# Autonomous Program Structure of
Third Year B. Tech. Fifth Semester
(Mechanical Engineering)
Academic Year: 2022-2023 Onwards

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</tr>
</thead>
<tbody>
<tr>
<td>20ME501</td>
<td>Computer Aided Engineering (CAE)</td>
<td>20ME502</td>
<td>Heat Transfer (HT)</td>
</tr>
<tr>
<td>20ME503</td>
<td>Power Train Design (PTD)</td>
<td>20ME504</td>
<td>Industrial Inspection &amp; Quality Control (IIQC)</td>
</tr>
<tr>
<td>20ME505</td>
<td>Numerical Methods (NM)</td>
<td>20OEHS501</td>
<td>Open Elective I (Humanities)</td>
</tr>
<tr>
<td>20ME504</td>
<td>Industrial Inspection &amp; Quality Control (IIQC) Lab</td>
<td>20ME501L</td>
<td>Computer Aided Engineering (CAE) Lab</td>
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<tr>
<td>20ME505L</td>
<td>Numerical Methods (NM) Lab</td>
<td>20ME506L</td>
<td>Thermal Lab (ET &amp; HT)</td>
</tr>
<tr>
<td>20ME507L</td>
<td>Design Lab- II (MD &amp; PTD)</td>
<td>20AC501</td>
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</tr>
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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>20OEHS501A</td>
<td>Entrepreneurship Development</td>
</tr>
<tr>
<td>20OEHS501B</td>
<td>Intellectual Property Rights</td>
</tr>
<tr>
<td>20OEHS501C</td>
<td>Introduction to Digital Marketing</td>
</tr>
<tr>
<td>20OEHS501D</td>
<td>Law for Engineers</td>
</tr>
<tr>
<td>20OEHS501E</td>
<td>Organizational Behaviour</td>
</tr>
<tr>
<td>20OEHS501F</td>
<td>Project Management</td>
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</table>

### Course Code and Title

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### Open Elective I (Humanities)

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<tr>
<td>1</td>
<td>20OEHS501A</td>
<td>Entrepreneurship Development</td>
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<tr>
<td>2</td>
<td>20OEHS501B</td>
<td>Intellectual Property Rights</td>
</tr>
<tr>
<td>3</td>
<td>20OEHS501C</td>
<td>Introduction to Digital Marketing</td>
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<tr>
<td>4</td>
<td>20OEHS501D</td>
<td>Law for Engineers</td>
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<td>5</td>
<td>20OEHS501E</td>
<td>Organizational Behaviour</td>
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<td>6</td>
<td>20OEHS501F</td>
<td>Project Management</td>
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**Total**

<table>
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<tr>
<th>Lecture</th>
<th>Tutorial</th>
<th>Practical</th>
<th>In Sem</th>
<th>End Sem</th>
<th>Practical</th>
<th>Oral</th>
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<th>Credit</th>
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<tr>
<td>15</td>
<td>3</td>
<td>10</td>
<td>425</td>
<td>300</td>
<td>50</td>
<td>75</td>
<td>800</td>
<td>23</td>
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**Grand Total**

| Total    | 28 | 725 | 125 | 800 | 23 |
## T. Y. B. Tech. -- Semester-I

<table>
<thead>
<tr>
<th>Course Name</th>
<th>Computer Aided Engineering (CAE)</th>
<th>L</th>
<th>T</th>
<th>P</th>
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<tbody>
<tr>
<td>Course Code</td>
<td>20ME501</td>
<td>3</td>
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### Course Objectives:

To make students

1. To apply the homogeneous transformation of geometric 2D/3D CAD entities
2. To model the curves and surfaces geometry
3. To understand generalized FEM procedure along with the type of analysis and meshing technique
4. To compute stresses, strains, and deflection in the given problem under static loading
5. To compute stresses, strains, and deflection in the given problem under static loading by applying finite element methods for solving 2D structural problems

### Course Outcomes:

Students will be able to

After successful completion of the course, students will be able to

1. Apply homogeneous transformation matrix for geometrical transformations of 2D & 3D CAD entities for basic geometric transformations
2. Model the curves and surfaces geometry
3. Apply finite element methods to solve 1D structural problems
4. Understand generalized FEM procedure along with the type of analysis and meshing technique
5. Compute stresses, strains, and deflection in the given problem under static loading by applying finite element methods to solve 2D structural problems

