic Year 2013-2014, for MPGI, SOE, Nanded. Center No. 727

Part – I

<table>
<thead>
<tr>
<th>Sr. NO.</th>
<th>Name of Subject</th>
<th>Teaching hrs/week</th>
<th>Examination Scheme - Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
</tr>
<tr>
<td>1</td>
<td>Advanced Optimization Techniques</td>
<td>03</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Material Science</td>
<td>03</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Research Methodology</td>
<td>03</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Elective-I</td>
<td>03</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Elective-II</td>
<td>03</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Mechanical Lab-I</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Seminar-I</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Comprehensive Viva-I</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>15</td>
<td>-</td>
</tr>
</tbody>
</table>

*Elective Subjects:

<table>
<thead>
<tr>
<th>Elective</th>
<th>Group A Design</th>
<th>Group B CAD/CAM</th>
<th>Group C Thermal</th>
<th>Group D Industrial Engg.</th>
<th>Group E Production</th>
</tr>
</thead>
</table>

*Note: Candidates are required to opt the elective subjects (Elective I, II, III & IV) from the same group as mentioned above.
Swami Ramanand Tirth Marathwada University, Nanded

Proposed Teaching/Examination Scheme for the degree of Master of Engineering (Mechanical Engineering)

w. e. f. Academic Year 2013-2014

Part – II

<table>
<thead>
<tr>
<th>Sr. NO.</th>
<th>Name of Subject</th>
<th>Teaching hrs/week</th>
<th>Examination Scheme - Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L T P Total Hrs</td>
<td>Theory</td>
</tr>
<tr>
<td>1</td>
<td>Advanced Machine Design</td>
<td>03 - - 03</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Finite Element Methods</td>
<td>03 - - 03</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>Advanced Manufacturing Processes</td>
<td>03 - - 03</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>Elective-III</td>
<td>03 - - 03</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>Elective-IV</td>
<td>03 - - 03</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>Mechanical Lab-II</td>
<td>- - 04 04</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Seminar-II</td>
<td>- - 02 02</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Comprehensive Viva-II</td>
<td>- - -</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note: Candidates are required to opt the elective subjects (Elective I, II, III & IV) from the group as mentioned above.
## Proposed Teaching/Examination Scheme for the degree of Master of Engineering (Mechanical Engineering)

*Swami Ramanand Tirth Marathwada University, Nanded*

**w. e. f. Academic Year 2013-2014**

### Part – III

<table>
<thead>
<tr>
<th>Sr. NO.</th>
<th>Name of Subject</th>
<th>Teaching Scheme hrs/week</th>
<th>Examination Scheme - Marks</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>CH</td>
</tr>
<tr>
<td>1</td>
<td>Dissertation Phase - I</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>-</td>
<td>12</td>
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</table>

### Part – IV

<table>
<thead>
<tr>
<th>Sr. NO.</th>
<th>Name of Subject</th>
<th>Teaching Scheme hrs/week</th>
<th>Examination Scheme - Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>CH</td>
</tr>
<tr>
<td>1</td>
<td>Dissertation Phase - II</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>-</td>
<td>20</td>
</tr>
</tbody>
</table>

Grand Total (Part-I+II+III+IV) 2200

L: Lecture hours per week  
T: Tutorial Hours per week  
P: Practical hours per week  
CH: Contact Hours

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Part-I

1. ADVANCED OPTIMIZATION TECHNIQUES

Teaching Scheme:  
Lectures: 03 hrs / week

Examination Scheme:  
Theory Paper: 100 Marks (3 hrs)
Class Test: 20 Marks (1 hr)
Term Work: 25 Marks

<table>
<thead>
<tr>
<th>Units</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Introduction:</strong> Optimal problem formulation, engineering optimization problems, optimization algorithms.</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td><strong>Single Variable Optimization Algorithms:</strong> Optimality criteria, bracketing methods, region elimination methods, point estimation methods, gradient base, root finding using optimization techniques.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Multivariable optimization algorithms:</strong> Optimality criteria, unidirectional search, direct search method, gradient based methods, computer programs on above methods.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td><strong>Constrained Optimization Algorithms:</strong> Kuhn-Tucker conditions, transformation methods, sensitivity analysis, direct search for constrained minimization, linearised search techniques, feasible direction method, generalized reduced gradient method, computer programs on above methods.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td><strong>Special Optimization Algorithms:</strong> Integer programming, Geometric programming, Genetic Algorithms, Simulated annealing, global optimization, Computer programs on above methods.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td><strong>Optimization in operations research:</strong> Linear programming problem, simplex method, artificial variable techniques, dual phase method, sensitivity analysis.</td>
<td>6</td>
</tr>
</tbody>
</table>

Term Work:  
Minimum four assignments based on the above syllabus including computer programs.

Reference Books:  

2. MATERIAL SCIENCE

Teaching Scheme:
Lectures: 03 hrs / week

Examination Scheme:
Theory Paper: 100 Marks (3 hrs)
Class Test: 20 Marks (1 hr)
Term Work: 25 Marks

<table>
<thead>
<tr>
<th>Units</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Materials and Classification: Solid materials- Classification, Ceramics, composites and metal glasses, selection and application on tool steel, Magnetic alloys, Copper, aluminum and magnesium alloys, Bearing alloys, Super hard materials, Plastics, Alloying techniques- Thermal, Mechanical and chemical methods, Powder metallurgy techniques, Macro and micro analysis of materials, Macro analysis of ferrous and non ferrous materials, Dendritic structures, Segregation and bonding, Heterogeneity formed through treatment and mechanical working.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Mechanical Properties: Strengthening mechanism of materials, elements of dislocation theories, Strain hardening, Grain size control, Single crystal growth, Reinforcing fibers for polymers, Composite structure, determination of mechanical properties of materials, Dynamic tests, Fracture and toughness tests, Low temperature and high temperature tests, Creep characteristics, Hot hardness tests, Total intra-granular cracking and aggressive media, Ceramics and composites, Insulation, Strength and aging of plastics.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Processing of Materials for Casting and Joining: Plastic working of materials, Strain hardening, Recovery and recrystallisation, Formability, Forgibility and drawability of materials, Powder processing mach inability of materials, thermal treatment for better mach inability of metals, Universal mach inability index.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Modern Materials and Alloys: Super alloys-refractory materials, Ceramic and their applications, Low melting alloys, Advanced Composites-Particulate and dispersioned composites, Metal matrix and ceramic matrix composites, Carbon-Carbon composites, Ti and Ni based alloys for gas turbine applications, Margining and cryogenic steels-Newer materials and their treatment for automobile applications, materials for Naval and nuclear systems. Smart and Nano materials.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Polymers and polymerization: Structure and properties of thermoplastics and thermo sets, Engineering applications, Property modifications, Mechanical, thermal behavior of composites with polymer matrix, ceramics glasses.</td>
<td>6</td>
</tr>
</tbody>
</table>

Term Work:
Minimum four assignments based on the above syllabus.

