# B.Tech.

IN

# MECHANICAL ENGINEERING

# CURRICULUM

# AND

# SYLLABI OF FIRST YEAR COURSES

(Applicable from 2023 Admission onwards)

**Department of Mechanical Engineering**
**NATIONAL INSTITUTE OF TECHNOLOGY CALICUT**
Kozhikode - 673601, KERALA, INDIA

# The Program Educational Objectives (PEOs) of B.Tech. in Mechanical Engineering

| | |
|---|---|
| **PEO1** | Excel in industry, technical profession and/or higher education by acquiring a strong foundation in mathematics, science and engineering fundamentals. |
| **PEO2** | Acquire scientific and engineering competencies to comprehend, analyze, design and create novel products and solutions to mechanical and industrial problems that are technically sound, economically feasible and socially acceptable. |
| **PEO3** | Exhibit professionalism, ethical attitude, communication and team working skills, multidisciplinary approach and an ability to relate engineering issues to the broader social context. |

# Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) of B.Tech. in Mechanical Engineering

| | |
|---|---|
| **PO1** | **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| **PO2** | **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. |
| **PO3** | **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. |
| **PO4** | **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| **PO5** | **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations. |
| **PO6** | **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. |
| **PO7** | **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| **PO8** | **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| **PO9** | **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| **PO10** | **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| **PO11** | **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| **PO12** | **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

| | |
|---|---|
| **PSO1** | Design and develop mechanical systems for structural, thermal and manufacturing applications. |
| **PSO2** | Ability to effectively utilize resources for improving the performance of mechanical systems. |
| **PSO3** | Demonstrate the ability to develop methods, procedures and solutions for cost-effective decisions in mechanical engineering. |

# CURRICULUM

**Total credits for completing B.Tech. in Mechanical Engineering is 150**.

**COURSE CATEGORIES AND CREDIT REQUIREMENTS:**

The structure of B.Tech. programmes shall have the following Course Categories:

| Sl. No. | Course Category | Number of Courses | Minimum Credits |
|---|---|---|---|
| 1. | Institute Core (IC) | 8 | 22 |
| 2. | Program Core (PC) and Program Electives (PE) | 31/32 | 82 |
| 3. | Open Electives (OE) | 8 | 24 |
| 4. | Institute Electives (IE)<br>( Entrepreneurship Innovation (EI) + Digital / Automation Technologies (DA) + Humanities, Social Science, Management (HM) ) | 6 | 18 |
| 5. | Activity Credits (AC) | -- | 4 |

## COURSE REQUIREMENTS

The effort to be put in by the student is indicated in the tables below as follows:
**L**: Lecture (One unit is of 50 minute duration)
**T**: Tutorial (One unit is of 50 minute duration)
**P**: Practical (One unit is of one hour duration)
**O**: Outside the class effort / self-study (One unit is of one hour duration)

**1. INSTITUTE CORE (IC)**

**a) Mathematics**

| Sl. No. | Course Code | Course Title | L | T | P | O | Credits |
|---|---|---|---|---|---|---|---|
| 1. | MA1003E | Mathematics I | 3 | 1* | 0 | 5 | 3 |
| 2. | MA1013E | Mathematics II | 3 | 1* | 0 | 5 | 3 |
| 3. | MA2003E | Mathematics III | 3 | 1* | 0 | 5 | 3 |
| 4. | MA2013E | Mathematics IV | 3 | 1* | 0 | 5 | 3 |
| | | **Total** | **12** | **4*** | **0** | **20** | **12** |

*Optional for Students (can be replaced by self-study)

**b) Basic Sciences and Drawing**

| Sl. No. | Course Code | Course Title | L | T | P | O | Credits |
|---|---|---|---|---|---|---|---|
| 1. | PH1002E | Mechanics and Waves | 3 | 0 | 0 | 6 | 3 |
| 2. | ME1011E | Engineering Graphics | 2 | 0 | 2 | 5 | 3 |
| | | **Total** | **5** | **0** | **2** | **11** | **6** |

**c) Professional Communication and Professional Ethics**

| Sl. No. | Course Code | Course Title | L | T | P | O | Credits |
|---|---|---|---|---|---|---|---|
| 1. | MS1001E | Professional Communication | 3 | 0 | 0 | 6 | 3 |
| 2. | ME2001E | Professional Ethics | 1 | 0 | 0 | 2 | 1 |
| | | **Total** | **4** | **0** | **0** | **8** | **4** |

## 2A. PROGRAMME CORE (PC)

| Sl. No. | Course Code | Course Title | L | T | P | O | Credits |
|---|---|---|---|---|---|---|---|
| 1. | ME1201E | Thermodynamics | 3 | 0 | 0 | 6 | 3 |
| 2. | ME1401E | Engineering Mechanics | 3 | 0 | 0 | 6 | 3 |
| 3. | ME1001E | Computer Programming and Numerical Methods | 2 | 0 | 2 | 5 | 3 |
| 4. | ME1391E | Mechanical Workshop | 0 | 0 | 2 | 1 | 1 |
| 5. | ME1311E | Materials Science | 3 | 0 | 0 | 6 | 3 |
| 6. | ME1411E | Solid Mechanics | 3 | 0 | 0 | 6 | 3 |
| 7. | ME1211E | Fluid Mechanics and Machinery | 3 | 1 | 0 | 8 | 4 |
| 8. | EE1013E | Electrical Engineering | 3 | 0 | 0 | 6 | 3 |
| 9. | EE1093E | Electrical Engineering Lab | 0 | 0 | 2 | 1 | 1 |
| 10. | ME2201E | Principles of Heat Transfer | 3 | 0 | 0 | 6 | 3 |
| 11. | ME2401E | Mechanics of Machines | 3 | 1 | 0 | 5 | 3 |
| 12. | ME2291E | Fluid Mechanics and Fluid Machinery Lab | 0 | 0 | 3 | 3 | 2 |
| 13. | ME2091E | Machine Drawing | 0 | 0 | 3 | 3 | 2 |
| 14. | ME2111E | Essentials of Management | 3 | 0 | 0 | 6 | 3 |
| 15. | ME2311E | Manufacturing Science | 3 | 0 | 0 | 6 | 3 |
| 16. | ME2211E | Thermal Engineering | 3 | 0 | 0 | 6 | 3 |
| 17. | CE2095E | Strength of Materials Lab | 0 | 0 | 2 | 1 | 1 |
| 18. | ME2292E | Thermal Engineering Lab | 0 | 0 | 3 | 3 | 2 |
| 19. | ME3101E | Operations Research | 3 | 0 | 0 | 6 | 3 |
| 20. | ME3301E | Metrology and Instrumentation | 3 | 0 | 0 | 6 | 3 |
| 21. | ME3302E | Additive and Subtractive Manufacturing Technologies | 2 | 0 | 0 | 4 | 2 |
| 22. | ME3391E | Production Engineering Lab | 0 | 0 | 3 | 3 | 2 |
| 23. | ME3392E | CAD / CAM Lab | 0 | 0 | 2 | 1 | 1 |
| 24. | ME3411E | Machine Design | 3 | 0 | 0 | 6 | 3 |
| 25. | ME3393E | Metrology and Instrumentation Lab | 0 | 0 | 3 | 3 | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 26. | ME3099E | Project-Part-I | 0 | 0 | 0 | 9 | 3 |
| 27. | ME4097E | Summer Internship | 0 | 0 | 0 | * | 2 |
| 28. | ME4098E | Project-Part-II | 0 | 0 | 0 | 9 | 3 |
| | | **Total** | **46** | **2** | **25** | **131** | **70** |

## 2B. LIST OF ELECTIVES (To be updated)

Following courses may be credited under the categories mentioned in the table below, in addition to the Programme Electives.

| Sl. No. | Course Code | Course Title | L | T | P | O | Credits | Additional Categories | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | OE | EI | DA | HM |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

There can be multiple programme elective baskets, if required. Departments can group programme electives according to areas of specialization that the students can opt

## 3. OPEN ELECTIVES (OE)

Courses offered by Other Departments/Schools/Centres or Approved Online Platforms, with a limit on the maximum number of courses from such platforms specified as per BTech Ordinances and Regulations. In addition, PE courses offered by the Parent department shall be included in this category for students of the Parent department.