### Unit/Module: 1  Computer Graphics  8 hours  CO: 1

Transformations (2D & 3D): Introduction, Formulation, Translation, Shear, Rotation, Scaling and reflection, Homogeneous representation, Concatenated transformation, Mapping of geometric models, Inverse transformations, Introduction to 3D transformation

Projections: Orthographic, Isometric, Perspective projections

### Unit/Module: 2  Curve and Surface Modeling  6 hours  CO: 2
Curves – Introduction, Analytical curves (Line, circle, ellipse, parabola, hyperbola), Synthetic curves (Hermite Cubic Spline, Bezier, B-Spline Curve)

Surfaces – Introduction, Surface representation, Analytic surfaces, Synthetic Surfaces, Hermite bicubic, Bezier, B-Spline, Coons patch surface, Applications in freeform surfaces

<table>
<thead>
<tr>
<th>Unit/Module: 3</th>
<th>One Dimensional Finite Element Analysis</th>
<th>8 hours</th>
<th>CO: 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>One Dimensional Problem: Finite element modeling, coordinate and linear shape function, Assembly of Global Stiffness Matrix and Load Vector, Properties of Stiffness Matrix, Finite Element Equations, (stepped bar, spring in series and parallel), Temperature Effects, Penalty approach,</td>
<td></td>
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<tr>
<td>Trusses: Introduction, 2D Trusses, Element stiffness matrix for truss, Assembly of Global Stiffness Matrix, load vector</td>
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</table>

<table>
<thead>
<tr>
<th>Unit/Module: 4</th>
<th>Two Dimensional Finite Element Analysis</th>
<th>8 hours</th>
<th>CO: 4</th>
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</thead>
<tbody>
<tr>
<td>Plane Stress/Strain problems in 2D elasticity, constitutive relations, Constant Strain Triangle (CST), Liner Strain Rectangle (LSR), displacement function, Pascal”s triangle, compatibility, and completeness requirement, geometric isotropy, convergence requirements, strain filed, stress filed.</td>
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<tr>
<td>Formulation of element stiffness matrix and load vector for Plane Stress/Strain problems</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Assembly of global stiffness matrix and load vector, Boundary conditions, solving for primary variables (displacement), stress calculations</td>
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</table>

<table>
<thead>
<tr>
<th>Unit/Module: 5</th>
<th>Practical Finite Element Analysis</th>
<th>6 hours</th>
<th>CO: 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction: Brief History of FEM, Finite Element Terminology (nodes, elements, domain, continuum, Degrees of freedom, loads and constraints), General FEM procedure, Applications of FEM in various fields, p and h formulation, Advantages and disadvantages of FEM</td>
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<tr>
<td>Type of Analysis: Linear static, nonlinear, dynamic, buckling, thermal, fatigue, CFD, Crash</td>
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<tr>
<td>Introduction to meshing, Types of the element, meshing Techniques. 1D, 2D, and 3D Meshing, Mesh quality check. Effect of mesh density in the critical region, Effect of biasing in the critical region</td>
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</table>

| Total Lab hours: | 36 hours |

**Text Books:**

4. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite, Pune

**Reference Books:**


### Course Name
Heat Transfer

<table>
<thead>
<tr>
<th>Course Code</th>
<th>20ME502</th>
</tr>
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<tbody>
<tr>
<td>Pre-requisite</td>
<td>Physics, Calculus, Fluid Mechanics</td>
</tr>
<tr>
<td>Syllabus Version</td>
<td>V:1.1</td>
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</tbody>
</table>

### Course Objectives:

**Course prepares students to**

1. To apply laws of heat transfer to ascertain the heat transfer
2. To formulate heat conduction equation using given boundary conditions
3. To identify the requirement of extended surfaces for heat transfer enhancement
4. To ascertain the heat transfer rate in forced and natural convection
5. To predict the radiation heat transfer with the use of radiation shield for given application
6. To calculate efficiency of heat exchanger