Reference Books:

5 of 44
Part-I

3. Research Methodology

Teaching Scheme:

Lectures: 03 hrs / week

Examination Scheme:

Theory Paper: 100 Marks (3 hrs)

Class Test: 20 Marks (1 hr)

Term Work: 25 Marks

<table>
<thead>
<tr>
<th>Units</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Research Concept: Concept, meaning, objectives, motivation, Types of research, approaches (descriptive research, conceptual, theoretical, applied and experimental research) Formulation of Research Task: Literature Review, importance &amp; methods, sources, field study, laboratory, experiments, critical analysis of already generated facts, hypothetical proposal for future development and testing, selection of research task, prioritization of research, introduction to hypothesis testing.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Mathematical Modeling and Simulation: Concept of modeling, Classification of mathematical models, modeling with ordinary differential equations, differential equations, partial differential equations, graphs, Simulation concept, types (quantitative, experimental, computer, statistical process of formulation of model based on simulation. Experimental Modeling: Definition of experimental design, examples, single factor experiments, guidelines for designing experiments.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>General model of Process: Input factors/variables, Output parameters/variables, controllable/uncontrollable variables, dependent/independent variables, compounding variables, extraneous variables and experimental validity. Process optimization and designed experiments: Methods for study of response surface, First order design. Determining optimum combinations of factors, determination of steepest ascent, and Taguchi approach to parameter design.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Analysis of Results: Parametric and non parametric, Descriptive and Inferential Data, types of data, Methods and techniques of data collection, sampling and sample design, Non parametric test, error analysis, analysis of variance, significance of variance, analysis of co-variance, multiple regression, Introduction to Analytical hierarchical process, Factor analysis, Cluster analysis, Fuzzy logic, testing linearity of model, testing adequacy of model</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Report Writing: Types of report, layout of research report, interpretation of results, layout and format, style of writing, typing, references, pagination tables, figures, conclusions, appendices.</td>
<td>6</td>
</tr>
</tbody>
</table>

Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

Part-I (Electives)

Group A: Design

A-1. MACHINE STRESS ANALYSIS

Teaching Scheme:

Lectures: 03 hrs / week

Examination Scheme:

Theory Paper: 100 Marks (3 hrs)

Class Test: 20 Marks (1 hr)

Term Work: 25 Marks

<table>
<thead>
<tr>
<th>Units</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Theory of Elasticity:</strong> Plane stresses and plain strain: Plane strain and stress and strain at a point, differential equations of equilibrium, boundary conditions, compatibility equations, and Airy’s stress function. <strong>Two-dimensional problems in rectangular coordinates:</strong> Solutions by polynomials, end effects, Saint Venant’s principle. Two-dimensional problems in polar coordinates: General equations in polar coordinates, stress distribution symmetrical about axis, strain components in polar coordinates.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td><strong>Applications of Energy Methods:</strong> First and second theorems, Castigliano’s theorems, applications for analysis of loaded members to determine deflections and reactions at supports. <strong>Theory of Torsion:</strong> Torsion of prismatic bars of non-circular cross sections, Thin walled hallow and rectangular cross sections, Saint Venant’s theory, Prandtle’s membrane analogy, Kelvin’s fluid flow analogy, wrapping of the cross sections.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td><strong>Experimental Stress Analysis:</strong> Stress analysis by – mechanical, optical and electrical strain gauges, strain rosette, whole field methods, Moire fringe method, brittle coating for strain indication.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td><strong>Shear Center and Unsymmetrical Bending:</strong> Shear center for beams of different cross sections, bending and deflections of beams subjected to unsymmetrical bending.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td><strong>Contact Stresses:</strong> Hertz’s contact stresses, expression for principle stresses, deflection of bodies in point contact, stress in bodies in point and line contacts.</td>
<td>6</td>
</tr>
</tbody>
</table>

Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

1.  Timoshenko and Young, “Theory of Elasticity”, TMH Publications.
## A-2. KINEMATICS, DYNAMICS AND SYNTHESIS

### Teaching Scheme:

- **Lectures:** 03 hrs / week

### Examination Scheme:

- **Theory Paper:** 100 Marks (3 hrs)
- **Class Test:** 20 Marks (1 hr)
- **Term Work:** 25 Marks

### Units

<table>
<thead>
<tr>
<th>Units</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Introduction:</strong> Concepts related to kinematics and mechanisms, Degrees of freedom, Grubler’s Criteria, Transmission and Deviation angles, Mechanical advantage.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td><strong>Kinematic Synthesis:</strong> Type, number and dimensional synthesis, Spacing of accuracy points, Chebyshev polynomials, Motion and function generation, Graphical synthesis with two, three and four prescribed motions and points, The complex number modeling in kinematic synthesis, The Dyad Standard form, Freudentein’s equation for three point function generation coupler curves, Robert’s law, Cognates of the slider crank chain.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td><strong>Path Curvature Theory:</strong> Fixed and moving centrode, Inflection points and inflection circle, Euler’s –savary Equation, Bobiller’s and Hartsman construction.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td><strong>Dynamic Force Analysis:</strong> Introduction, Inertia force in linkages, Kineto static analysis by superposition and matrix approach, Time response of mechanisms, Force and moment balancing of linkages.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td><strong>Spatial Mechanism:</strong> Introduction to 3-dimensional mechanisms, Planar Finite, Rigid body and spatial transformation, Analysis of spatial mechanisms.</td>
<td>6</td>
</tr>
</tbody>
</table>

### Term Work:

- Minimum four assignments based on the above syllabus.

### Reference Books:

Part-I (Electives)

Group B: CAD/CAM

B-I. COMPUTER AIDED DESIGN

Teaching Scheme:  
Lectures: 03 hrs / week

Examination Scheme:  
Theory Paper: 100 Marks (3 hrs)  
Class Test: 20 Marks (1 hr)  
Term Work: 25 Marks

<table>
<thead>
<tr>
<th>Units</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
</table>
| 1     | **Product design process:** Importance of design, design process, technological innovation and the design process, Team behavior and tools; Embodiment design: Product architecture, configuration of design, parametric design, Industrial design, Human factors design, Design for X (DFX)  
**CAD:** Introduction, Role of CAD, CAD system architecture, Hardware and software for CAD, Software modules, ICG, Graphics Software, Ground rules for design of GS, functions of GS, modeling and simulation, Solid modeling methods | 6   |
| 2     | **An overview of modeling software:** like UG/NX, Solid Works, Autodesk Inventor, Professional, AutoCAD, PRO/E, CATIA: Capabilities, Modules, Coordinate systems, Sketching tools, solid modeling tools, surface modeling tools, expression/parameters toolbox, data exchange tools, API and customization facilities  
**Geometric transformations:** 2D and 3D; transformations of geometric models like translation, scaling, rotation, reflection, shear; homogeneous representations, concatenated representation; Orthographic projections | 6   |
| 3     | **CAD/CAM Data exchange and data storage:** Introduction, graphics and computing standards, data exchange standards like IGES, STEP, Model storage - Data structures - Data base considerations – Object oriented representations - Organizing data for CIM applications - Design information system  
**Mathematical representations of solids:** Fundamentals, Solid models, Classification of methods of representations, half spaces, boundary representation, CSG, sweep representations, Octree representations, primitive instancing, cell decomposition, spatial occupancy enumeration | 6   |
| 4     | **Mathematical representations of curves and surfaces:** Curve representation, Parametric representation of analytic and synthetic curves; Surface models, Surface representations, Parametric representation of analytic and synthetic surfaces | 6   |
| 5     | **Assembly modeling:** Representation, mating conditions, representation schemes, generation of assembling sequences AI approaches and applications in CAD, Knowledge Based Engineering, OpenGL, Introduction to Advanced visualization topics in CAD like Modern representation schemes like FBM, PM, Feature recognition, Design by features, Tolerance modeling, System customization and design automation, Open Source CAD like Open CASCADE | 6   |
Term Work:

Minimum four assignments based on the above syllabus.