## 4. INSTITUTE ELECTIVES (IE)

In case of the Institute Electives, courses in the appropriate categories offered by other departments/schools/centres also can be credited instead of the courses offered by the Department of Mechanical Engineering, subject to the approval from the Course Faculty and Faculty Advisor.

**a) Entrepreneurship / Innovation Basket (EI):**

Courses proposed by the Departments/Schools/Centres and approved by Institute Innovation Council. Total credits required is 3.

**b) Digital Automation Technologies (DA):**

Courses related to programming / automation tools & techniques / Industry 4.0. Total credits required is 6.

**c) Humanities, Social Science, Management (HM):**

Courses such as Indian and Foreign languages, Economics, Engineering Management, Financial Management and Design Thinking. Total credits required is 9.

## 5. ACTIVITY CREDITS (AC)

A minimum of 80 Activity Points are to be acquired for obtaining the 4 Activity Credits required in the curriculum.

Activity points acquired should be a minimum of 20 at the end of S4.
Activity points acquired should be a minimum of 40 at the end of S6.

Details of AC will be finalized later.

# PROGRAMME STRUCTURE

**Semester I**

| Sl. No. | Course Code | Course Title | L | T | P | O | Credits | Category |
|---|---|---|---|---|---|---|---|---|
| 1. | MA1003E | Mathematics I | 3 | 1 | 0 | 5 | 3 | IC |
| 2. | PH1002E | Mechanics and Waves | 3 | 0 | 0 | 6 | 3 | IC |
| 3. | ME1201E | Thermodynamics | 3 | 0 | 0 | 6 | 3 | PC |
| 4. | MS1001E | Professional Communication | 3 | 0 | 0 | 6 | 3 | IC |
| 5. | ME1401E | Engineering Mechanics | 3 | 0 | 0 | 6 | 3 | PC |
| 6. | ME1001E | Computer Programming and Numerical Methods | 2 | 0 | 2 | 5 | 3 | PC |
| 7. | ME1391E | Mechanical Workshop | 0 | 0 | 2 | 1 | 1 | PC |
| | | **Total** | **17** | **1** | **4** | **35** | **19** | **--** |

**Semester II**

| Sl. No. | Course Code | Course Title | L | T | P | O | Credits | Category |
|---|---|---|---|---|---|---|---|---|
| 1. | MA1013E | Mathematics II | 3 | 1 | 0 | 5 | 3 | IC |
| 2. | ME1311E | Materials Science | 3 | 0 | 0 | 6 | 3 | PC |
| 3. | ME1411E | Solid Mechanics | 3 | 0 | 0 | 6 | 3 | PC |
| 4. | ME1211E | Fluid Mechanics and Machinery | 3 | 1 | 0 | 8 | 4 | PC |
| 5. | ME1011E | Engineering Graphics | 2 | 0 | 2 | 5 | 3 | IC |
| 6. | EE1013E | Electrical Engineering | 3 | 0 | 0 | 6 | 3 | PC |
| 7. | EE1093E | Electrical Engineering Lab | 0 | 0 | 2 | 1 | 1 | PC |
| | | **Total** | **17** | **2** | **4** | **37** | **20** | **--** |

**Semester III**

| Sl. No. | Course Code | Course Title | L | T | P | O | Credits | Category |
|---|---|---|---|---|---|---|---|---|
| 1. | MA2003E | Mathematics III | 3 | 1 | 0 | 5 | 3 | IC |
| 2. | ME2001E | Professional Ethics | 1 | 0 | 0 | 2 | 1 | IC |
| 3. | ME2201E | Principles of Heat Transfer | 3 | 0 | 0 | 6 | 3 | PC |
| 4. | ME2401E | Mechanics of Machines | 3 | 1 | 0 | 5 | 3 | PC |
| 5. | | DA Elective - 1 | 3 | 0 | 0 | 6 | 3 | DA |
| 6. | | Open Elective - 1 | 3 | 0 | 0 | 6 | 3 | OE |
| 7. | ME2291E | Fluid Mechanics and Fluid Machinery Lab | 0 | 0 | 3 | 3 | 2 | PC |
| 8. | ME2091E | Machine Drawing | 0 | 0 | 3 | 3 | 2 | PC |
| | | **Total** | **16** | **2** | **6** | **36** | **20** | **--** |

**Semester IV**

| Sl. No. | Course Code | Course Title | L | T | P | O | Credits | Category |
|---|---|---|---|---|---|---|---|---|
| 1. | MA2013E | Mathematics IV | 3 | 1 | 0 | 5 | 3 | IC |
| 2. | ME2111E | Essentials of Management | 3 | 0 | 0 | 6 | 3 | PC |
| 3. | ME2311E | Manufacturing Science | 3 | 0 | 0 | 6 | 3 | PC |
| 4. | ME2211E | Thermal Engineering | 3 | 0 | 0 | 6 | 3 | PC |
| 5. | | Entrepreneurship / Innovation Elective | 3 | 0 | 0 | 6 | 3 | EI |
| 6. | | Open Elective - 2 | 3 | 0 | 0 | 6 | 3 | OE |
| 7. | CE2095E | Strength of Materials Lab | 0 | 0 | 2 | 1 | 1 | PC |
| 8. | ME2292E | Thermal Engineering Lab | 0 | 0 | 3 | 3 | 2 | PC |
| | | Minor Course - 1 | 3 | 0 | 0 | 6 | 3 | MC |
| **Total** (Excluding the Minor Course) | | | **18** | **1** | **5** | **39** | **21** | **--** |

**Semester V**

| Sl. No | Course Code | Course Title | L | T | P | O | Credits | Category |
|---|---|---|---|---|---|---|---|---|
| 1. | ME3101E | Operations Research | 3 | 0 | 0 | 6 | 3 | PC |
| 2. | ME3301E | Metrology and Instrumentation | 3 | 0 | 0 | 6 | 3 | PC |
| 3. | ME3302E | Additive and Subtractive Manufacturing Technologies | 2 | 0 | 0 | 4 | 2 | PC |
| 4. | | HM Elective - 1 | 3 | 0 | 0 | 6 | 3 | HM |
| 5. | | DA Elective - 2 | 3 | 0 | 0 | 6 | 3 | DA |
| 6. | | Open Elective - 3 | 3 | 0 | 0 | 6 | 3 | OE |
| 7. | ME3391E | Production Engineering Lab | 0 | 0 | 3 | 3 | 2 | PC |
| 8. | ME3392E | CAD / CAM Lab | 0 | 0 | 2 | 1 | 1 | PC |
| | | Minor Course - 2 | 3 | 0 | 0 | 6 | 3 | MC |
| **Total** (Excluding the Minor Course) | | | **17** | **0** | **5** | **38** | **20** | **--** |