### Course Outcomes:

**Students will be able to**

1. apply laws of heat transfer to ascertain the heat transfer rate in steady and transient state heat conduction in solids
2. formulate the equation for heat conduction with heat generation applying suitable BC”s
3. evaluate the requirement of extended surfaces for heat transfer and calculate the heat transfer enhancement using it.
4. analyse the convective heat transfer rate using appropriate correlations
5. predict the heat transfer rate in radiation mode and with the use of radiation shield
6. calculate the efficiency of heat exchanger for given set of operating conditions

### Unit/Module: 1  Steady State Conduction Heat Transfer  10 hours  CO: 1,2,3


### Unit/Module: 2  Transient Heat Conduction Analysis  4 hours  CO: 1

Transient heat conduction in solids using lumped heat capacity analysis

### Unit/Module: 3  Convection Heat Transfer  8 hours  CO: 4

Natural convection over vertical flat plate and cylinder. Non dimensional parameters and its significance.

<table>
<thead>
<tr>
<th>Unit/Module: 4</th>
<th>Radiation Heat Transfer</th>
<th>8 hours</th>
<th>CO:5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fundamental concepts and laws of radiation, Black and Gray body radiation analysis, Radiation between two gray surfaces, Radiation shields.</td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit/Module: 5</th>
<th>Heat Exchangers</th>
<th>8 hours</th>
<th>CO:6</th>
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</thead>
</table>

Total Lecture hours: 38 hours

Text Books:
<table>
<thead>
<tr>
<th>Course Name</th>
<th>Power Train Design</th>
<th>L</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Code</td>
<td>20ME503</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Prerequisite</td>
<td>Strength of machine elements, Machine Design</td>
<td>Syllabus Version</td>
<td>V:1.1</td>
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</tbody>
</table>

### Course Objectives:

**To make students**

1. To analyze the forces in rigid drives during power transmission.
2. To design gear pairs based on strength.
3. To select a drive element from the manufacturer's catalogue.
4. To analyze the requirements for specifications for transmission systems.
5. To design and analyze transmission systems in electric and hybrid vehicles.

### Course Outcomes:

**Students will be able to**

After successful completion of the course, student will be able to

1. analyze the forces in rigid drives during power transmission.
2. design a gear pair based on strength.
3. select a drive element from the manufacturer's catalogue.
4. analyze the requirements for specifications for transmission systems.
5. design and analyze transmission systems in hybrid vehicles.

#### Unit/Module: 1  Elements of transmission systems- Rigid Drives  6 hours  CO: 1,2

- Rigid drives-I: Classification and selection of rigid drives, conjugate action, standard tooth systems, force analysis, modes of failures, gear design based on AGMA strength equations and for dynamic load, thermal considerations.

#### Unit/Module: 2  Anti-friction Bearings and Flexible Drives  6 hours  CO: 3

- Modes of failures, static and dynamic load ratings, equivalent dynamic load, reliability and survival of bearing, load-life relationship and selection of bearings from manufacturer’s catalogue.
- Power rating, tensions, stresses and selection from manufacturer’s catalogue for flexible drives.

#### Unit/Module: 3  Mechanical Transmission Systems  4 hours  CO: 4

- Manual transmission systems (MT), Automatic transmission systems (AT), hydraulic torque converter, epicyclic gear box. Gear boxes for automobiles and industrial use: Constant mesh, sliding mesh, synchromesh, differential and planetary gearbox.
<table>
<thead>
<tr>
<th>Unit/Module: 4</th>
<th>Transmission in Electric and Hybrid Vehicles</th>
<th>8 hours</th>
<th>CO: 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructional, operational and performance features, transmission configurations, torque-speed characteristics, sizing of motor and components, motors, power splitting concepts and interface within powertrain system, powertrain architecture -parallel, series and combined, types of EVs, vehicle layout and packaging options, energy devices &amp; combinations, duty cycles in Indian cities, performance, sustainability assessment.</td>
<td></td>
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<tr>
<td><strong>Total hours:</strong></td>
<td><strong>24 hours</strong></td>
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**Text Books:**

9. Iqbal Husain, „Electric and Hybrid Vehicles, Design Fundamentals”, CRC PRESS.

**Reference Books:**

Course Name: Industrial Inspection & Quality Control (IIQC)
Course Code: 20ME504
Pre-requisite: Manufacturing Process, Machine Drawing

Course Objectives:

To make students
1. Understand the GD & T symbols and its use w.r.to selection of methods of measurement and measuring instruments.
2. Aware about the concept of IS-919 tolerance, limits of size, fits, geometric and position tolerances, gauges and their design procedure.
3. Understand the advances in Metrology [viz. CMM, Laser, Machine Vision System] for industrial inspection etc.
4. Understand the process of use of Quality Control Technique in engineering industries.
5. Understand Quality Management System.