Software Documentation, tutorials, manuals of any three of following software’s
1. UG/NX
2. Solid Works
3. CATIA
4. Autodesk Inventor Professional
5. AutoCAD
6. Open CASCADE
7. ANSYS Design modeler
8. Pro/E

Reference Books:

## Part-I (Electives)

**Group B: CAD/CAM**

### B-2. PRODUCT LIFECYCLE MANAGEMENT

<table>
<thead>
<tr>
<th>Units</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>INTRODUCTION:</strong> Background, Overview, Need, Benefits, and Concept of Product Life Cycle, Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement, Threads of PLM- computer aided design (CAD), engineering data management (EDM), Product data management (PDM), computer integrated manufacturing (CIM, comparison of PLM to Engineering resource planning (ERP). PLM characteristics - singularity, cohesion, traceability, reflectiveness.</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td><strong>PRODUCT LIFE CYCLE ENVIRONMENT</strong> Product Data and Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Developing a PLM strategy, Strategy identification and selection, PLM System Architecture (2tier/3tier/4tier etc),</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td><strong>INTRODUCTION TO PDM</strong> Benefits and Terminology, CIM Data, PDM functions, definition and architectures of PDM systems, Engineering data, engineering workflow and PDM acquisition and implementation, Resolving Data Issues, product data interchange, present market constraints, collaborative product development, Internet and developments in client server computing, portal integration</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td><strong>COMPONENTS OF PDM</strong> Components of a typical PDM setup - hardware and document management – creation and viewing of documents - creating parts-version - control of parts and documents, configuration management for product structure, change management and associated activities</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td><strong>FUNDAMENTAL CONCEPTS OF DATABASE MANAGEMENT</strong> Introduction to DBMS, Entity-Relationship model, Relational model, SQL concepts, Object-Based databases and XML, DBMS architectures, Distributed databases, introduction to search with sample search algorithms,</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td><strong>COMPONENTS OF PLM</strong> Different phases of product lifecycle and corresponding technologies, Product development processes and methodologies, Foundation technologies and standards (e.g. visualization, collaboration and enterprise application integration), Information authoring tools (e.g., MCAD, ECAD, and technical publishing), Core functions (e.g., data vaults, document and content management, workflow and program management), Product organizational structure, Human resources in product lifecycle. Methods, techniques, Practices, Methodologies, Processes, System components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards, Vendors of PLM Systems and Components, Examples of PLM in use.</td>
<td>5</td>
</tr>
</tbody>
</table>
Term Work:

Minimum four assignments based on the above syllabus.

TEXT/REFERENCE BOOKS


OTHER REFERENCES

Relevant recent technical articles, research papers, key note addresses, etc.
Part-I (Electives)

Group C: Thermal

C-I. ADVANCED THERMODYNAMICS

Teaching Scheme:

Lectures: 03 hrs / week

Examination Scheme:

Theory Paper: 100 Marks (3 hrs)

Class Test: 20 Marks (1 hr)

Term Work: 25 Marks

<table>
<thead>
<tr>
<th>Units</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Equation of State</strong>: State postulate for simple system and equation of state, Ideal gas equation, Deviation from ideal gas, Equation of state for real gases, generalized Compressibility chart, Laws of corresponding states. <strong>Properties of Pure Substances</strong>: Phase change process of pure substances, PVT surface, P-v &amp; P-T diagrams, Use of steam tables and charts in common use.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td><strong>Laws of thermodynamics</strong>: 2nd law Analysis for Engg. Systems, Entropy flow &amp; entropy generation, Increase of entropy principle, entropy change of pure sub, T –ds relations, entropy generation, thermo electricity, Onsager equation. Exergy analysis of thermal systems, decrease of Exergy principle and Exergy destruction.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td><strong>Thermodynamic Property Relations</strong>: Partial Differentials, Maxwell relations, Clapeyron equation, general relations for du, dh, ds, and Cv and Cp, Joule Thomson Coefficient, Δh, Δu, Δs of real gases.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td><strong>Chemical Thermodynamics</strong>: Chemical reaction – Fuels and combustion, Enthalpy of formation and enthalpy of combustion, First law analysis of reacting systems, adiabatic flame temperature Chemical and phase equilibrium – Criterion for chemical equilibrium, equilibrium constant for ideal gas mixtures, some remarks about Kp of ideal-gas mixtures, fugacity and activity, Simultaneous relations, Variation of Kp with Temperature, Phase equilibrium, Gibb’s phase rule, Third law of thermodynamics, Nerst heat theorem and heat death of universe.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td><strong>Gas Mixtures</strong>: Mass &amp; mole fractions, Dalton’s law of partial pressure, Amagat’s law, Kay’s rule. <strong>Statistical Thermodynamics</strong>: Fundamentals, equilibrium distribution, Significance of Lagrangian multipliers, partition function for Canonical Ensemble, partition function for an ideal monatomic gas, equipartition of energy, Bose Einstein statistics, Femi-Dirac statistics.</td>
<td>6</td>
</tr>
</tbody>
</table>

Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

1. Cengel, “Thermodynamics:, TMH
### Part-I (Electives)

**Group C: Thermal**

#### C-2. ADVANCED HEAT TRANSFER

**Teaching Scheme:**

**Lectures:** 03 hrs / week

**Examination Scheme:**

**Theory Paper:** 100 Marks (3 hrs)

**Class Test:** 20 Marks (1 hr)

**Term Work:** 25 Marks

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<table>
<thead>
<tr>
<th>Units</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Transient heat conduction. Lumped heat capacity systems. Response of thermocouple. Use of Heisler charts for solving one dimensional unsteady state heat transfer problems in infinite plates, cylinders and spheres. Periodic heat flow.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Boiling heat transfer. The pool boiling curve. Modes of pool boiling and correlations. Transition boiling and system influences. Forced convection boiling in tubes. Two phase flow in horizontal tubes. Limiting heat fluxes in flow boiling. Condensation heat transfer phenomenon. Condensation number, laminar film condensation on a vertical plate, Correlations for condensation inside and outside a vertical tube, on inclined plates, on outer surface of horizontal tube, on horizontal tube blank, turbulent film condensation, Drop wise condensation. Design considerations of Heat pipe.</td>
<td>6</td>
</tr>
</tbody>
</table>
Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