**Semester VI**

| Sl. No. | Course Code | Course Title | L | T | P | O | Credits | Category |
|---|---|---|---|---|---|---|---|---|
| 1. | ME3411E | Machine Design | 3 | 0 | 0 | 6 | 3 | PC |
| 2. | | HM Elective - 2 | 3 | 0 | 0 | 6 | 3 | HM |
| 3. | | Programme Elective - 1 | 3 | 0 | 0 | 6 | 3 | PE |
| 4. | | Open Elective - 4 | 3 | 0 | 0 | 6 | 3 | OE |
| 5. | | Open Elective - 5 | 3 | 0 | 0 | 6 | 3 | OE |
| 6. | ME3393E | Metrology and Instrumentation Lab | 0 | 0 | 3 | 3 | 2 | PC |
| 7. | ME3099E | Project-Part-I | 0 | 0 | 0 | 9 | 3 | PC |
| | | Minor Course - 3 | 3 | 0 | 0 | 6 | 3 | MC |
| **Total** (Excluding the Minor Course) | | | **15** | **0** | **3** | **42** | **20** | **--** |

**Semester VII**

| Sl. No. | Course Code | Course Title | L | T | P | O | Credits | Category |
|---|---|---|---|---|---|---|---|---|
| 1. | | HM Elective - 3 | 3 | 0 | 0 | 6 | 3 | HM |
| 2. | | Programme Elective - 2 | 3 | 0 | 0 | 6 | 3 | PE |
| 3. | | Open Elective - 6 | 3 | 0 | 0 | 6 | 3 | OE |
| 4. | | Open Elective - 7 | 3 | 0 | 0 | 6 | 3 | OE |
| 5. | | Open Elective - 8 | 3 | 0 | 0 | 6 | 3 | OE |
| 6. | ME4097E | Summer Internship | 0 | 0 | 0 | * | 2 | PC |
| 7. | ME4098E | Project-Part-II | 0 | 0 | 0 | 9 | 3 | PC |
| | | Minor Course - 4 | 3 | 0 | 0 | 6 | 3 | MC |
| **Total** (Excluding the Minor Course) | | | **15** | **0** | **0** | **39** | **20** | **--** |

Note: ME4097E Summer Internship (including the academic internship) is to be completed during the vacation after S6, and the evaluation will be done in S7. Working hours will be decided by the organization in which the internship is done.

**Semester VIII**

| Sl. No. | Course Code | Course Title | L | T | P | O | Credits | Category |
|---|---|---|---|---|---|---|---|---|
| 1. | ME4099E / ME4xxxE | Project-Part-III / Programme Elective – 3, Programme Elective – 4 | 0/6 | 0 | 0 | 18/ 12 | 6 | PE |
| 2. | ME4096E | Activity Credits (minimum of 80 points) | - | - | - | - | 4 | AC |
| **Total** | | | | | | | **10** | **--** |

# DETAILED SYLLABUS

## MA1003E MATHEMATICS I
## (Common to CE/ME/PE/MSE branches)

Pre-requisites: Nil

| L | T | P | O | C |
|---|---|---|---|---|
| 3 | 1 | 0 | 5 | 3 |

**Total Lecture Sessions: 39**

**Course Outcomes:**
CO1: Find the limits, check for continuity and differentiability of real valued functions of one variable.
CO2: Find the limits, check for continuity and differentiability of real valued functions of two variables.
CO3: Find the maxima and minima of real valued functions of one or two variables.
CO4: Test the consistency of the system of linear equations and then solve it.
CO5: Diagonalise symmetric matrices and use it to find the nature of quadratic forms.

System of linear equations: Gauss elimination method, row echelon form, row space, row rank, existence and uniqueness, homogeneous system, Linear independence and span of row vectors, Linearly independent solutions, rank-nullity relation for homogeneous linear system. Eigenvalues and eigenvectors of a matrix, Cayley-Hamilton theorem, eigenvectors associated with distincteigenvalues, diagonalisation of matrices, symmetric, skew-symmetric and orthogonal matrices and their eigenvalues, orthogonal diagonalisation of symmetric matrices, bilinear and quadratic forms, definiteness of quadratic forms, transformation into principal axes.

Functions of one variable: limit, continuity, differentiability, local maxima and local minima, mean value theorems, Taylor's theorem, indeterminate form, L'hôpital's rule, integration, fundamental theorem of calculus, applications: finding volume and area, improper integrals, Gamma and Beta functions. Parameterised curves in space, arc length, tangent and normal vectors, curvature and torsion.

Functions of several variables: limit, continuity, partial derivatives, partial differentiation of composite functions, directional derivatives, gradient, applications like finding local maxima and local minima of functions of two variables, critical point, saddle point, Taylor's formula for two variables, Hessian, second derivative test, method of Lagrange multipliers, Evaluation of double integral, improper integrals, change of variables, Jacobian, polar coordinates, triple integral, cylindrical and spherical coordinates, applications:mass of a lamina, centre of gravity, moments of inertia.

**References:**

[1] Anton, H., Bivens, I., and Davis, S., 2015, *Calculus*, 10th ed., John Wiley & Sons, New York.
[2] Thomas, G. B., Weir, M.D., and Hass, J., 2015, *Thomas' Calculus*, 12th ed., India: Pearson Education, New Delhi.
[3] Kreyszig, E., 2015, *Advanced Engineering Mathematics*, 10th ed., John Wiley & Sons, New York.
[4] G. Strang, 2016, *Introduction to Linear Algebra*, Wellesley-Cambridge Press, Wellesley, MA.

## PH1002E MECHANICS AND WAVES

Pre-requisites: Nil

| L | T | P | O | C |
|---|---|---|---|---|
| 3 | 0 | 0 | 6 | 3 |

**Total Lecture Sessions: 39**

**Course Outcomes:**

CO1: Solve problems in mechanics and oscillations using Newton’s equations of motion.

CO2: Apply ideas of calculus of variations and Lagrangian for problems in classical mechanics.

CO3: Apply wave mechanics to describe interference, diffraction and polarization of waves.

CO4: Apply ideas of interference for various engineering problems.