Course Outcomes:
Students will be able to
1. Select suitable instrument / gauge / method to measure linear and angular dimensional.
2. Specify the standard process to design limit gauges.
3. Select and apply/use appropriate Quality Management Tool and Quality Control Technique for clearly defined problem.
4. Apply Statistical Quality Control tool(s) to analyse and interpret the data.

Unit/Module: 1 Geometric Dimensioning, Tolerancing and Inspection Needs

- GD&T Basics: Need and Rules, Features and Material Conditions [MMC & LMC] Regardless of Feature”s Size & Rule, Functional Gauging,
- Datums: Types, Selection & Datums Control, MMB and LMB, Adding GD&T to a Design;
- Feature Control Frame: SLOF for Drawings (Size, Location, Orientation & Form)
- Form Tolerances: (Surface, Median Line/MMC): Straightness, Flatness, Circularity, Cylindricity Orientation Tolerances: (Surface, Axis): Parallelism, Perpendicularity Angularity Profile Tolerances: Profile of a Surface and Line – Basics, Profile (Modifiers)
- Location Tolerances: True Position Concentricity, Symmetry: Runout Tolerances, Circular and Total Runout and Real Life Example

Unit/Module: 2 Inspection Gauge and Dedicated Metrology

- Design of Gauges: Tolerances, Limits and Fits [IS 919-1993], Taylor”s principle, Types of gauges, Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials, Considerations of gauge design (numerical).
• **Comparators:** Mechanical, Pneumatic, Optical, Electrical (LVDT)

• **Gear Metrology and Thread Metrology:** Types of errors, dedicated instruments and applications

### Unit/Module: 3 Advances in Industrial Inspection

<table>
<thead>
<tr>
<th>Unit/Module</th>
<th>Content</th>
<th>Hours</th>
<th>CO</th>
</tr>
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<tbody>
<tr>
<td>3</td>
<td><strong>Coordinate Measuring Machine (CMM):</strong> Fundamental features of CMM – development of CMMs – role of CMMs – types of CMM and Applications, – types of probes</td>
<td>3</td>
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<tr>
<td></td>
<td><strong>Machine Vision Systems:</strong> vision system measurement – Multisensory systems.</td>
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<td></td>
<td><strong>Interferometer:</strong> Principle, NPL Interferometer</td>
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<td></td>
<td><strong>Laser Metrology:</strong> Basic concepts, laser types, laser interferometers, and applications</td>
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<td><strong>Industry 4.0:</strong> Inspection 4.0</td>
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### Unit/Module: 4 Quality: Tools, Techniques and System

**Quality:** Characteristics & elements, Cost vs Value, Deming's cycles & 14 Points, Juran Trilogy

**Quality Tools:** 7 QC Tools, Quality Function Deployment, FMECA, 5S, Kaizen, Poka yoke, Kanban, Six Sigma: DMAIC - Concept and application

**Quality Management System:** Introduction to ISO 9001, TS-16949, ISO-14000.

### Unit/Module: 5 Statistical quality control and Acceptance Sampling

**Statistical quality control:** Statistical concept, Frequency diagram, Concept of variance analysis, Control Chart for Variable (X & R Chart) & Attribute (P & C Chart), Process Capability Indices: (cp, cpk, ppk), Statistical Process Control (Numerical).