# D-I. TOTAL QUALITY MANAGEMENT

**Teaching Scheme:**

**Lectures:** 03 hrs / week

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**Examination Scheme:**

**Theory Paper:** 100 Marks (3 hrs)

**Class Test:** 20 Marks (1 hr)

**Term Work:** 25 Marks

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<table>
<thead>
<tr>
<th>Units</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EVOLUTION OF QUALITY: Quality control-Quality Assurance-total quality management-Core concepts-Quality Gurus and their contribution-Quality costs-Quality measurement.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>TOOLS OF QUALITY: Review of SQC-Quality control Vs Process control-Control charts-Applications-Problems-Old and New seven tools of quality-Applications.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>TECHNIQUES OF QUALITY: Quality Function Deployment (QFD) -Failure mode effect Analysis (FMEA)- Just in time-KANBAN-KAIZEN-5S Principles-Zero defects-POKA-YOKE-Quality circles.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>ISO 9000/QS Philosophy-Elements-Requirements-Benefits-Procedures-Documentation-Certification-Auditing-Implementation- Cost of Certification.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>CASE STUDIES: Case studies in Quality Management (The students may be asked to select case studies and present).</td>
<td>6</td>
</tr>
</tbody>
</table>

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**Term Work:**

Minimum four assignments based on the above syllabus.

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**References:**

# D-2. PRODUCT LIFECYCLE MANAGEMENT

**Teaching Scheme:**

- **Lectures:** 03 hrs / week

**Examination Scheme:**

- **Theory Paper:** 100 Marks (3 hrs)
- **Class Test:** 20 Marks (1 hr)
- **Term Work:** 25 Marks

<table>
<thead>
<tr>
<th>Units</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>INTRODUCTION:</strong> Background, Overview, Need, Benefits, and Concept of Product Life Cycle, Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement, Threads of PLM- computer aided design (CAD), engineering data management (EDM), Product data management (PDM), computer integrated manufacturing (CIM), comparison of PLM to Engineering resource planning (ERP), PLM characteristics - singularity, cohesion, traceability, reflectiveness.</td>
</tr>
<tr>
<td>2</td>
<td><strong>PRODUCT LIFE CYCLE ENVIRONMENT</strong> Product Data and Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Developing a PLM strategy, Strategy identification and selection, PLM System Architecture (2 tier/3 tier/4 tier etc),</td>
</tr>
<tr>
<td>3</td>
<td><strong>INTRODUCTION TO PDM</strong> Benefits and Terminology, CIM Data, PDM functions, definition and architectures of PDM systems, Engineering data, engineering workflow and PDM acquisition and implementation, Resolving Data Issues, product data interchange, present market constraints, collaborative product development, Internet and developments in client server computing, portal integration</td>
</tr>
<tr>
<td>4</td>
<td><strong>UCOMPONENTS OF PDM</strong> Components of a typical PDM setup - hardware and document management – creation and viewing of documents - creating parts-version - control of parts and documents, configuration management for product structure, change management and associated activities</td>
</tr>
<tr>
<td>5</td>
<td><strong>FUNDAMENTAL CONCEPTS OF DATABASE MANAGEMENT</strong> Introduction to DBMS, Entity-Relationship model, Relational model, SQL concepts, Object-Based databases and XML, DBMS architectures, Distributed databases, introduction to search with sample search algorithms,</td>
</tr>
<tr>
<td>6</td>
<td><strong>COMPONENTS OF PLM</strong> Different phases of product lifecycle and corresponding technologies, Product development processes and methodologies, Foundation technologies and standards (e.g. visualization, collaboration and enterprise application integration), Information authoring tools (e.g., MCAD, ECAD, and technical publishing), Core functions (e.g., data vaults, document and content management, workflow and program management), Product organizational structure, Human resources in product lifecycle, Methods, techniques, Practices, Methodologies, Processes, System components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards, Vendors of PLM Systems and Components, Examples of PLM in use.</td>
</tr>
</tbody>
</table>
Term Work:

Minimum four assignments based on the above syllabus.

TEXT/REFERENCE BOOKS


OTHER REFERENCES

Relevant recent technical articles, research papers, key note addresses, etc.
Part-I (Electives)

Group E: Production

E-I. METAL FORMING PROCESSES

Teaching Scheme:                              Examination Scheme:

Lectures: 03 hrs / week                        Theory Paper: 100 Marks (3 hrs)

Class Test: 20 Marks (1 hr)

Term Work: 25 Marks

<table>
<thead>
<tr>
<th>Units</th>
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<th>Hrs</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>Introduction:</strong> Stress/strain/strain-rate characteristics of materials, Yield criteria, classification of metal working processes, Formability and theory of sheet metal working, Friction and lubrication in metal working operation, Theories of friction and lubrication, Assessment of friction at interface.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td><strong>Process Analysis:</strong> Various methods of analyzing the metal working processes (slip-line field theory, Upper bound solution, stab methods).</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td><strong>Mechanics of Forming Processes:</strong> Rolling-Determination of rolling pressure, roll separating force, driving torque and power, Power loss in bearings, Forging-Forces in strip forging and disc forging, Drawing-determination of force and power, Maximum allowable reduction, Deep drawing force analysis, Analysis of tube drawing process with fixed and moving mandrel, Tandem tube drawing, Bending-determination of work load and spring back, Extrusion-Determination of work load from stress analysis and energy consideration, Power loss, Hydrostatic extrusion, Punching &amp; Blanking-Mode of metal deformation and failure, 2D deformation model and fracture analysis, determination of work force.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td><strong>Hydrostatic Extrusion:</strong> Comparison with conventional extrusion, Pressure required extruding, variables affecting the process.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td><strong>High Speed Forming:</strong> Classification, Comparison of low and high speed forming, operation problems in high speed forming operation, Introduction to high forming process such as explosive forming, Electrical and Mechanical high speed forming techniques.</td>
<td>6</td>
</tr>
</tbody>
</table>

Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

1. Rowe Arnold, “An Introduction to the Principles of Metal Working”
4. Johnson & Mellore Van Nostrand, “Plasticity for Mechanical Engineers”.
5. “High Velocity Working of Metals”, ASTM E EEE
Part-I (Electives)
Group E: Production

E-2. NON CONVENTIONAL MACHINING PROCESSES

Teaching Scheme:  
Lectures: 03 hrs / week

Examination Scheme:  
Theory Paper: 100 Marks (3 hrs)
Class Test: 20 Marks (1 hr)
Term Work: 25 Marks

<table>
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<tr>
<th>Units</th>
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<th>Hrs</th>
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</thead>
</table>
| 1     | Introduction:  
- Introduction to unconventional machining processes, their needs and classification.  
- Brief introduction to the type of energy source employed in AJM, USM, WJM, EDM, ECM, ECG, LBM< PAM, EBM. | 6 |
| 2     | Machining Energy Based Processes  
Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining Ultrasonic Machining. (AJM, WJM, AWJM and USM). Working principles – equipment used – Process parameters – MRR-Variation in techniques used – Applications. | 6 |
| 3     | Electrical Energy Based Processes  
| 4     | Thermal Energy Based Processes  
Laser Beam machining (LBM), plasma Arc machining (PAM) and Electron Beam Machining (EBM). Principles-Equipment- Types-Beam control techniques – Applications. | 6 |
ECM Tooling: ECM tooling technique, Tool & insulation materials, Tool size Electrolyte flow arrangement, Handling of slug, Applications such as Electrochemical turning, Electrochemical Grinding, Electrochemical Honing, deburring, Advantages, Limitations.  
Chemical Machining (CHM): Introduction, Elements of process Chemical blanking process:-Preparation of work piece. Preparation of masters, masking with photo resists, etching for blanking, applications of chemical blanking, chemical milling (Contour machining) :-Process steps – masking, Etching, process characteristics of CHM :-material removal rate accuracy, surface finish, Hydrogen embrittlement, Advantage & application of CHM. | 6 |
Term Work:

Minimum four assignments based on the above syllabus.