**Oscillations**
Review of Newtonian Mechanics – Force – Newton’s II law and equations of motion – examples – Oscillations – equation of motion – solutions of the equations – damped oscillations – forced oscillations – resonance – coupled oscillations

**Lagrangian Mechanics**
Constraints – generalized coordinates – degrees of freedom – Virtual Displacement – D’Alembert’s Principle – Lagrangian – Variational Principle – Euler-Lagrange equations – examples – cyclic coordinates – conserved physical quantities

**Wave Motion**
Waves – longitudinal and transverse waves – wave equation – solutions – superposition principle –wave groups, group velocity and dispersion – interference of waves – diffraction – polarization

**Light Waves and Interference**
Light as a wave – Young’s double slit experiment – fringe pattern – visibility – coherence – diffraction – interferometry – Michelson interferometer – Mach-Zehnder interferometer – LASER: working principle, characteristics and applications

**References:**

[1] D. J. Morin, 2008, *Introduction to Classical Mechanics: With Problems and Solutions*, Cambridge University Press.
[2] D. Kleppner and R. J. Kolenkow, 2017, *An Introduction to Mechanics (1st Edition)*, McGraw Hill.
[3] Spiegel M. R., *Theoretical Mechanics*, (Schaum Series), McGraw Hill, 2017.
[4] D. Halliday, R. Resnick and J. Walker, 2013, *Fundamentals of Physics (10th Edition)*, John Wiley & Sons.
[5] F. L. Pedrotti, L. M. Pedrotti and L. S. Pedrotti, 2017, *Introduction to Optics (3rd Edition)*, Cambridge University Press.

# ME1201E THERMODYNAMICS

Pre-requisites: Nil

| L | T | P | O | C |
|---|---|---|---|---|
| 3 | 0 | 0 | 6 | 3 |

**Total Lecture Sessions: 39**

**Course Outcomes:**

CO1: Learn about phase changes of pure substances and evaluate their thermodynamic properties.

CO2: Evaluate energy transfers and efficiencies of thermo-mechanical systems.

CO3: Distinguish between reversible and irreversible processes and evaluate associated entropy change.

CO4: Perform second law (exergy) analysis of thermo-mechanical systems.

CO5: Analyze various thermodynamic property relations

**Basic Concepts**

Thermodynamic systems – Properties – State and equilibrium – Processes and cycles – Continuum – Classical thermodynamics – Forms of energy – energy transfer by heat and work – Temperature and zeroth law of thermodynamics – Pure substances – Phases – Phase change processes and property diagrams – Property tables – Equations of state – Ideal gas – compressibility factor.

**First Law**

First law of thermodynamics applied to closed systems executing processes and cycles – Energy transfer by mass – First law of thermodynamics applied to steady and unsteady flow processes – Steady flow engineering devices– Internal energy, enthalpy and specific heats of ideal gases – Thermodynamic processes executed by ideal gases.

**Second Law**

Limitations of first law – Thermal energy reservoirs and heat engines – Definitions of thermal efficiency and COP– refrigerators and heat pumps – Kelvin-Planck and Clausius statements – equivalence of the two statements – reversible and irreversible processes – Internal and external irreversibilities – Carnot cycle and Carnot principles – Absolute temperature scale – Carnot heat engine – Carnot refrigerator and heat pump.

**Entropy and Exergy**

Definition of entropy – Clausius inequality– Principle of increase of entropy – Entropy change of pure substances – Illustration of processes in T-S coordinates – T-ds relations – Entropy change of ideal gases – Reversible work and irreversibility – Exergy – Useful work, dead state and exergy function – Exergy and irreversibility in open and closed systems – Exergy transfer by heat, work and mass – Second law efficiency.

**Property Relations**

General thermodynamic relations – Combined First and Second law equations – Helmholtz and Gibb's functions – Maxwell's relations – Clapeyron equation – Joule Thomson coefficient – General relations for change in properties.

**References:**


[1] Cengel, Y. A., Boles, M. A., and Kanoglu, M., 2019, *Thermodynamics: An Engineering Approach*, 9th ed., McGraw Hill.

[2] Borgnakke, C., and Sonntag, R. E., 2020, *Fundamentals of Thermodyn*amics, 10th ed., John Wiley & Sons.

[3] Moran, M. J., Shapiro, H. N., Boettner, D. D., and Bailey, M. B., 2018, *Fundamentals of Engineering Thermodynamics*, 9th ed., John Wiley & Sons.

## MS1001E PROFESSIONAL COMMUNICATION

Pre-requisites: NIL

| L | T | P | O | C |
|---|---|---|---|---|
| 3 | 1 | 0 | 5 | 3 |

**Total Lecture Sessions : 39**

**Course Outcomes:**

CO1: Distinguish the role and purpose of communication at the workplace and for academic purposes.

CO2: Decide strategies and modes for effective communication in a dynamic workplace.

CO3: Combine multiple approaches for successful and ethical information exchange.

CO4: Estimate best communication practices to assist productivity and congeniality at the workplace.

**Listening and Reading Comprehension**

Conversation starters: introductions and small talk - Seek and provide information, clarification, polite enquiries, requests, congratulate people, apologise, give and respond to feedback - Describe graphs, tables, and charts - Words often confused: Lexicon and Meaning - Sense Groups - Listening for specific purposes: Listening to lectures, Summarise academic lectures for note-taking - Appropriate Language to Request and Respond - Public Speaking

**Vocabulary and Speaking**

Developing professional vocabulary - Basic Sentence Structures from Reading Texts - Concord - Functions of Auxiliary Verbs and Modals - Strategies for Effective Reading - Skimming and Scanning, Determine themes and main ideas, Predicting content using photos, images and titles - Critical Reading: Discussing and Summarising text points - Understanding Text Structures: sequencing, comparing and contrasting, relating cause and effect, problems and problem-solving - Discussing Rhetorical and Cultural Aspects in Texts - Text Appreciation: Drawing inferences, Framing Opinions and Judgments on Reading Text

**Effective Writing**

Note Making and Summarising: Prepare notes from reading texts, Paraphrasing - Use of Multimedia for Assistive Purposes - Paragraph Writing: cohesive devices to connect sentences in a paragraph - transitional devices - Use Text Structures in Paragraphs: sequencing, comparing and contrasting, relating cause and effect, problems and problem-solving - Avoiding Ambiguity and Cleft Sentences - Applications- Writing Instructions, Descriptions and Explanations - Official Letters of Request and Denial - Official E-mails - Abstract Writing - Digital Resources for Effective Communication

**Communication at Workplace**

Communication Theory - Process of Communication - Modes of Communication - Verbal and Non-Verbal Communication - Tone in Communication - Formal and Informal Communication at Workplace - Passive, Assertive and Aggressive Styles of Communication - Positive Body Language - Group Discussions - Presentation - Workplace Communication - Active Listening - Giving Feedback - Communication Etiquette - Persuasion - Negotiation - Tone and Voice - Telephone etiquette - Establishing Credibility in Conversations - Digital Communication and Netiquette: Conducting Oneself in Virtual Interactions, Constructive use of Social media - Ethical and Culturally Sensitive Communication: Ethical considerations in professional communication, Addressing diversity, Inclusive Communication Practices

**References:**


[1] Bhatnagar, N., and Bhatnagar, M., 2010, Communicative English for engineers and professionals. Dorling Kindersley.
[2] Foley, M., and Hall, D., 2018, Longman advanced learners 'grammar: A self-study reference & practice book with answers. Pearson Education.
[3] Garner, B. A., 2012, HBR Guide to better business writing: Engage readers, tighten and Brighten, make your case. Harvard Business Review Press.
[4] Hewings, M., 2013, Advanced grammar in use: A reference and practice book for Advanced learners of English. Cambridge University Press.
[5] Ibbotson, M., 2015, Cambridge English for Engineering. Cambridge University Press.
[6] Kumar, S., and Lata, P. 2015, *Communication Skills.* Oxford University Press.
[7] Sudarshana, N., and Savitha, C., 2016, *English for Technical Communication.* Cambridge English.