**Acceptance Sampling:** Sampling Inspection, OC Curve and its characteristics, sampling methods, Sampling Plan: Single, Double (Numerical), Multiple, Comparison of Plan, calculation of sample size, AOQ, Probability of Acceptance (Numerical)

<table>
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<th>Unit/Module</th>
<th>Content</th>
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### Text Books:


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<th>Publisher</th>
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<tbody>
<tr>
<td>1.</td>
<td>ASTME, Handbook of Industrial Metrology, Prentice Hall of India Ltd.</td>
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<tr>
<td>3.</td>
<td>Online Education resources: viz. NPTEL web site:</td>
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<td>(1) npTEL.ac.in/courses/112106179</td>
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<td>(2) <a href="http://www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html">www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html</a>;</td>
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<td>(3) <a href="http://www.me.iitb.ac.in/~ramesh/courses/ME338/metrology6.pdf">www.me.iitb.ac.in/~ramesh/courses/ME338/metrology6.pdf</a>; npTEL.ac.in/courses/110101010/;</td>
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<td>(4) freevideolectures.com › Mechanical › IIT Madras</td>
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<td>(5) npTEL.ac.in/courses/112107143/37.</td>
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</table>
Course Name | Numerical Methods | L | T | P
--- | --- | --- | --- | ---
Course Code | 20ME505 | 2 | 1 | -
Pre-requisite | Engineering Mathematics | Syllabus Version | V:1.1

Course Objectives:
To make students
1. To understand numerical errors and error propagation.
2. To apply numerical methods for finding the root of the equation.
3. To solve simultaneous linear algebraic equations by numerical methods.
4. To use numerical methods for curve fitting and interpolation.
5. To apply numerical methods for integration and differentiation
6. To implement numerical techniques for ordinary and partial differential equations.

Course Outcomes:
Students will be able to
After successful completion of the course, student will be able to
1. Understand errors and error propagation.
2. apply numerical method for finding root of the equation
3. solve simultaneous linear algebraic equations by numerical methods
4. use numerical methods for curve fitting and interpolation
5. apply numerical methods for integration and differentiation
6. Obtain an approximate solution of ordinary and partial differential equations applying numerical techniques.

Unit/Module: 1 | Roots of Equations and Errors | 3 hours | CO: 1, 2
--- | --- | --- | ---
Bisection method, Newton Raphson method, Successive approximation method
Types of errors, error propagation

Unit/Module: 2 | Simultaneous Linear Algebraic Equations | 4 hours | CO: 3
--- | --- | --- | ---
Gauss elimination method, LU decomposition method, Thomas algorithm for tridiagonal matrix, Gauss Seidel method, Jacobi iterative method

Unit/Module: 3 | Curve Fitting and Interpolation | 6 hours | CO: 4
Least square technique- straight line, quadratic equation, power equation, exponential equation

Interpolation- Newton”s forward interpolation, Lagrange”s Interpolation, Spline interpolation

<table>
<thead>
<tr>
<th>Unit/Module: 4</th>
<th>Numerical Integration and Differentiation</th>
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<th>CO: 5</th>
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<tbody>
<tr>
<td>Numerical Integration: trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Gauss quadrature two point formula and three point formula, double integration</td>
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<tr>
<td>Numerical Differentiation:</td>
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<table>
<thead>
<tr>
<th>Unit/Module: 5</th>
<th>Ordinary and Partial Differential Equations</th>
<th>8 hours</th>
<th>CO: 6</th>
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<tbody>
<tr>
<td>Euler”s method, Heun”s method, Runge Kutta fourth order method, Runge Kutta second order method for simultaneous ordinary differential equations</td>
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<tr>
<td>PDE: Finite difference method, Elliptic equation, parabolic equation</td>
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<table>
<thead>
<tr>
<th>Total Course hours:</th>
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</table>

Texts and Reference materials:

2. Hill
3. Steven C Chapra, Applied numerical methods with MATLAB for engineers and scientists, Tata McGraw Hill
4. Dr. B.S. Grewal, Numerical methods in Engineering and science, Khanna Publishers
5. E. Balagurusamy, Numerical methods, Tata McGraw Hill
6. Laurene Fausett, Applied Numerical analysis using MATLAB, PHI
7. P.Kandasamy, K.Thilagavathy, K.Gunavathi, Numerical Methods, S. Chand
<table>
<thead>
<tr>
<th>Course Name</th>
<th>Computer Aided Engineering (CAE) Lab</th>
<th>L</th>
<th>T</th>
<th>P</th>
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<tbody>
<tr>
<td>Course Code</td>
<td>20ME501 L</td>
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<td>2</td>
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<tr>
<td>Pre-requisite</td>
<td>Strength of material, Computer Aided Machine Drawing</td>
<td>Syllabus Version</td>
<td>V:1.1</td>
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</table>