Recommended Books:


Reference Books:

6. MECHANICAL LAB - I

Teaching Scheme:  
Practical: 04 hrs / week

Examination Scheme:  
Term Work: 50 Marks

Minimum five experiments based on the above syllabus of Part-I which may include computer programs.

7. SEMINAR - I

Teaching Scheme:  
Tutorials: 02 hrs / week

Examination Scheme:  
Term Work: 25 Marks

It shall be based on the literature survey on any topic, which may lead to Dissertation in that area. It will be submitted as a report. The candidate will have to deliver a seminar presentation before the faculty members.

8. COMPREHENSIVE VIVA-I

Examination Scheme:  
Oral: 50 Marks

Comprehensive Viva-I is based on oral assessment of all the subjects of Part-I conducted by internal examiners and external examiner(s) appointed by University.
Part-II

1. ADVANCED MACHINE DESIGN

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<tr>
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<th>Hrs</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Fundamentals of Design Considerations:</strong> Principal planes and principal stresses, tri-axial State of stresses, Mohr’s circle for tri-axial state of stresses and strains, volumetric strains, Principal stresses computed from principal strains, Principal strains due to perpendicular stresses &amp; shear stresses.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td><strong>Mechanical Springs:</strong> Design of square or rectangular bar helical springs, Belleville springs, ring springs, torsion bar springs, theory of rectangular or square bars helical springs under axial loading, cone or flat disc spring theory.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td><strong>Cams:</strong> Basic curves, cam size determination, calculating cam profiles, advance curves, polydyne cams dynamics of high speed cam systems, surface materials, stresses and accuracy, ramps.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td><strong>Fracture and Creep:</strong> Fracture Mechanics approach to design. Causes and interpretation of failures, Creep behavior; rupture theory; creep in high temperature low cycle fatigue; designing against creep.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td><strong>Computer Aided Machine Design:</strong> Philosophy of Computer Aided Machine Design, Interactive design software, Basic advantages of analysis Software, Design of machine components (springs, gears, temporary fasteners, permanent fasteners, belts and ropes) through interactive programming.</td>
<td>6</td>
</tr>
</tbody>
</table>

Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

10. Spotts M. F., “Mechanical Design Analysis”, PHI Publications, New Delhi
Part-II
2. FINITE ELEMENT METHOD

Teaching Scheme:
Lectures: 03 hrs / week

Examination Scheme:
Theory Paper: 100 Marks (3 hrs)
Class Test: 20 Marks (1 hr)
Term Work: 25 Marks

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<tr>
<th>Units</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction to Finite Difference Method and Finite Element Method, Advantages and disadvantages, Mathematical formulation of FEM, Variational and Weighted residual approaches</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Shape functions, Natural co-ordinate system, Element and global stiffness matrix, Boundary conditions, Errors, Convergence and path test, Higher order elements.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Application to plane stress and plane strain problems, Axi-symmetric and 3D bodies, plate bending problems with isotropic and anisotropic materials, structural stability, other applications e.g., Heat conduction and fluid flow problems. Idealisation of stiffness of beam elements in beam-slab problems.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Applications of the method method to materially non-linear problems, Organisation of the Finite Element programmes, Data preparation and mesh generation through computer graphics, Numerical techniques, 3D problems.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>FEM an essential component of CAD, Use of commercial FEM packages, Finite element solution of existing complete designs, Comparison with conventional analysis.</td>
<td>6</td>
</tr>
</tbody>
</table>

Term Work:
Minimum four assignments based on the above syllabus.

Reference Books:

7. O. C. Zenkiewicy & Morgan, “Finite Element and Approximation”
8. Introduction to Finite Element Method in Engineering by S.S.Rao, Butterworth Heinmann Publication
Part-II

3. ADVANCED MANUFACTURING PROCESSES

Teaching Scheme:

Lectures: 03 hrs / week

Examination Scheme:

Theory Paper: 100 Marks (3 hrs)

Class Test: 20 Marks (1 hr)

Term Work: 25 Marks

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<tr>
<th>Units</th>
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<tbody>
<tr>
<td>1</td>
<td>Metal cutting: Need for rational approach to the problem of cutting metals-Observation in metal cutting. Energy considerations in machining, Modern theories in mechanics of cutting, Review of Merchant and Lee Shaffer theories, critical comparison, Measurement of cutting forces-Classification of cutting force dynamometer, Drill, Milling and grinding dynamometer, Heat distribution in machining-effects of various parameters on temperature, Method of temperature measurement in machining, Hot machining, Cutting fluids.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Tool Materials, Tool Life and Tool Wear &amp; Wear Mechanisms: Essential requirements of tool materials, Developments in tool materials. ISO specifications for inserts and tool holders, Tool life, Conventional and accelerated tool life tests, Concepts of machinability and machinability index, Economics of machining, Reasons for failure of cutting tools, Forms of wear, Chatter in machining, Chatters types, Mechanism of chatter based on force v/s Speed graph, Mechanism of grinding, Various parameters affecting grinding process, Machinability data systems.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Sheet Metal Forming &amp; Special Forming Processes: Review of conventional processes, HERF techniques, Super plastic forming techniques, Principles and process parameters, Advantages, applications and limitations of HERF techniques, Orbital forging, Isothermal forging, Hot and cold iso-static pressing, High speed extrusion, Rubber pad forming, Water hammer forming, Fine blanking.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Special Casting Processes &amp; Recent Advances in Casting: Shell molding, precision investment casting, CO2 molding, Centrifugal casting, Die and continuous casting, Low pressure die casting, Squeeze casting, Full mould casting process, Layout of mechanized foundry, sand reclamation, Material handling in foundry, Pollution control in foundry, recent trends in casting, Computer aided design of casting.</td>
<td>6</td>
</tr>
</tbody>
</table>
Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

Teaching Scheme:

Lectures: 03 hrs / week

Examination Scheme:

Theory Paper: 100 Marks (3 hrs)

Class Test: 20 Marks (1 hr)