## ME1401E ENGINEERING MECHANICS

Pre-requisites: NIL

| L | T | P | O | C |
|---|---|---|---|---|
| 3 | 0 | 0 | 6 | 3 |

**Total Lecture Sessions: 39**

**Course Outcomes:**

CO1: Determine the resultants of a force system.

CO2: Solve rigid body statics problems using equations of equilibrium.

CO3: Determine the first and second moments of area for planar surfaces.

CO4: Perform kinematic analysis of particles.

CO5: Solve particle dynamics problems using Newton's laws, energy methods and momentum methods

**Equivalent force systems**
Introduction: idealizations of mechanics, vector and scalar quantities, equality and equivalence of vectors, laws of mechanics, elements of vector algebra – Important vector quantities: position vector, moment of a force about a point, moment of a force about an axis – couple and couple moment: definition, couple moment as a free vector, moment of a couple about a line – Equivalent force systems: translation of a force to a parallel position, resultant of a force system, simplest resultant of special force systems – distributed force systems.

**Rigid body statics**
Equations of equilibrium: free-body diagram, free bodies involving interior sections, general equations of equilibrium – problems of equilibrium – static indeterminacy – Friction forces: laws of Coulomb friction, simple contact friction problems.

**Properties of surfaces**
First moment and centroid of plane area – second moments and product of area for a plane area: transfer theorems, rotation of axes, polar moment of area, principal axes.

**Particle kinematics**
Introduction – differentiation of a vector with respect to time – velocity and acceleration calculations in rectangular coordinates – velocity and acceleration in terms of path variables and cylindrical coordinates – simple kinematical relations and applications.

**Particle dynamics**
Newton's law for rectangular coordinates – rectilinear translation – Newton's law for cylindrical coordinates – Newton's law for path variables – general motion of a system of particles – energy methods: introduction, conservative force field, conservation of mechanical energy, alternative form of work-energy equation – energy methods for a system of particles – methods of momentum for particles – Linear impulse and momentum relations for a single particle and system of particles – moment-of-momentum equation for a single particle and system of particles.

**References:**


[1] Shames, I. H., and Rao, G. K. M., 2005, *Engineering Mechanics – Statics and Dynamics*, 4th ed., Pearson Education India.
[2] Beer, F. P., Johnston Jr., E. R., Cornwell, P. J., Self, B. P., Mazurek, D. F., and Sanghi, S., 2019, *Vector Mechanics for Engineers – Statics and Dynamics.* 12th ed., McGraw Hill.
[3] Meriam, J. L., Kraige, L. G., and Bolton, J. N., 2021, *Engineering Mechanics – Statics and Dynamics*, 9th ed., Wiley.
[4] Hibbeler, R. C., 2017, *Engineering Mechanics – Statics and Dynamics*, 14th ed., Pearson.

## ME1001E COMPUTER PROGRAMMING AND NUMERICAL METHODS

Pre-requisites: NIL

| L | T | P | O | C |
|---|---|---|---|---|
| 2 | 0 | 2 | 5 | 3 |

**Total Sessions: 26L + 26P**

**Course Outcomes:**

CO1: Develop simple programs using the basic features of Python programming language.

CO2: Use advanced features of Python to develop efficient programs for solving complex problems.

CO3: Obtain the numerical solutions of various problems using Python programming.

**Basics of Python**
Setting up Python and managing packages – Jupyter notebook and logical operators – variables and assignment – data structures: string, list, tuple, set, dictionary and arrays – functions: basics, local and global variables, advanced features – branching statements – iterations using loops.

**Advanced Concepts**
Object oriented programming – representation of numbers – errors and good programming practices – debugging – reading and writing data – visualization and plotting: 2D & 3D plots, maps & movies.

**Numerical Methods using Python**
Linear algebra: solution of a system of equations, eigen values and eigen vectors - least squares regression – interpolation – Taylor series – root finding – numerical differentiation.

**References:**

[1] Kong, Q., Siauw, T., and Bayen, A. M., 2021, *Python Programming and Numerical Methods: A Guide for Engineers and Scientists*, Academic Press.
[2] Kiusalaas, J., 2013, *Numerical Methods in Engineering with Python 3*, Cambridge University Press.
[3] Matthes, E., 2023, *Python Crash Course: A Hands-On, Project-Based Introduction to Programming*, 3rd ed., No Starch Press.
[4] Chapra, S. C., and Canale, R. P., 2021, *Numerical Methods for Engineers*, 8th ed., McGraw Hill.

## ME1391E MECHANICAL WORKSHOP

Pre-requisites: Nil

| L | T | P | O | C |
|---|---|---|---|---|
| 0 | 0 | 2 | 1 | 1 |

**Total Practical Sessions: 26**

**Course Outcomes:**

CO1: Identify and use various tools used in a machine shop and perform the basic lathe operations such as turning, facing, chamfering, knurling etc.

CO2: Identify and use various tools used in fitting and welding and perform operations such as chipping, filing, cutting, drilling, etc., and prepare multiple joints and welds

CO3: Identify and use various tools in carpentry & sheet metal work and perform multiple operations for the preparation of joints using wood and fabrication using sheet metal

CO4: Identify and use various tools in smithy & foundry and to practice forging, moulding and casting

The course is intended to expose the student to various manufacturing processes through hands on training in different sections of Central Workshop. During the course, the student learns the properties and selection of different materials and acquires the skill in using various tools and measuring devices.

1. **Machine Shop:** Study of the basic lathe operations. Turning, step turning, facing, chamfering, thread cutting, grooving, knurling etc.
2. **Fitting:** Study of tools- chipping, filing, cutting, drilling, tapping, about male and female joints, stepped joints. Cutting and edge preparation for lap and butt joints.
3. **Welding:** Study of arc and gas welding, accessories, joint preparation. Welding of lap and butt joints, Single V and Double V.
4. **Carpentry:** Study of tools and joints – planing, chiseling, marking and sawing practice, one typical joint- Tee halving/cross halving/Mortise and Tenon/ Dovetail.
5. **Sheet Metal:** Study of tools, selection of different gauge sheets, types of joints. Fabrication of a tray or a funnel.
6. **Smithy:** Study of tools. Forging of square or hexagonal prism/chisel/bolt.
7. **Foundry:** Study of tools, sand preparation. Moulding practice using the given pattern and demonstration on casting.

**References:**

[1] Chapman, W. A. J, 2007, *Workshop Technology - Parts 1 & 2*, 4th ed., New Delhi, India, CBS Publishers & Distributors Pvt. Ltd.
[2] O'Bren, A. (Editor), 2001, *Welding Handbook*. 9th ed., Miami, American Welding Society.
[3] Anderson, J., 2002, *Shop Theory*, New Delhi, India, Tata McGraw Hill.
[4] Douglass, J. H., 1995, *Wood Working with Machines*, Illinois, McKnight & McKnight Pub. Co.
[5] Tuplin, W. A., 1996, *Modern Engineering Workshop Practice*, Odhams Press.
[6] Jain, P. L., 2009, *Principles of Foundry Technology*, 5th ed., New Delhi, India, Tata McGraw Hill.

