# Scheme of Teaching and Examination for M.Tech. Tool Engineering

## I Semester

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
<th>Teaching hours/week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for</th>
<th>Total Marks</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>16MDE11</td>
<td>Applied Mathematics</td>
<td>Lecture: 4 Practical / Field Work / Assignment / Tutorials: 3</td>
<td>Duration of Exam in Hours: 3</td>
<td>Marks for: 50</td>
<td>Total Marks: 150</td>
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<tr>
<td>16MST12</td>
<td>Finite Element Method</td>
<td>Lecture: 4 Practical / Field Work / Assignment / Tutorials: 3</td>
<td>Duration of Exam in Hours: 3</td>
<td>Marks for: 50</td>
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<td>4</td>
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<tr>
<td>16MTE 13</td>
<td>Press Tool Design</td>
<td>Lecture: 4 Practical / Field Work / Assignment / Tutorials: 3</td>
<td>Duration of Exam in Hours: 3</td>
<td>Marks for: 50</td>
<td>Total Marks: 150</td>
<td>4</td>
</tr>
<tr>
<td>16 MTE 16</td>
<td>Cutting Tools Theory and Design</td>
<td>Lecture: 4 Practical / Field Work / Assignment / Tutorials: 3</td>
<td>Duration of Exam in Hours: 3</td>
<td>Marks for: 50</td>
<td>Total Marks: 150</td>
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<tr>
<td></td>
<td>Elective - I</td>
<td>Lecture: 4 Practical / Field Work / Assignment / Tutorials: 3</td>
<td>Duration of Exam in Hours: 3</td>
<td>Marks for: 50</td>
<td>Total Marks: 150</td>
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<td>16 MCM 16</td>
<td>Manufacturing Engineering Lab 1</td>
<td>Lecture: -- Practical / Field Work / Assignment / Tutorials: 3</td>
<td>Duration of Exam in Hours: --</td>
<td>Marks for: 25</td>
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<td>16 MTE 17</td>
<td>SEMINAR</td>
<td>Lecture: -- Practical / Field Work / Assignment / Tutorials: 3</td>
<td>Duration of Exam in Hours: --</td>
<td>Marks for: 25</td>
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<td>Total</td>
<td>Lecture: 20 Practical / Field Work / Assignment / Tutorials: 13</td>
<td>Duration of Exam in Hours: 15</td>
<td>Marks for: 300</td>
<td>Total Marks: 850</td>
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## Elective-I

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>16MTE151</td>
<td>Non Traditional Machining</td>
</tr>
<tr>
<td>16MTE 152</td>
<td>Gauges and Measurements</td>
</tr>
<tr>
<td>16MTE153</td>
<td>Plastic Processing</td>
</tr>
<tr>
<td>16MTE154</td>
<td>Tooling for Manufacture in Automation</td>
</tr>
</tbody>
</table>
Course Objectives:
The main objectives of the course are to enhance the knowledge of various methods in finding the roots of an algebraic, transcendental or simultaneous system of equations and also to evaluate integrals numerically and differentiation of complex functions with a greater accuracy. These concepts occur frequently in their subjects like finite element method and other design application oriented subjects.

Course Content:


5. Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering

**Text Books:**

**Reference Books:**

**Course Outcomes:**
The Student will be able to
1. Model some simple mathematical models of physical Applications.
2. Find the roots of polynomials in Science and Engineering problems.
3. Differentiate and integrate a function for a given set of tabulated data, for Engineering Applications

**FINITE ELEMENT METHOD**
(Common to MTE,MST)

<table>
<thead>
<tr>
<th>Sub Code</th>
<th>16MST12</th>
<th>IA Marks</th>
<th>50</th>
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<tbody>
<tr>
<td>Hrs/ Week</td>
<td>04</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
<tr>
<td>Total Hrs.</td>
<td>50</td>
<td>Exam Marks</td>
<td>100</td>
</tr>
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**Course Objectives**

1. Introduce the various aspects of FEM as applied to engineering problems.
2. Apply the fundamental concepts of mathematical methods and theory of elasticity to solve simple continuum mechanics problems.