Term Work: 25 Marks

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<tbody>
<tr>
<td>1</td>
<td>Introduction: Reliability concepts and patterns of failure, reliability Management, reliability, for system effectiveness. Reliability and hazard rates: Failure data, reliability function, failure rate and hazard rate, common distributions in failure mechanisms – experimental, Weibull, gamma, Normal, log normal, extreme value, model selection for components failure, failure analysis.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Reliability prediction and analysis: Reliability prediction based on exponential distribution, system reliability analysis – block diagram method, fault tree and success tree methods, event tree method, failure model, failure mechanism.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Reliability design: Design for reliability, design process, assessment methodology, reliability allocation reliability improvement, selection of components to improve system reliability.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Maintenance in context: maintenance and profitability, terro-technology, application of terro-technology. Principles: the structure of plant, reason for nature of maintenance work, the production maintenance system a dynamic model.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Establishing a maintenance plan-preliminary consideration: items, classification of items, maintenance procedure, guidelines for machine procedures to items. Maintenance planning and control: Basic requirements, Management information, labour costs, computer based Management information system, work planning and work control, basic rules for success.</td>
<td>6</td>
</tr>
</tbody>
</table>

Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

4. F. J. Henley, “Designing for reliability and safety control”, Hiromitsu
Part-II (Electives)
Group A: Design

A-IV. ADVANCED MECHANICAL VIBRATIONS

Teaching Scheme:

Lectures: 03 hrs / week

Examination Scheme:

Theory Paper: 100 Marks (3 hrs)

Class Test: 20 Marks (1 hr)

Term Work: 25 Marks

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<tr>
<th>Units</th>
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<th>Hrs</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>Introduction</strong>: Characterization of engineering vibration problems, Review of single degree freedom systems with free, damped and forced vibrations.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td><strong>Two-degree of Freedom Systems</strong>: Principal modes of vibration, Spring coupled and mass coupled systems, Forced vibration of an undamped close coupled and far coupled systems. Undamped vibration absorbers, Forced damped vibrations, Vibration isolation.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td><strong>Multi-degree Freedom systems</strong>: Eigen-value problem, Close coupled and far coupled systems, Orthogonality of mode shapes, Model analysis for free, damped and forced vibration systems, Approximate methods for fundamental frequency- Rayleigh,s, Dunkerely, Stodolas and Holzer method, Method of matrix iteration, Finite element method for close coupled and far coupled systems.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td><strong>Continuous systems</strong>: Forced vibration of systems governed by wave equation, Free and forced vibrations of beams/bars.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td><strong>Transient Vibrations</strong>: Response to an impulsive, step and pulse input, Shock spectrum. <strong>Non-linear Vibrations</strong>: Non-linear systems, Undamped and forced vibration with non-linear spring forces, Self-excited vibrations.</td>
<td>6</td>
</tr>
</tbody>
</table>

Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

4. V.P.Singh, “Mechanical Vibrations”, Dhanapat Rai & sons
B-III. RELIABILITY AND MAINTENANCE ENGINEERING

Teaching Scheme:
Lectures: 03 hrs / week

Examination Scheme:
Theory Paper: 100 Marks (3 hrs)
Class Test: 20 Marks (1 hr)
Term Work: 25 Marks

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<tr>
<th>Units</th>
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<th>Hrs</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction: Reliability concepts and patterns of failure, reliability Management, reliability, for system effectiveness. <strong>Reliability and hazard rates:</strong> Failure data, reliability function, failure rate and hazard rate, common distributions in failure mechanisms – experimental, Weibull, gamma, Normal, log normal, extreme value, model selection for components failure, failure analysis.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td><strong>Reliability prediction and analysis:</strong> Reliability prediction based on exponential distribution, system reliability analysis – block diagram method, fault tree and success tree methods, event tree method, failure model, failure mechanism.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td><strong>Reliability design:</strong> Design for reliability, design process, assessment methodology, reliability allocation reliability improvement, selection of components to improve system reliability.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td><strong>Maintenance in context:</strong> maintenance and profitability, terro-technology, application of terro-technology. <strong>Principles:</strong> the structure of plant, reason for nature of maintenance work, the production maintenance system a dynamic model.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td><strong>Establishing a maintenance plan-preliminary consideration:</strong> items, classification of items, maintenance procedure, guidelines for machine procedures to items. <strong>Maintenance planning and control:</strong> Basic requirements, Management information, labour costs, computer based Management information system, work planning and work control, basic rules for success.</td>
<td>6</td>
</tr>
</tbody>
</table>

Term Work:
Minimum four assignments based on the above syllabus.

Reference Books:
4. F. J. Henley, “Designing for reliability and safety control”, Hiromitsu
Part-II (Electives)

Group B: CAD/CAM

B-IV. COMPUTER INTEGRATED MANUFACTURING

Teaching Scheme:

| Lectures: 03 hrs / week |

Examination Scheme:

| Theory Paper: 100 Marks (3 hrs) |
| Class Test: 20 Marks (1 hr) |
| Term Work: 25 Marks |

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<th>Hrs</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>Introduction:</strong> The meaning and origin of CIM- the changing manufacturing and management scene – External communication – islands of automation and software-dedicated and open systems-manufacturing automation protocol – related activities of a company marketing engineering – production planning – plant operations – physical distribution – business and financial management.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td><strong>Shop Floor Control and Introduction of FMS:</strong> Shop floor control-phase – factory data collection system – automatic identification methods- Bar code technology- automated data collection system. FMS-components of FMS – type –FMS workstation – material handling and storage systems- FMS layout – computer control systems-application and benefits.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td><strong>CIM Implementation and Data Communication:</strong> CIM and company strategy – system modeling tools – IDEF models – activity cycle diagram CIM open system architecture (CIMOSA) – manufacturing enterprise wheel-CIM architecture- Product data management CIM implementation software. Communication fundamentals- local area networks – topology – LAN implementations – network management and installations.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td><strong>Open System and Database For CIM:</strong> Open systems-open system inter connection manufacturing automations protocol and technical office protocol (MAP /TOP). Development of databases – database terminology- architecture of database systems-data modeling and data associations – relational data bases – database operators – advantages of database and relational database.</td>
<td>6</td>
</tr>
</tbody>
</table>
Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

Part-II (Electives)
Group C: Thermal

C-III. COMPUTATIONAL FLUID DYNAMICS

Teaching Scheme:

Lectures: 03 hrs / week

Examination Scheme:

Theory Paper: 100 Marks (3 hrs)
Class Test: 20 Marks (1 hr)
Term Work: 25 Marks

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<tr>
<th>Units</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>Conservation Laws of Fluid Motion and Boundary Conditions:</strong> Governing equations of fluid flow and heat transfer, Equations of state, Navier-Stokes equations for a Newtonian fluid.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td><strong>Classification of physical behavior:</strong> Classification of fluid flow equations, Auxiliary conditions for viscous fluid flow equations.</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td><strong>Turbulence and its Modeling:</strong> Transition from laminar to turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, characteristics of simple turbulent flows, Free turbulent flows, Flat plate boundary layer and pipe flow, Turbulence models, Mixing length model, The k-e model, Reynolds stress equation models, Algebraic stress equation models.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><strong>The Finite Volume Method for Diffusion Problems:</strong> Introduction, one-dimensional steady state diffusion, two-dimensional diffusion problems, three-dimensional diffusion problems, discreted equations for diffusion problems.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td><strong>The Finite Volume Method for Convection-Diffusion Problems:</strong> Steady one-dimensional convection and diffusion, The central differencing scheme, Properties of discretisation schemes-Conservativeness, Boundedness, Transportiveness, Assessment of the central differencing scheme for convection-diffusion problems, The upwind differencing scheme.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td><strong>One-dimensional unsteady heat conduction,</strong> Discretisation of transient convection-diffusion equation, Solution procedures for unsteady flow calculations, Implementation of Inlet, outlet and wall boundary conditions, constant pressure boundary condition.</td>
<td>6</td>
</tr>
</tbody>
</table>

Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

Part-II (Electives)

Group C: Thermal

C-IV. REFRIGERATION AND CRYOGENIC SYSTEMS

Teaching Scheme:

Lectures: 03 hrs / week

Examination Scheme:

Theory Paper: 100 Marks (3 hrs)

Class Test: 20 Marks (1 hr)

Term Work: 25 Marks

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<tr>
<td>1</td>
<td><strong>Vapour Compression refrigeration:</strong> system: Simple systems, Multi-evaporator system; Multi expansion system; Cascade systems; Study of p-h; T-s; h-s and T-h charts for various refrigerants, Concept of Heat pump. <strong>Refrigerant:</strong> Designation, selection, desirable properties, refrigerant blends, secondary refrigerants, refrigerant recycling, reclaim and charging, alternative refrigerants, Refrigerant lubricant mixture behavior, ODP, GWP concepts.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td><strong>Vapour absorption refrigeration:</strong> Standard cycle and actual cycle, thermodynamic analysis, Li-Br-water, NH-3-water systems, Three fluid absorption systems, half effect, single effect, single-double effect, double effect, and triple effect system. <strong>Non-conventional refrigeration system (Principle and thermodynamic analysis only):</strong> Thermoelectric refrigeration, thermo-acoustic refrigeration, adsorption refrigeration, steam jet refrigeration, vortex tube refrigeration, and magnetic refrigeration.</td>
<td>6</td>
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<td>3</td>
<td><strong>Compressor rating and selection:</strong> Hermetic, reciprocating, screw, Scroll and centrifugal Compressors based on applications. <strong>Evaporators:</strong> types, thermal design, effect of lubricants accumulation, draining of Lubricants, selection and capacity control. <strong>Condenser:</strong> types, thermal design, purging, selection and capacity control.</td>
<td>6</td>
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<tr>
<td>4</td>
<td><strong>Introduction to Cryogenics:</strong> Importance of cryogenics, Development history of cryogenics, Application areas of cryogenics, Material properties at Cryogenics Temperatures, super conductivity applications, Cryogenics in space Industries. Cryogenics in Aviation and Aerospace Industry, Cryobiology.</td>
<td>6</td>
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<tr>
<td>5</td>
<td><strong>Liquefaction systems:</strong> Carnot Liquefaction system, F.O.M. and Yield of Liquefaction system, Inversion Curve – Joule Thomson Effect. Linde system, Linde-Hampson System, Precooled Linde Hampson System, Claudes system, Dual pressure System, Kapitza system, Heylandt system, Philips machine.</td>
<td>6</td>
</tr>
</tbody>
</table>
Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

1. R. J. Dossat, “Principles of refrigeration”, Pearson Education Asia
5. ASHRAE Handbook (i) Fundamentals (ii) Refrigeration
6. ISHRAE handbooks
Teaching Scheme:  
Lectures: 03 hrs / week  

Examination Scheme:  
Theory Paper: 100 Marks (3 hrs)  
Class Test: 20 Marks (1 hr)  
Term Work: 25 Marks  

<table>
<thead>
<tr>
<th>Units</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
</table>
| 1     | Introduction: Reliability concepts and patterns of failure, reliability Management, reliability, for system effectiveness.  
       | Reliability and hazard rates: Failure data, reliability function, failure rate and hazard rate, common distributions in failure mechanisms – experimental, Welbull, gamma, Normal, log normal, extreme value, model selection for components failure, failure analysis. | 6 |
| 2     | Reliability prediction and analysis: Reliability prediction based on exponential distribution, system reliability analysis – block diagram method, fault tree and success tree methods, event tree method, failure model, failure mechanism. | 6 |
| 3     | Reliability design: Design for reliability, design process, assessment methodology, reliability allocation reliability improvement, selection of components to improve system reliability. | 6 |
| 4     | Maintenance in context: maintenance and profitability, terro-technoloy, application of terro-technology.  
       | Principles: the structure of plant, reason for nature of maintenance work, the production maintenance system a dynamic model. | 6 |
| 5     | Establishing a maintenance plan-preliminary consideration: items, classification of items, maintenance procedure, guidelines for machine procedures to items.  
       | Maintenance planning and control: Basic requirements, Management information, labour costs, computer based Management information system, work planning and work control, basic rules for success. | 6 |

Term Work:  
Minimum four assignments based on the above syllabus.

Reference Books:
4. F.J. Henley, “Designing for reliability and safety control”, Hiromitsu  
### Part-II (Electives)

**Group D: Industrial Engineering**

**D-IV. INVENTORY AND SUPPLY CHAIN MANAGEMENT**

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**Teaching Scheme:**

- **Lectures:** 03 hrs / week

**Examination Scheme:**

- **Theory Paper:** 100 Marks (3 hrs)
- **Class Test:** 20 Marks (1 hr)
- **Term Work:** 25 Marks

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<table>
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<tr>
<th>Units</th>
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<th>Hrs</th>
</tr>
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</table>
| 1     | **Introduction to Supply Chain Management (SCM):**  
Concept of Logistics Management, Concept of supply management and SCM, Core competency, Value chain, Elements of supply chain efficiency, Flow in supply chains, Key issues in supply chain management, Decision phases in supply chain, Supply chain integration, Process view of a supply chain, Competitive Strategy and supply chain strategies, Uncertainties in supply chain, Supply chain drivers. | 4 |
| 2     | **Sourcing and Procurement:**  
Outsourcing benefit, Importance of suppliers, evaluating a potential supplier, Supply contracts, Competitive bidding and Negotiation, E-procurement  
**Purchasing:** Objectives, Relations with other departments, Centralised and Decentralised purchasing, Purchasing procedure, Types of orders, Tender buying, Purchasing department records, Computer based Systems/EDI.  
**Stores Management:** Functions, Storage methods, Receiving, Inspection, Issues, and Inventory Valuation. | 4 |
| 3     | **Introduction to Inventory Management:**  
Selective Control Techniques, MUSC-3D systems, Various costs.  
**Independent Demand Systems:** Deterministic Models, Quantity Discounts - all units, incremental price; Sensitivity, Make-or-buy decisions.  
**Multi-item Joint Replenishment:** Economic Production Quantity for multiple items.  
**Inventory System Constraints:** Exchange Curve (Optimal Policy Curve), Working Capital restrictions, Storage Space restrictions. | 12 |
| 4     | **Independent Demand Systems (Probabilistic Models):**  
**Single order Quantities:** Payoff Matrix, Expected Value Criterion, Lost sales case, Mathematical formulation of discrete and continuous cases.  
**Dynamic Order Quantities:** Q- system, P- system, Mathematical modeling under known stock out costs and service levels.  
**Managing inventory in supply chain:** Bullwhip effect, Information and supply chain trade-offs | 10 |

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Term Work:

Minimum four assignments based on the above syllabus.