## MA1013E MATHEMATICS II
## (Common to CE/ME/PE/MSE branches)

Pre-requisites: Nil

| L | T | P | O | C |
|---|---|---|---|---|
| 3 | 1 | 0 | 5 | 3 |

**Total Lecture Sessions: 39**

**Course Outcomes:**

CO1: Find the parametric representation of curves and surfaces in space and evaluate integrals over curves and surfaces

CO2: Understand the convergence of sequences and series and various methods of testing for convergence.

CO3: Solve linear ODEs with constant coefficients.

CO4: Formulate some engineering problems as ODEs and hence solve such problems.

CO5: Use Laplace transform and its properties to solve differential equations and integral equations.

Vector field: divergence, curl, identities involving divergence and curl, scalar potential. Line integral, independence of path, irrotational and solenoidal vector fields, Green's theorem for plane, parameterized surface, surface area and surface integral, flux, Gauss' divergence theorem, Stokes' theorem.

Numerical sequences, Cauchy sequence, convergence of sequences, series, convergence of series, tests for convergence, absolute convergence. Sequence of functions, power series, radius of convergence, Taylor series, periodic functions and Fourier series expansions, half-range expansions.

Existence and uniqueness of solution of first order ordinary differential equations (ODE)s, methods of solutions of first order ODE, linear ODE, linear homogeneous second order ODEs with constant coefficients, fundamental system of solutions, Wronskian, linear independence of solutions, method of undetermined coefficients, solution by variation of parameters, Euler-Cauchy differential equations, applications of ODEs.

Laplace transform, sufficient condition for existence, inverse Laplace transform, Dirac delta function, transforms of derivatives and integrals, shifting theorems, convolution, differentiation and integration of transform, solution of differential equations and integral equations using Laplace transform.

**References:**

[1] Kreyszig, E., 2015, *Advanced Engineering Mathematics*, 10th ed., India: Wiley, New Delhi.
[2] Anton, H., Bivens, I., and Davis, S., 2015, *Calculus*, 10th ed., John Wiley & Sons, New York.
[3] Arnold, V.I., 2006, *Ordinary Differential Equations*, Springer, New York.
[4] Dyke, P., 2014, *An Introduction to Laplace Transforms and Fourier Series*, Springer, New York.

## ME1311E MATERIALS SCIENCE

Pre-requisites: NIL

| L | T | P | O | C |
|---|---|---|---|---|
| 3 | 0 | 0 | 6 | 3 |

**Total Lecture Sessions: 39**

**Course Outcomes:**

CO1: Correlate the structure with properties of engineering materials

CO2: Identify the techniques for material characterisation.

CO3: Relate the phase evolution in materials with the processing conditions.

CO4: Describe the deformation of metals and various thermo-mechanical treatments of alloys.

CO5: Identify the properties and applications of major metallic and non-metallic engineering materials.

Engineering materials: classification, requirements, properties and selection of engineering materials – structure of solids: crystalline and non-crystalline materials, crystal structures, metallic, ionic and covalent solids – solid solutions: interstitial, substitutional ordered and disordered solid solutions – Hume-Rothery rules – crystal imperfections – edge and screw dislocations – Burgers vector – interaction between dislocations – techniques for materials characterisation: optical microscopy, electron microscopy (SEM and TEM), energy and wavelength-dispersive spectroscopy, X-ray diffraction – grain size and grain size measurement – ASTM grain size number.

Phase diagrams: evolution of phase diagrams, phase rule, equilibrium diagrams of binary alloys, isomorphous (Cu-Ni), eutectic (Pb-Sn), detailed study of Fe-C systems, tie-line and lever rule – phase transformations: solidification of metals, homogeneous and heterogeneous nucleation,supercooling, critical radius – microstructural changes during solidification: grain growth, dendritic pattern, equiaxed and columnar grains – solidification and structure of castings: coring, homogenization – transformations in steel – T-T-T diagram – diffusion in solids: mechanisms of diffusion, Fick's laws of diffusion, applications.

Deformation of metals: cold working, hot working – elastic and plastic deformations: mechanisms of plastic deformation, deformation by slip, slip systems, slip planes and slip directions, multiplication of dislocations: Frank-reed source – deformation by twinning – critical resolved shear stress – strengthening mechanisms: work hardening, dispersion hardening, precipitation hardening, solid solution strengthening, grain refinement – creep: mechanism, creep resistant materials – fatigue failure – heat treatment of steels: stress relieving, annealing, normalising, hardening, tempering – annealing of a cold worked article: recovery, recrystallisation and grain growth – hardenability – surface hardening techniques.

Ferrous alloys: steels, alloy steels, tool steels, stainless steels – effect of alloying elements on properties of steels – cast irons: classification, structure, properties, applications – non-ferrous alloys: Major alloys of Al, Cu, Mg, Zn and Ti and their applications – non-metallic materials: plastics, elastomers, composites, ceramics and glasses – advanced engineering materials: smart materials, shape memory alloys, functionally graded materials, super alloys and high-entropy alloys – introduction to functional materials: electrochemical energy storage: battery materials, fuel cells, supercapacitors – photovoltaic cells – dielectric materials – thermoelectrics – biomaterials – nanomaterials – materials for hydrogen production and storage.

**References:**


[1] Callister, W. D., and Rethwisch, D. G., 2018, *Materials Science and Engineering*, 10$^{th}$ ed., John Wiley.

[2] Smith, W. F., Hashemi, J., and Presuel-Moreno, F., 2022, *Foundations of Materials Science and Engineering*, 6$^{th}$ ed., McGraw-Hill.

[3] Raghavan, V., 2013, *Material Science and Engineering: A First Course*, PHI Learning.

[4] Abbaschian, R., and Reed-Hill, R. E., 2009, *Physical Metallurgy Principles*, 4$^{th}$ ed., Affiliated East-West Press.

[5] Porter, D. A., Easterling, K. E., and Sherif, M. Y., 2009, *Phase Transformations in Metals and Alloys*, 3$^{rd}$ ed., Taylor & Francis.

[6] Meyers, M. A., and Chawla, K. K., 2009, *Mechanical Behavior of Materials*, 2$^{nd}$ ed., Cambridge University Press.

[7] Huggins, R. A., 2016, *Energy Storage Fundamentals, Materials and Applications*, Springer.

[8] Shackelford, J. F., 2021, *Introduction to Materials Science for Engineers*, 9$^{th}$ ed., Pearson Education.

[9] Kasap, S. O., 2005, *Principles of Electronic Materials and Devices*, McGraw-Hill.

[10] Askeland, D. R., and Wright, W. J., 2021, *The Science and Engineering of Materials*, $7^{th}$ ed. Cengage Learning.

## ME1411E SOLID MECHANICS

Pre-requisites: NIL

| L | T | P | O | C |
|---|---|---|---|---|
| 3 | 0 | 0 | 6 | 3 |

**Total Lecture Sessions: 39**

**Course Outcomes:**

CO1: Perform structural analysis of components with uniform stress distribution.

CO2: Design the shafts carrying torsional loads.

CO3: Perform stress analysis of beams under different loading conditions.

CO4: Carry out the deflection analysis of beams.