Course Content:

1. Introduction to Finite Element Method: Engineering Analysis, History, Advantages, Classification, Basic steps, Convergence criteria, Role of finite element analysis in computer-aided design., Mathematical Preliminaries, Differential equations formulations, Variational formulations, weighted residual methods

   6 Hours

2. One-Dimensional Elements-Analysis of Bars and Trusses, Basic Equations and Potential Energy Functional, 1D Bar Element, Admissible displacement function, Strain matrix, Stress recovery, Element equations, Stiffness matrix, Consistent nodal force vector: Body force, Initial strain, Assembly Procedure, Boundary and Constraint Conditions, Single point constraint, Multi-point constraint, Truss Element, Shape functions for Higher Order Elements, \( C^0 \), \( C^1 \) elements

   Two-Dimensional Elements-Analysis of Plane Elasticity Problems: Three- Triangular Element, Four-Noded Quadrilateral Element (QUAD 4), Shape functions for Higher Order Elements (LST, QUAD 8), Lagrange element, Strain-Displacement \([B]\) matrix, Stiffness\([K]\) matrix and Jacobian of CST and QUAD4 elements.

   13 Hours


   16 Hours


   11 Hours

5. Dynamic Considerations: Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar
element, truss element, beam element. Lumped mass matrix, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.

Text Books:

Reference Books:
4. Bathe K. J. Finite Elements Procedures, PHI.

Course Outcome: Students will be able to
1. Define the element properties such as shape function and stiffness matrix for the various elements.
2. Formulate element properties for 1D and 2D elements.
3. Develop skill to solve simple beam problems using the steps of FEM.

Press Tool Design

<table>
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<tbody>
<tr>
<td>16MTE13</td>
<td>50</td>
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</table>

Hrs/ Week : 04   Exam Hours : 03
Total Hrs. : 50: Exam Marks : 100

Course Objective:
The course makes students to learn intricacies involved in design of press tools and understand various tools used in practice.

Course Content:


Strip Layout: Basic rules, economic layout, bridge size, calculation of plug point/center of pressure.
Press Tool Operations: Piercing, blanking, slitting, cropping, trimming, shaving, lancing, bending, curling, calibrating, drawing, Embossing, coining, flanging, fine blanking.  

2. Design of Press Tool Elements: Die plates, punches, punch holder plates, stripper plates, and calculation of stripping force, bolster plates, pilots, ejectors, shedders, material s ops, pillar, bush, slender punches, Stock guides, stock feeding device and die sets.

Types of Press Tools: Progressive tools, stage tools, compound tools, combination tools, cam actuated die, horn dies, sub press dies, inverted dies, bulging dies, levering dies, trimming dies, shaving dies, riveting dies, assembly dies, lamination dies.

Extrusion: Forward, backward, combined extrusion, Modern metal forming techniques.


5. Preparation and Presentation of Typical Designs in the Form of Drawings for the Following
   1. Piercing & blanking tool.
   2. Progressive tool
   3. Stage tool
   4. Bending tool
   5. Compound tool

Text Books:
Reference Books:

Course Outcome:
Students will be in a position to understand press tool types ,its design and press tool operations which makes them aware of type applications for which this knowledge can be applied.

CUTTING TOOL THEORY AND DESIGN

<table>
<thead>
<tr>
<th>Sub Code</th>
<th>IA Marks</th>
<th>Hrs/ Week</th>
<th>Exam Hours</th>
<th>Total Hrs.</th>
<th>Exam Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>16MTE16</td>
<td>50</td>
<td>04</td>
<td>03</td>
<td>50</td>
<td>100</td>
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</table>

Course Objective:
The course aims at giving exposure to students on metal cutting theory and its practice in industries.