References
Part-II (Electives)
Group E: Production

E-III. RELIABILITY AND MAINTENANCE ENGINEERING

Teaching Scheme:
Lectures: 03 hrs / week

Examination Scheme:
Theory Paper: 100 Marks (3 hrs)
Class Test: 20 Marks (1 hr)
Term Work: 25 Marks

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<tr>
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</table>
| 1     | **Introduction**: Reliability concepts and patterns of failure, reliability Management, reliability, for system effectiveness.  
**Reliability and hazard rates**: Failure data, reliability function, failure rate and hazard rate, common distributions in failure mechanisms – experimental, Weibull, gamma, Normal, log normal, extreme value, model selection for components failure, failure analysis. | 6 |
| 2     | **Reliability prediction and analysis**: Reliability prediction based on exponential distribution, system reliability analysis – block diagram method, fault tree and success tree methods, event tree method, failure model, failure mechanism. | 6 |
| 3     | **Reliability design**: Design for reliability, design process, assessment methodology, reliability allocation reliability improvement, selection of components to improve system reliability. | 6 |
| 4     | **Maintenance in context**: maintenance and profitability, terro-technology, application of terro-technology.  
**Principles**: the structure of plant, reason for nature of maintenance work, the production maintenance system a dynamic model. | 6 |
| 5     | **Establishing a maintenance plan-preliminary consideration**: items, classification of items, maintenance procedure, guidelines for machine procedures to items.  
**Maintenance planning and control**: Basic requirements, Management information, labour costs, computer based Management information system, work planning and work control, basic rules for success. | 6 |
Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

4. F. J. Henley, “Designing for reliability and safety control”, Hiromitsu
## Part-II (Electives)

### Group E: Production

#### E-IV. COMPUTER INTEGRATED MANUFACTURING

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**Teaching Scheme:**

**Lectures:** 03 hrs / week

**Examination Scheme:**

**Theory Paper:** 100 Marks (3 hrs)

**Class Test:** 20 Marks (1 hr)

**Term Work:** 25 Marks

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<tbody>
<tr>
<td>1</td>
<td><strong>Introduction:</strong> The meaning and origin of CIM- the changing manufacturing and management scene – External communication – islands of automation and software-dedicated and open systems-manufacturing automation protocol – related activities of a company marketing engineering – production planning – plant operations – physical distribution – business and financial management.</td>
<td>6</td>
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<tr>
<td>3</td>
<td><strong>Shop Floor Control and Introduction of FMS:</strong> Shop floor control-phase – factory data collection system – automatic identification methods- Bar code technology-automated data collection system. <strong>FMS</strong>-components of FMS – type – FMS workstation – material handling and storage systems-FMS layout – computer control systems-application and benefits.</td>
<td>6</td>
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<tr>
<td>4</td>
<td><strong>CIM Implementation and Data Communication:</strong> CIM and company strategy – system modeling tools – IDEF models – activity cycle diagram CIM open system architecture (CIMOSA) – manufacturing enterprise wheel-CIM architecture- Product data management CIM implementation software. Communication fundamentals- local area networks – topology – LAN implementations – network management and installations.</td>
<td>6</td>
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<tr>
<td>5</td>
<td><strong>Open System and Database For CIM:</strong> Open systems-open system inter connection manufacturing automations protocol and technical office protocol (MAP /TOP). Development of databases – database terminology- architecture of database systems-data modeling and data associations – relational data bases – database operators – advantages of database and relational database.</td>
<td>6</td>
</tr>
</tbody>
</table>
Term Work:

Minimum four assignments based on the above syllabus.

Reference Books:

6. MECHANICAL LAB - II

Teaching Scheme:

Practical: 04 hrs / week

Examination Scheme:

Term Work: 50 Marks

Minimum five experiments based on the above syllabus of Part-II which may include computer programs.

7. SEMINAR - II

Teaching Scheme:

Tutorials: 02 hrs / week

Examination Scheme:

Term Work: 25 Marks

It shall be based on the literature survey on any topic, which may lead to Dissertation in that area. It will be submitted as a report. The candidate will have to deliver a seminar presentation before the faculty members.

8. COMPREHENSIVE VIVA-II

Examination Scheme:

Oral: 50 Marks

Comprehensive Viva-II is based on oral assessment of all the subjects of Part-II conducted by internal examiners and external examiner(s) appointed by University.
Part-III
DISERTATION – Phase I

Teaching Scheme:  
Contact Hours: 12 hrs / week

Examination Scheme:  
Term Work: 100 Marks

The dissertation shall consist of a report on any research work done by the candidate or a comprehensive and critical review of any recent development in the subject or detailed report of the project work consisting of a design and/or development work that the candidate has executed. The report must include comprehensive literature work on the topic selected for dissertation.

Term work:

The Dissertation - Phase I will be in the form of seminar report on the dissertation work being carried out by the candidate and will be assessed by examiners appointed by the department, one of whom will be the guide and other(s) will be expert examiner(s) from the department.
PART IV

DISSERTATION- Phase II

<table>
<thead>
<tr>
<th>Teaching Scheme:</th>
<th>Examination Scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contact Hours:</strong> 20 hrs / week</td>
<td><strong>Term Work:</strong> 150 Marks</td>
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<tr>
<td></td>
<td><strong>Viva – voce:</strong> 150 Marks</td>
</tr>
</tbody>
</table>

The Dissertation – Phase II will be in continuation of Dissertation phase – I and shall consist of a report on the research work done by the candidate or a comprehensive and critical review of any recent development in the subject or detailed report of the project work consisting of a design and / or development work that the candidate has executed. The examinee shall submit the dissertation in the required number of copies.

The dissertation work may consist of an extensive work, study or analysis of field/industrial problems with appropriate solutions or remedies. It may be any of the following:

1. Fabrication of model, machine, prototype on the basis of innovative ideas.
2. Modeling and/or simulation of a system and improvements in the system.
3. Design of experiments, experimental setups, fabrication of test equipment/rigs, experimentation and Statistical analysis, comparison with the existing data.
4. Renovation of machines, testing equipments.
5. Extensive analysis of some problems solved with the help of suitable software.
6. Design, modeling, analysis and so on as deemed fit.

The bona-fide work carried out for Dissertation Phase – II should be potentially rich in terms of academics.

**Dissertation Report**

The project report shall be hard bound. It is a report on the work done by the student. It should have Literature review, problem definition and formulation, adopted methodology, experimentation plan if any, Results, conclusions, discussion and its relevance to the further work.

**Term work:**

The Dissertation will be assessed by internal examiners appointed by the Institute, one of whom will be the guide and others will be concerned faculty members from the Department.

**Viva-voce:**

It shall consist of a defense presented by the examinee on his work in the presence of examiners appointed by the university, one of whom will be the guide and other will be an external examiner.