CO5: Use transformation of stresses and strains to analyse components with compound loading.

CO6: Analyse columns carrying axial compressive loads.

**Components with Uniform Stress Distribution**

Introduction: general concepts, definition of stress, stress tensor – stress analysis of axially loaded members – shear stresses and direct shear problems – strength-based design of members (deterministic method) − axial strains and deformations in bars – Hooke’s Law – Poisson's ratio – thermal strain – Saint Venant's principle – elastic strain energy – statically indeterminate systems – strain tensor – constitutive relationships for shear – generalized Hooke's law for isotropic materials – relationships between elastic constants – analysis of thin-walled pressure vessels.

**Design of Shafts**

Torsion of circular elastic bars: stress distribution and angle of twist – statically indeterminate problems – torsion of inelastic circular bars – strain energy in torsion – torsion of thin-walled tubes.

**Stress Analysis of Beams**

Axial force, shear force and bending moment diagrams: sign conventions, axial force, shear force and bending moments by direct approach and integration – bending stresses in beams: elastic flexure formula, bending stresses – elastic strain energy in bending – inelastic bending – elastic bending with axial loads – shear stresses in beams: shear flow and shear stress formula.

**Deflection of Beams**

Deflection of beams: direct integration method, superposition techniques, moment-area method – elementary treatment of statically indeterminate beams.

**Transformation of Stress and Strain**

Transformation of stresses and strains (two-dimensional case only): equations of transformation, principal stresses – Mohr's circles of stress and strain – strain gauge rosettes – compound stresses: superposition and its limitations, eccentrically loaded members.

**Theory of Columns**

Buckling theory – Euler's formula – effect of end conditions – eccentric loads and secant formula.

**References:**

[1] Popov, E. P., 2015, *Engineering Mechanics of Solids*, 2nd ed., Pearson Education.
[2] Beer, F. P., Johnston, E. R., DeWolf, J. T., Mazurek, D. F., and Sanghi, S., 2020, *Mechanics of Materials*, 8th ed., McGraw Hill Education India.
[3] Timoshenko, S. P., and Young, D. H., 2003, *Elements of Strength of Materials*. East West.
[4] Shames, I. H., and Pitarresi, J. M., 2015, *Introduction to Solid Mechanics*, 3rd ed., Pearson.
[5] Crandall, S. H., Dahl, N. C., Lardner, T. J., and Sivakumar, M. S., 2017, *An Introduction to Mechanics of Solids*, 3rd ed., Tata McGraw-Hill.
[6] Timoshenko, S. P., and Goodier, J. N., 1970, *Theory of Elasticity*. McGraw Hill International.
[7] Sadd, M. H., 2014, *Elasticity: Theory, Applications and Numerics*, 3rd ed., Academic Press.

## ME1211E FLUID MECHANICS AND MACHINERY

Pre-requisites: Nil

| L | T | P | O | C |
|---|---|---|---|---|
| 3 | 1 | 0 | 8 | 4 |

**Total Lecture Sessions: 39**

**Course Outcomes:**

CO1: Static and kinematic analysis of fluids.

CO2: Apply the principle of conservation laws for typical flow situations.

CO3: Analysis of ideal, viscid fluid flows, and boundary layer flow over a surface.

CO4: Perform dimensional analysis, model and similitude.

CO5: Acquire knowledge of constructional details of hydraulic machines and conduct model studies

CO6. Select fluid machines and other hydraulic devices for various applications.

**Fluid properties, fluid statics and kinematics**
Fundamental concepts: stress, fluid, continuum, properties of fluids: Density, viscosity, compressibility, surface tension, capillarity, and vapor pressure – Fluid statics: Fundamental equation, pressure measurement, forces on submerged bodies, buoyancy and stability – Fluid kinematics: Scalar and vector fields, description of flow field and motion.

**Conservation equations, control volumes and potential flows**
Systems: control mass and control volume, Reynolds Transport Theorem (RTT), Conservation of mass, momentum and energy from RTT – Application of continuity, momentum, and energy equation to: inertial control volumes and non-inertial volumes – Stream function: concept, constancy and significance – Euler's equation, Bernoulli's equation and Irrotational flow – Applications: Venturimeter, orificemeter, flow nozzles, mouthpieces, Pitot tube with concepts of static and stagnation pressure – Potential flows: uniform flows, source or sink and vortex.

**Navier-Stokes Equation, boundary layer theory, and turbulent flows**
Exact solution of Navier-Stokes Equation: parallel flow in straight channel, and Hagen Poiseuille flow –
Boundary layer theory — Equations, Blasius solution, Momentum-Integral Equations and solution for flat plate, Boundary layer separation and control — Introduction to turbulent flows: nature, origin and structure, Reynolds stresses, near wall turbulent flow, turbulent boundary layer.

**Viscous pipe flows and Dimensional analysis**
Viscous flow through Pipes: concept of friction factor, Fanning and Darcy-Weisbach equation, Moody diagram, minor losses, Flow through pipes in series and parallel — Need for dimensional analysis, methods of dimensional analysis, Similitude, types of similitude, Model analysis.

**Rotodynamics and Hydraulic machines**
Classification of fluid machines, Basic equation of energy transfer in rotodynamic machines. Impulse and reaction turbines, efficiencies, principle of similarity and dimensional analysis – Pelton, Francis and Kaplan turbines: working principles, analysis for force and power generation, and draft tubes, Specific speed, unit quantities, performance curves, governing of turbines, cavitation. Centrifugal pumps: working principle; work done by the impeller; performance curves – Reciprocating pumps: working, Effect of acceleration and friction – Hydraulic systems: working principles of static and dynamics systems: Press, ram, accumulator, rotary positive displacement pump, fluid couplings and torque convertors.

**References:**

[1] Fox, R. W., McDonald, A. T., Pritchard, P. J., and Mitchell, J. W., 2018, *Fluid Mechanics*, John Wiley and Sons, NY.
[2] Cengel, Y. A., and John, M. C., 2019, *Fluid Mechanics Fundamental and Applications*, McGraw Hill Series.
[3] White, F. M., and Xue, H., 2022, *Fluid Mechanics*, McGraw Hill.
[4] Som, S. K., Biswas, G., and Chakraborty, S., 2017, *Fluid Mechanics and Fluid Machines*, McGraw Hill.
[5] Shames, I. H., 2013, *Mechanics of Fluids*, McGraw Hill Education.
[6] Kundu, P. K., Cohen, I. M., and Dowling, D. R., 2012, *Fluid Mechanics*, Elsevier.

[7] Munson, B. R., Okiishi, T. H., Huebsch, W. W., and Rothmayer, A. P., 2015, *Fluid Mechanics*, Wiley.
[8] Gupta, V., and Gupta, S. K., 2015, *Fluid Mechanics and Its Applications*, New Age International Private Limited.
[9] Shepherd, D. G., 1956, *Principles of Turbo Machinery*, Macmillan Company.
[10] Lal, J., 1975, *Hydraulic Machines*, Metropolitan book Co.
[11] Roshko, A., and Liepmann, H. W., 2003, *Elements of Gas Dynamics*, Dover Publications Inc.
[12] Streeter, V., Wylie, E. B., and Bedford, K. W., 2017, *Fluid Mechanics*, McGraw Hill.