Course Content:
1. Mechanism of chip formation Review of deformation mechanism, Fracture, Mechanism of yielding, overview of chip formation, concept of shearing strain. Mechanism of Metal Cutting, Force system during turning - velocity relationships – Force analysis in turning, milling, drilling etc.. **12 Hours**

2. Measurement of cutting forces and dynamometer Tool wear mechanisms, types and causes of wear.
**Turning Tools:** Indexable Inserts, Chip breakers, ISO classification of inserts and tool holders. **12 Hours**

3. **Milling Cutters:** Standardization, geometry, Face Mills, Shoulder Mills, End Mills, Deep shoulder Mills, T-Slot cutters.
**Drilling:** Drills with index able inserts, Deep hole drills, carbide tipped drills, Core drills, Counter pores, and Counter sinks.

4. **Boring:** Types of boring tool, Boring heads, Cartridges. REAMER Types of reamers, Geometry of flutes. TOOLS FOR CNC.

5. **Design Exercise:** Design of Single point tool, Drill, Broach, Form tools, Reamer.

**Text Books:**
2. **Metal Cutting Theory and Cutting Tool Design,** Arshinov M I R Publications.

**Reference Books:**
2. **Production Technology,** HMT.
4. **Modelling of Metal Forming and Machining Processes,** Prakash M Dixit, Uday S dixit, Springer and verlag publication, 2008

**Course Outcome:** Students will be able to understand mechanism of chip formation, measurement of cutting forces and its importance in cutting tool design, design of various cutting tools.
Elective-I

NON-TRADITIONAL MACHINING
(Common to MTE,MST,MCM,IAE,MAR)

Sub Code : 16MTE151 IA Marks : 50
Hrs/ Week : 04 Exam Hours : 03
Total Hrs. : 50 Exam Marks : 100

Course learning objectives:

1. To demonstrate the need for development of newer/ non-traditional machining processes.
2. The student will be able to identify different energy sources like fluid motion, electric current, high speed electrons, high energy radiation, etc.
3. To analyse the concept, mechanism, parameters associated with the processes.
4. To demonstrate the operational principles, advantages applications, limitations of the various non-traditional machining processes.

Course Content:


Ultra Sonic Machining: Definition, Mechanism of metal removal, elements of the process, Tool feed mechanisms, Theories of mechanics, effect of parameters, Different types of concentrators, horn design, applications, Limitations.

Abrasive Jet Machining: Principle, Process parameters, Influence of process parameters on MRR, applications, advantages and disadvantages.


3. Chemical Machining: Introduction, fundamental principle types of chemical machining, Maskants, Etchants, Advantages and disadvantages, applications, chemical blanking, chemical milling (contour machining), Hydrogen embrittlement.

Plasma arc Machining: Introduction, Plasma, Generation of Plasma and equipment, Mechanism of metals removal, PAM parameters, process characteristics, types of torches, applications.
Electron beam machining (EBM): Introduction, Equipment for production of Electron beam, Theory of electron beam machining, Thermal & Non thermal type, Process characteristics, applications.  12 Hours


Ion Beam Machining: principle, equipment, working, sputtering rate, applications.  6 Hours

Types of high velocity forming methods: explosion forming process, electro-hydraulics forming, magnetic pulse forming. Applications, Advantages and limitations.  6 Hours

Text Books:
2. Modern Machining Processes - P.K Mishra

Reference Books:
1. New technology - Bhattacharya, Institution of Engineers, India
4. High velocity forming of metals - F.M Wilson ASTME PreticeHall.
5. Modern Manufacturing Methods - Adithan

Course Outcomes:

1. Student will be in a position to appreciate the merits of non traditional machining and its application in Industries.
2. Justify and demonstrate the benefits of non-traditional machining processes over traditional machining processes.

3. Students will be able to decide a process suitable for a particular material based on the availability of the sources.

GAUGES AND MEASUREMENTS

Sub Code : 16MTE152  IA Marks : 50
Hrs/ Week : 04  Exam Hours : 03
Course Objective:
The course aims at making students learn about various gauges and measurement techniques.

Course Content:
1. **Introduction**: Definition and objectives of metrology Linear measurement: neutral axis significance, imperial standard yard, international standard meter, airy points, Basel points, line, end & wave length standards, Slip Gages.