**Course Objectives:**

1. To prepare a program in MATLAB/OCTAVE tool for finding transformations of CAD object
2. To formulate 1D FEM problem for static structural analysis
3. To use finite element tool for solve bar, beam, and truss problem of static structural
4. To use finite element tool for static structural of mechanical components

**Course Outcomes:**

After successful completion of the course, students will be able to

1. Develop program in MATLAB tool for finding transformations of CAD object
2. Write a program to formulate 1D FEM problem for static structural analysis and solve
3. Compute stresses, strains, and deflection in the given 1D and 2D problem under static loading
4. Analyze plane stress/plane strain problem under static loading
5. Compute stresses, strains, and deflection of any mechanical component using 3D elements

**Lab Work:**

1. Build and execute a computer program on concatenated Transformation
2. Program to formulate a static structural analysis of stepped bar/beams
3. Static structural analysis of stepped bar/beam using FEA tool
4. Program to formulate a static structural analysis of truss
5. Static structural analysis of trusses using FEA tool
6. Static structural analysis of any mechanical element/part/component i.e. plate with a hole, bracket, seat belt hook, etc.
7. Static structural analysis of any mechanical component using 3D elements
8. Static structural analysis of any mechanical assembly

**Text Books/References:**

1. Nitin S. Gokhale, Practical Finite Element Analysis, Finite to Infinite; First edition
2. ANSYS user guide [https://www.ansys.com/academic/learning-resources](https://www.ansys.com/academic/learning-resources)
Course Name: Industrial Inspection & Quality Control (IIQC)  

Course Code: 20ME504 L

Pre-requisite: Manufacturing Process, Machine Drawing

Syllabus Version: V:1.1

Course Objectives:

To make students

6. Understand the GD & T symbols and its use w.r.to selection of methods of measurement and measuring instruments.
7. Aware about the concept of IS-919 tolerance, limits of size, fits, geometric and position tolerances, gauges and their design procedure.
8. Understand the advances in Metrology [viz. CMM, Laser, Machine Vision System] for industrial inspection etc.
9. Understand the process of use of Quality Control Technique in engineering industries.

Course Outcomes:

Students will be able to

5. Demonstrate the use of different length and angle measuring instruments and comparators.
6. Calibrate the measuring instrument and design the limit gauges
7. Select and apply/use appropriate Quality Management Tool and Quality Control Technique for clearly defined problem.
8. Apply Statistical Quality Control tool(s) to analyse and interpret the inspection data.

- Part [A] Experiment no. 1 and 6 are mandatory. Perform any three from experiment no. 2 to 5 & any three from experiment no. 7 to 10.

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<thead>
<tr>
<th>Expt. No.</th>
<th>Description</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Expt. No.1</td>
<td>Measurement of linear and angular dimensions using standard measuring instruments.</td>
<td>2 hours</td>
<td>1</td>
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<tr>
<td>Expt. No.2</td>
<td>Error determination of linear / angular measuring instruments and determination of linear and angular dimensions of given part, MSA (Gauge R &amp; R).</td>
<td>2 hours</td>
<td>2</td>
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<tr>
<td>Expt. No.3</td>
<td>Calibration of measuring instrument. Example – Dial gauge, Micrometer, Vernier (any one)</td>
<td>2 hours</td>
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<td>Expt. No.4</td>
<td>Verification of dimensions &amp; geometry of given components using Mechanical comparator.</td>
<td>2 hours</td>
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<td>Expt. No.5</td>
<td>Machine tool alignment testing on machine tool – Lathe / Drilling / Milling.</td>
<td>2 hours</td>
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<tr>
<td>Expt. No.6</td>
<td>Demonstration of surfaces inspection using optical flat/interferometers.</td>
<td>2 hours</td>
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<tr>
<td>Expt. No.7</td>
<td>Determination of geometry &amp; dimensions of given composite object / single point tool, using profile projector and tool maker’s microscope.</td>
<td>2 hours</td>
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<tr>
<td>Expt. No.</td>
<td>Description</td>
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<tr>
<td>8</td>
<td>Measurement of thread parameters using floating carriage diameter measuring</td>
<td>2 hours</td>
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<td></td>
<td>machine.</td>
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<td>9</td>
<td>Measurement of spur gear parameters using Gear Tooth Vernier, Span Micrometer/</td>
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<td></td>
<td>Gear Rolling Tester.</td>
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<td>10</td>
<td>Determination of given geometry using coordinate measuring machine</td>
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<td>(CMM).</td>
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**Part [B] Statistical Quality Control (SQC) (Any Two assignments)**

Note: Use of computational tools [such as Minitab / Matlab / MS Excel] are recommended.