## ME1011E ENGINEERING GRAPHICS

Pre-requisites: NIL

| L | T | P | O | C |
|---|---|---|---|---|
| 2 | 0 | 2 | 5 | 3 |

**Total Sessions: 26L + 26P**

**Course Outcomes:**

CO1: Use Indian Standard Code of Practice in Engineering Drawing.

CO2: Represent engineering objects by orthographic views.

CO3: Convert orthographic views of an engineering object into the isometric view.

CO4: Use software for drawing and visualizing engineering objects.

**Introduction to Engineering Graphics and Scales**
Drawing instruments and their uses, lines, lettering and dimensioning, Engineering drawing using software - Geometrical construction – Importance of Scales in engineering graphics.

**Orthographic Projections**
First and third angle projections (using software) - Orthographic projection of points on principal, profile, and auxiliary planes - Orthographic projection of straight line in simple and oblique positions - Application of orthographic projection of line - Orthographic projection of planes in simple and oblique position on principal and profile planes - Orthographic projection of lines and planes on auxiliary planes - Orthographic projection of solids in simple and oblique positions on principal and profile planes - Orthographic projections of solids in oblique position using auxiliary plane method

**Section, Development and Isometric view**
Orthographic projection of solids in section - Development of surfaces of solids - Method of isometric projection (Using software).

**References:**

[1] Bhatt, N. D., 2023, *Engineering Drawing*, 54th ed. Charotar Publishing House.
[2] Agrawal, B., and Agrawal, C. M., 2019, *Engineering Drawing*, 3rd ed. McGraw Hill Education.
[3] Venugopal, K., and Raja, P.V., 2022, Engineering Drawing + Auto CAD, 6th Edition, New Age Intl. Pvt Ltd.

## EE1013E ELECTRICAL ENGINEERING

Pre-requisites: NIL

| L | T | P | O | C |
|---|---|---|---|---|
| 3 | 0 | 0 | 6 | 3 |

**Total Lecture Sessions: 39**

**Course Outcomes:**

CO1: Acquire knowledge about the analysis of electric and magnetic circuits.

CO2: Acquire knowledge about the electrical measurements and measuring instruments.

CO3: Acquire knowledge about the fundamental principles and classification of electromagnetic machines.

CO4: Acquire knowledge about the major electrical machines such as transformers, dc machines, alternators and induction machines.

**Electric and Magnetic Circuits**

Node and mesh analysis of simple dc circuits - Thevenins theorem - Norton's theorem - Superposition theorem - star-delta transformation - alternating quantities - sinusoidal emf and current - frequency - average and rms values - representation of sinusoidal quantities - waveforms - phasors - Cartesian, polar and exponential forms - real, reactive and apparent power - power factor - analysis of simple RL, RC and RLC circuits - three phase system - phase sequence - balanced and unbalanced loads - power in three phase system - definition of magnetic quantities - analysis of simple magnetic circuits - Faraday's laws of electromagnetic induction - Lenz's law -,statically and dynamically induced emfs - self and mutual inductances - coefficient of coupling.

**Electrical Measurements**

Measuring instruments like voltmeters, ammeters, watt meters and energy meters - measurement of high and low resistances using voltmeter-ammeter method - measurement of power in single phase circuits - three voltmeter method - three ammeter method - wattmeter method - measurement of power in three phase circuits - two-wattmeter method - measurement of energy - single-phase energy meter.

**Electromagnetic Machines**

Fundamental principles - classification - static and rotating machines - transformers - generators - motors - elements of electromagnetic machines - windings - development of emf and torque - rotating magnetic field - introduction to power generation, transmission and distribution.

**Major Electrical Machines**

Transformers - construction - principle of operation - types - equivalent circuit - phasor diagram - voltage regulation - losses and efficiency - OC and SC tests - load test - applications.

DC Machines - construction - principle of operation - losses and efficiency - types - generators - emf equation - open circuit and external characteristics of shunt generator - motors - speed and torque equations - speed control - load test - performance characteristics of shunt and series motors - applications.

Alternators - construction - principle of operation - types - emf equation - voltage regulation - synchronous generators - synchronous motors - applications.

Induction machines - construction - principle of operation - types - three phase and single phase induction motors - torque vs slip characteristics - equivalent circuit - phasor diagram - losses and efficiency - methods of starting - speed control - load test - performance characteristics of squirrel cage and slip ring induction motors - applications.

**References:**

[1] Suresh Kumar, K.S., 2009, *Electric Circuits & Networks*, Pearson Education.
[2] Nahvi, M., and Edminister, J. A., 2014, *Electric Circuits* (*Schaum's Outlines)*, 6th ed., McGraw Hill.
[3] Sawhney, A. K., 2015, *A Course in Electrical, Electronic Measurements and Instrumentation*, Dhanpat Rai & Co., India.
[4] Clayton, A. E., and Hancock, N. N., 2003, *Performance and Design of DC Machines*, CBS Publishers and Distributors Pvt. Ltd.
[5] Nagarath, I. J., and Kothari, D. P., 2010, *Electric Machines*, 4th ed., Tata McGraw Hill Education Private Limited, New Delhi.

[6] Say, M. G., 1983, *The Performance and Design of Alternating Current Machines*, CBS Publishers and Distributors Pvt. Ltd.
[7] Toro, V. D., 1988, *Electrical Machines and Power Systems*, Prentice Hall.

## EE1093E ELECTRICAL ENGINEERING LAB

Pre-requisites: NIL

| L | T | P | O | C |
|---|---|---|---|---|
| 0 | 0 | 2 | 1 | 1 |

**Total Practical Sessions: 26**

**Course Outcomes:**

CO1: Acquire hands on experience of measuring various electrical quantities.

CO2: Acquire hands on experience of conducting various tests on dc machines.

CO3: Acquire hands on experience of conducting various tests on transformers.

CO4: Acquire hands on experience of conducting tests on induction machines.

**List of Experiments:**

1. Determination of V-I characteristic of a linear resistor and measurement of high and low resistances using voltmeter-ammeter method.
2. Measurement of power in a single phase circuit using a wattmeter.
3. Measurement of power in a 3-phase circuit using two-wattmeter method.
4. Measurement of energy using a single-phase energy meter and verification by power measurement.
5. Determination of the open circuit and external characteristics of a dc shunt generator.
6. Load test on a dc shunt motor and the determination of its performance characteristics.
7. Load test on a dc series motor and the determination of its performance characteristics.
8. Determination of efficiency and regulation of a single phase transformer by conducting (i) OC and SC tests and (ii) load test.
9. Load test on a squirrel cage induction motor and the determination of its performance characteristics.
10. Load test on a slip ring induction motor and the determination of its performance characteristics.

**References:**

[1] Sawhney, A. K, 2015, *A Course in Electrical and Electronic Measurements and Instrumentation*, Dhanpat Rai & Co., India.

[2] Nagarath, I. J., and Kothari, D. P., 2010, *Electric Machines*, 4th ed., Tata McGraw Hill Education Private Limited, New Delhi.

[3] Say, M. G., 1983, *The Performance and Design of Alternating Current Machines*, CBS Publishers and Distributors Pvt. Ltd.

[4] Toro, V. D., 1988, *Electrical Machines and Power Systems*, Prentice Hall.