   **Angular Measurement**: introduction, caparison with linear measurement sine bar: principle, types, advantages & limitations, uses, problems on sine bar angle blocks (angle gauges), practical uses, material, construction, limitations problems on angle blocks.

   10 Hours

2. **Geometric Dimensioning & Tolerancing (Gd&T)**: Introduction, ANSI, ASME & ISO systems of GD&T, functional dimensioning, feature & feature of size, advantages & limitations, feature control frame, fourteen characteristic symbols, form controls, profile controls, orientation controls, location controls, runout controls, datum.

   **Limits, Fits And Tolerance**: Definitions, need of tolerance, types of tolerance, tolerance analysis (addition & subtraction of tolerances) interchangeability & selective assembly, representation of holes & shaft as per I.S. class & grade of tolerance, difference between allowance & tolerance.

   16 Hours

3. **Fits**: Definition, types of fits, clearance, interference & transition, tolerance disposition chart, problems (calculation of fits) hole base system & shaft base system, procedure for solving on finding the hole & shaft tolerance upper & lower limits.

   8 Hours

4. **Design Of Gauges**: Taylor’s principle, MMC & LMC of hole & shaft types of gauges (plain, threaded, limit, single end, double end, progressive, position, etc) important points for gauge design, limitations of gauges, problems on gauge design.

   6 Hours


   12 Hours

Text Books:
2. Westermann Tables for metal trade – Jut scharkus, New age international Publishers

Reference Books:
2. Geometric Dimensioning and Tolerancing. A Self Study Workbook By Alex Krulikowski.
Course Outcome:

Students will be able to understand specification of limits, fits and tolerance, design of gauges and its uses.
Course Objective:

The course aims at providing knowledge about various aspects of plastic processing.

Course Content:

1. **Plastic Processing:** Basic principle of processing, shape and size, processing parameters, their effect and behavior, Rheology of ideal fluids, and real polymers, Effects of melt behavior on processing and product performance.

2. **Injection Moulding:** Principles, process variables, moulding cycle, machinery used, parts and function, specification, construction and maintenance of injection moulding machine, start up and shut down procedure, cylinder, nozzles, interaction of moulding variables, press capacity, projected area, shot weight, concepts and their relationship to processing, trouble shooting in injection moulding, microprocessors controlled injection moulding machines. 16 Hours

3. **Extrusion:** Basic principles of extruders, and extrusion process, different types of extrudes i.e. barrel, screw, drive mechanics, head, constructional features of dies, sizing and haul-off equipment for extruders of mono filaments and tubes, blown film lines, wire and cable covering system, pipe profile extrusion, co-extrusion, process variables in extrusion like heating, temperature control, dies well, and melt fracture, spacing and orientation, treating, printing and sealing, quality of extruder products, fault, causes and remedy.

   **Compression and Transfer Moulding:** Techniques, various types of compression moulds, machinery used, and common moulding faults and remedies. Transfer moulding, its advantage over compression moulding, equipment used, press capacity, integral mold, and auxiliary mould, moulding cycle, ram pressure, clamping pressure, faults and remedies. 12 Hours

3. **Blow Moulding:** Blow moulding process, processing parameter, materials used, hand operated and automatic blow moulding machine, extrusion blow moulding, moulding cycle, faults and remedies.

   **Thermo Forming:** Basic principles, types of thermoforming, thermoforming moulds, processing parameters, faults and remedies.
Rotational Moulding: Basic principle, charge size, wall thickness, temperature control, fault causes and remedies. \[12 \text{ Hours}\]

4. **Calendaring**: Basic principle, process variable, end product properties and applications, secondary processing techniques like powder coating, casting, machining, and joining of plastics, metalizing, printing. \[6 \text{ Hours}\]

5. **Processing of Engineering Plastics**: precautions, and start up procedure, preheating, shutdown procedure, quality control, and waste management. Ram Extrusion of PTFE, Processing of reinforced plastics, like filament winding, Hand-lay-up, spray moulding, SMC, DMC, Centrifugal casting, pultrusion, resin transfer moulding. \[6 \text{ Hours}\]

**TEXT BOOKS:**
1. Plastic Processing Data Hand Book – Dominic V Rosato P.E.

**REFERENCE BOOKS:**

**Course Outcome:**
Students will demonstrate their understanding of plastic processing, injection moulding, extrusion and thermo forming.
Course Objective:
Students are introduced to metal cutting principles, cutting tool materials, types of cutting tools and its nomenclature. Students get orientation into clamping methods and jigs used in automated environment.