**Assignment 1**

Note: For completing this assignment....

1. The templates ('.excel format') for drawing/developing Pareto Chart, Cause and Effect Diagram, FMEA sheet, 5S Sheet & Kaizen Sheet.
2. Make a screenshot and paste it in the '.ppt format' are made available on Google Classroom.

Part - I: Select any product / process and complete following steps...

i. Identify & enlist its Quality Characteristics,
ii. Identified Failure Modes [related to identified Quality Characteristics],
iii. Prepare Check Sheet,
iv. Draw Pareto Chart to prioritize quality characteristics,
v. Draw Cause and Effect Diagram,
vi. Develop FMEA Sheet

Part - II: Study any reference / case study available with you (in books or downloaded from internet) related to 5S activity & Kaizen activity then use attached formats of 5S & Kaizen Sheets, prepare it accordingly & add it (ie. its screenshot) in the same template file attached in '.ppt format' to complete this assignment...

[Note: Any opportunity of implementing 5S & Kaizen activity at any possible work place like, industry, workshops, shops, your home etc... you are most welcome. Only you need to explain it properly in the given format].

**Assignment 2**

Q.1. Instructions... for Variable type data-set...

Refer excel sheet for data one variable & two attribute data sets,
1. Select appropriate type of charts,
2. Calculate three sigma limits for specific charts,
3. Plot Control Charts of Variables
4. Interpret the meaning,
5. Determine process capability,
6. Comment on what conclusion would you draw about the ability of the process to produce the items within specified limits or not?

Q.2. Instructions... for Attribute type data-set...

Refer excel sheet for data one variable & two attribute data sets,
1. Select appropriate type of charts,
2. Calculate three sigma limits for specific charts,
3. Control Charts of Attribute,

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**CO:** 3

**CO:** 4
4. Interpret the meaning,  
5. Determine process capability,  
6. Comment on what conclusion would you draw about the ability of the process to produce the items within specified limits or not?

Q. 3. Differentiate between single, double & multiple sampling plans.

| Total Lecture hours: | 25 hours |

**Text Books:**


**Reference Books:**

1. ASTME, *Handbook of Industrial Metrology*, Prentice Hall of India Ltd.


3. Online Education resources: viz. NPTEL web site:  
   (2) nptel.ac.in/courses/112106179  
   (2) [www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html](http://www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html);  
   (3) [www.me.iitb.ac.in/~ramesh/courses/ME338/metrology6.pdf](http://www.me.iitb.ac.in/~ramesh/courses/ME338/metrology6.pdf);  
   nptel.ac.in/courses/110101010/;  
   (4) [freevideolectures.com › Mechanical › IIT Madras](http://freevideolectures.com › Mechanical › IIT Madras)  
   (5) nptel.ac.in/courses/112107143/37.
<table>
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<tr>
<th>Course Name</th>
<th>Numerical Methods Lab</th>
<th>L</th>
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<tr>
<td>Course Code</td>
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<tr>
<td>Prerequisite</td>
<td>Engineering Mathematics</td>
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<td>Syllabus Version</td>
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**Course Objectives:**

1. To use numerical methods to solve problems
2. To use mathematical solver.
3. To prepare flowcharts for numerical methods.
4. To write programs for numerical methods

**Course Outcomes:**

After successful completion of the course, students will be able to

1. Apply numerical methods to solve engineering problems.
2. Employ mathematical solver for numerical methods.
3. Prepare flowcharts for numerical methods.
4. Write programs