Course Content:

1. **Mechanics of metal cutting**: Introduction, measurement of cutting forces and chip thickness, force components, chip formation and primary plastic deformation, shear plane and slip line theories for continuous chip formation.

   **Modern Cutting tool materials**: Material properties, HSS related materials, sintered tungsten carbide, cermets, ceramics, polycrystalline tools, tool coatings, coating methods, conventional coating materials, diamonds and CBN

   **Cutting tools**: Basic types of cutting tools, turning tools, indexable inserts, groove geometry, edge preparation, wiper geometry, insert clamping methods, tool angles, threading tools, grooving and cut-off tools, milling tools, types of milling cutters, milling inserts and edge clamping methods. Selection and application of Single point cutting tool and multipoint cutting tools. 

      12 Hours

2. **Optimization**: Machining cost and production rate verses cutting speed, role of computerized optimization system, economic considerations, optimization of machining system, machining conditions, constraints, depth of cut feed and speed.

   **Tooling Requirements for CNC Machines**: Tool holding systems modular and quick change tool holding system, tool holder spindle connection, cutting tool clamping systems, milling cutter driver, side lock type chuck, collet chucks, hydraulic chucks, milling chucks. Tool magazines, Automatic Tool Changers, robotized tool assembly, tool management system. Tool monitoring, presetting and offsets, wear and radius compensation

      12 Hours

3. **Location and Clamping Methods**: Basic principles of locating, locating methods & devices, Basic principles of clamping, clamping methods.

   **Fixtures**: Definitions, General considerations, Machine considerations, Process considerations, Product considerations, Types of fixtures, Vise fixtures, Milling fixtures, Boring fixtures, Broaching fixtures, Lathe fixtures, Grinding fixtures, Steps involved in designing a fixture.

      12 Hours

   **8 Hours**

5. **Plastics for tooling materials**: Introduction, Commonly used plastics for tooling, Epoxy plastics tools, Construction methods, Urethane dies, Force calculation for Urethane pressure pads.

   **6 Hours**

**Textbooks:**

**Reference Books:**
4. Dr. B.J. Ranganath, *Metal cutting and tool design*, Vikas publishing house

**Course Outcome:**
Students are able to decide a type of tool appropriate for machining a material, decide on nomenclature parameters and be able to design a clamping method.
Manufacturing Engineering Lab 1

Subject Code: 16MCM 16
IA Marks : 25
Total Hours : 84

Hours/Week : 6
Exam Hours: 3
Exam Marks : 50

Note:
1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a
   Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Exercises:
1. Optimizing machining time to produce mild steel components on a CNC turning Centre.
2. Characterize surface roughness of High carbon steel using a grinding machine.
3. To determine power required to machine a chosen component and evaluate suitability of the machine to manufacture the same.
4. To compare surface characteristics produced by conventional and CNC turning machines.
5. To Estimate the accuracy of taper produced on a shaft by grinding.
6. To measure cutting forces during machining of High carbon steel and optimize machining parameters.
7. To optimize a single point cutting tool for machining HC steel and to arrive at parameters like rake angle, relief angle, nose radius etc.
8. To study type of chips produced in machining Al/Composites materials/ HC alloy steels and to characterize chip thickness.
9. Construction of merchant circle diagram for turning operation of mild steel and to compute power requirement for turning operation.

10. Perform cutting/drilling/turning operations on mild steel/ high carbon steel/ composite material components and estimate power required for cutting/drilling/turning. 
(Ex: for the hole, dia& feed values are provided, Student has to find the volume of metal removed and energy consumed)
11. Determine the true taper and actual taper mathematically and perform turning operations (roughing cuts) on lathe and estimate the tool life of tool on similar cuts at different speeds.