**Lab Work:**

1. To prepare flowcharts and write programs for **finding Root of Equation**: i) Newton Raphson method ii) Successive approximation method iii) bisection method
2. To prepare flowcharts and write programs for **Simultaneous Linear Algebraic Equations**: i) Gauss elimination methods ii) LU decomposition method iii) Tridiagonal matrix algorithm iv) Jacobi iteration method v) Gauss Seidel method
3. To prepare flowcharts and write programs for **Curve Fitting**: i) straight line ii) quadratic equation iii) power equation iv) exponential equation
4. To prepare flowcharts and write programs for **Interpolation**: i) Newton’s forward interpolation ii) Lagrange interpolation iii) Inverse Lagrange Interpolation
5. To prepare flowcharts and write programs for **Numerical Integration**: i) Newton Cotes methods ii) Gauss quadrature methods iii) double integration
6. To prepare flowcharts and write programs for **Ordinary Differential Equations**: i) Heun’s methods ii) Runge Kutta method- 4th order iii) RK2 method for simultaneous ODE
7. To prepare flowchart and write program for **Partial Differential Equation**: parabolic explicit method
<table>
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<tr>
<th></th>
<th>Text Books/References:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Steven C Chapra, Applied Numerical Methods with MATLAB for engineers and Scientists, McGraw Hill Education</td>
</tr>
</tbody>
</table>
Course Name | Thermal Lab | L | T | P
---|---|---|---|---
Course Code | 20ME506 L | - | - | 2
Pre-requisite | Manufacturing Process, Machine Drawing | Syllabus Version | V:1.1

Course Objectives:
1. To Conduct experiments involving steady state heat transfer phenomenon
2. To Analyze and process the experimental data/observations to ascertain the heat transfer
   To illustrate the results in the graphical form
3. To Illustrate the results in the graphical form
4. To Compare the results with available theoretical/experimental results and deduce the conclusion
   from it
5. To study the boiler construction and working

Course Outcomes:
After successful completion of the course, students will be able to
1. Conduct experiments involving steady state heat transfer phenomenon
2. Analyze and process the experimental data/observations to ascertain the heat transfer rate
3. Illustrate the results in the graphical form to find the nature of temperature variation over time
   and length
4. Compare the results with available theoretical/experimental results and deduce the conclusion
   from it
5. Understand the construction and working of industrial boiler and its accessories

Lab Work:
1. Determination of Thermal Conductivity of insulating powder
2. Determine heat transfer through composite solid
3. Determination of heat transfer coefficient in Natural Convection
4. Determination of heat transfer coefficient in Forced Convection
5. Determination of Emissivity of a Test surface
6. Determination of Stefan Boltzmann Constant
7. Determination of critical heat flux for given wire
8. Determination of temperature distribution along the fin length
9. Trial on parallel and counter flow heat exchanger
10. Visit to the industry for the study of boiler construction and operations
## Text Books/References:

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</table>
Course Name: Design Lab

Course Code: 20ME507 L

Prerequisite: Strength of machine elements, Machine design, Transmission system design.

Course Objectives:
1. To select the relevant data for designing the given system.
2. To design machine elements for the given assembly.
3. To prepare the drawings for the designed assembly.
4. To present the project work.

Course Outcomes:
After successful completion of the course, students will be able to
1. select the relevant data for designing the given system.
2. design machine elements for the given assembly.
3. prepare the drawings for the designed assembly.
4. present the project/assignment in the form of ppt presentation

Lab Work: The lab work will begin in semester IV and conclude at the end of semester V.

A. Assignments based on,
   - Selection of materials for engineering applications.
   - Standards and codes in design.
   - Manufacturing and assembly considerations in design.

B. Case studies based on engineering applications,
   - Design of gripper for robotic arm.
   - Design of power screw screw for machine tools/gate valve/screw clamp..
   - Design of threaded fasteners for pillar cranes/flange bearing/cylinder head.
   - Design of spring for valve mechanism/plate clutch/eccentric cam.

C. Comprehensive Design Project (Project Based Learning): Design project to be done by a group of 3-4 students, based on a transmission system for the given application e.g. gear box. Each group will carry out the design tasks and present their work in the form of ppt. The project involves identification of functional requirements, configuration of specifications, selection of mechanisms, preparation of layout, design of individual elements, preparation of design report, modelling and analysis using suitable software.

Text Books/References:


