# Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

**[An Autonomous Institution, affiliated to VTU, Belgaum and Aided by Government of Karnataka]**

**Near Jnana Bharathi Campus, Mallathalli, Bangalore-560056**

## DEPARTMENT OF MECHANICAL ENGINEERING

# SYLLABUS & SCHEME

# 2026 - 2027

| Computer Aided Engineering Drawing for CV Stream | | Semester | I/II |
|---|---|---|---|
| Course Code | 1BCED103A/203A | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 2 :0 :2 : 0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |
| Examination type (SEE) | Theory (Conducted in batches similar to practical's) | | |

**Course Outcomes**

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

**CO 1.** Generate orthographic projections of points, lines, planes, and solids manually and with computer-aided tools.

**CO 2.** Develop the lateral surfaces of solids for real-world applications.

**CO 3.** Draw isometric views and convert isometric drawings to orthographic views.

**CO 4.** Create 3D models of basic building components.

**Module-1**

**Introduction:**

Significance of Engineering drawing, BIS Conventions of Engineering Drawing, Free hand sketching of engineering drawing, Scales.

Introduction to Computer Aided Drafting software, Co-ordinate system and reference planes HP, VP, RPP & LPP of 2D/3D environment. Selection of drawing sheet size and scale. Commands and creation of Lines, coordinate points, axes, polylines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet and curves.

**Orthographic Projections of Points, Lines and Planes:**

Introduction to Orthographic projections, Orthographic projections of points in 1$^{st}$ and 3$^{rd}$ quadrants.

Orthographic projections of lines (Placed in First quadrant only as per BIS)

Orthographic projections of planes: triangular, square, rectangular, pentagonal, hexagonal and circular lamina (Placed in First quadrant only using change of position method).

Number of Hours: 08

**Module-2**

**Orthographic Projection of Solids:**

Orthographic projection of right regular solids (Resting on HP only and inclined to both the planes); Prisms, Pyramids, Cylinders & Cones.

Number of Hours: 08

**Module-3**

**Section of Solids:**

Introduction, Section planes, Sectional views: apparent shapes and true shapes, Sections of right regular prisms, pyramids, cylinders and cones resting with their base on HP. (Concepts only and No Problems for practice)

**Development of Lateral Surfaces of Solids:**

Development of lateral surfaces of right regular Prisms, Pyramids, Cylinders & Cones and their frustums and truncations. Problems on applications of development of lateral surfaces like funnels and trays.

Number of Hours: 08

**Module-4**

**Isometric Views:**

Introduction to Isometric views, Isometric projections, Isometric scale.
Isometric view of hexahedron (cube), right regular prisms, pyramids, cylinders, cones and spheres, Isometric view of combination of two simple solids, step block.

Conversion of simple isometric drawings into orthographic views: Problems on conversion of Isometric view of simple objects / engineering components into orthographic views.

Number of Hours: 08

**Module-5**

**Building Components Drafting (For CIE Only):**

Modeling Basic Building Components: foundations, columns, beams, slabs, walls, doors windows, staircase, assigning materials and rendering building components.
Drafting a 2D floor plan for a simple single-storey residential/commercial building, Converting the floor plan into 3D model with walls, openings, and roof structure.
Concept of building drawing

Number of Hours: 08

**Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):**

**Textbooks:**


1. K. R. Gopalakrishna, & Sudhir Gopalakrishna: A Textbook of Computer Aided Engineering Drawing, 39th Edition, Subash Stores, Bangalore, 2017
2. Bhatt, N.D., Engineering Drawing: Plane and Solid Geometry, 53rd Edition, Charotar Publishing House Pvt. Limited, 2023.


**Reference books:**


1. S. N. Lal and T. Madhusudhan, Engineering Visualisation, engage Learning India Pvt. Ltd.; First Edition, 2022
2. P.J. Shah, Computer Aided Engineering Drawing, S. Chand Publishing, 2021
3. M. B. Shah & B.C. Rana., Engineering Drawing, Pearson Education, Revised Edition, 2009
4. V.B. Sikka, A Course in Civil Engineering Drawing, 11th edition, S.K. Kataria & Sons, reprint 2024.


**Web links and Video Lectures (e-Resources):**

- https://nptel.ac.in/courses/112104172
- https://nptel.ac.in/courses/112102304
- https://nptel.ac.in/courses/112105294
- https://www.coursera.org/courses?query=3d%20modeling&utm
- https://www.gsourcedata.com/a-guide-to-the-world-of-civil-engineering-drawings-the-architectural-atlas/

**Teaching-Learning Process (Innovative Delivery Methods):**

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

- Flipped Classroom
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching

**Assessment Structure:**

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least 5**0% of 50 marks**, i.e., **25 marks**.
- To pass the **SEE**, a student must score at least 40**% of 50 marks**, i.e., 20 **marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE is at least 45 out of 100 marks**.

**Continuous Internal Evaluation (CIE):**

| **SCHEME FOR INTERNAL ASSESSMENT (IA)** | | |
|---|---|---|
| | **DETAILS** | **MAX. MARKS** |
| **Manual Sketching (25)** | Classwork | 15 |
| | Assignment | 10 |
| **Computer Printout (15)** | Classwork | 15 |
| | **CIE*** | 10 |
| | **TOTAL IA MARKS** | 50 |
| * Continuous Internal Evaluation (CIE) is based on the one test conducted during the end-semester. | | |

**Semester End Examination (SEE):**

| **Scheme of Evaluation for Semester End Examination (SEE)** | | | |
|---|---|---|---|
| Unit | Maximum Marks | Manual Sketching | Computer solution and print out |
| 1 | 10 | 10 | 00 |
| 2 | 20 | 10 | 10 |
| 3 | 20 | 10 | 10 |
| **OR** | | | |
| 4 | 20 | 10 | 10 |
| **Total** | **50** | **30** | **20** |

| QUESTION PAPER PATTERN FOR SEMESTER END EXAMINATION (SEE) | | | | | | |
|---|---|---|---|---|---|---|
| **UNIT** | 1 | | 2 | | 3 | 4 |
| **Max. Marks** | 10 | | 20 | | 20 | 20 |
| **Q. No.** | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 |

NOTE:

1. Each Full question shall cover all the topics of the Unit.
2. Unit 2, Unit 3 and Unit 4 to have both manual sketching and computer solution/print out.
3. Unit 1 have only manual sketching.
4. Model question paper may be referred for distribution of topics in each Full Question.

| **Question no** | **Topics** | **Sketching** | **Drafting** | |
|---|---|---|---|---|
| 1 | Projection of lines | 10 M | ------- | **10 M** |
| | **OR** | | | |
| 2 | Projection of planes | 10 M | ----- | |
| 3 | Projection of solids | 10 M | 10 M | **20M** |
| | **OR** | | | |
| 4 | Projection of solids | 10 M | 10 M | |
| 5 | Isometric projection | 10 M | 10 M | **20 M** |
| | **OR** | | | |
| 6 | Development of solids | 10 M | 10 M | |
| | **Total Marks** | | | **50 M** |

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO1** | **PO1** | **PO12** |
| **CO1** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO2** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO3** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO4** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO5** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not | | | | | | | | | | | | |

| Computer Aided Engineering Drawing for CS Stream | | Semester | I/II |
|---|---|---|---|
| Course Code | 1BCED103B/203B | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 2 :0 :2 : 0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |
| Examination type (SEE) | Theory (Conducted in batches similar to practical's) | | |

**Course Outcomes**

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

**CO 1.** Generate orthographic projections of points, lines, planes, and solids manually and with computer-aided tools.

**CO 2.** Develop the lateral surfaces of solids for real-world applications.

**CO 3.** Draw isometric views and convert isometric drawings to orthographic views.

**CO 4.** Create 3D models of embedded, networking, and IoT devices.

**Module-1**

**Introduction:**

Significance of Engineering drawing, BIS Conventions of Engineering Drawing, Free hand sketching of engineering drawing, Scales.

Introduction to Computer Aided Drafting software, Co-ordinate system and reference planes HP, VP, RPP & LPP of 2D/3D environment. Selection of drawing sheet size and scale. Commands and creation of Lines, coordinate points, axes, polylines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet and curves.

**Orthographic Projections of Points, Lines and Planes:**

Introduction to Orthographic projections, Orthographic projections of points in 1$^{st}$ and 3$^{rd}$ quadrants.

Orthographic projections of lines (Placed in First quadrant only as per BIS)

Orthographic projections of planes: triangular, square, rectangular, pentagonal, hexagonal and circular lamina (Placed in First quadrant only using change of position method).

Number of Hours: 08

**Module-2**

**Orthographic Projection of Solids:**

Orthographic projection of right regular solids (Resting on HP only and inclined to both the planes); Prisms, Pyramids, Cylinders & Cones.

Number of Hours: 08

**Module-3**

**Section of Solids:**

Introduction, Section planes, Sectional views: apparent shapes and true shapes, Sections of right regular prisms, pyramids, cylinders and cones resting with their base on HP. (Concepts only and No Problems for practice)

**Development of Lateral Surfaces of Solids:**

Development of lateral surfaces of right regular Prisms, Pyramids, Cylinders & Cones and their frustums and truncations. Problems on applications of development of lateral surfaces like funnels and trays.

Number of Hours: 08

**Module-4**

**Isometric Views:**

Introduction to Isometric views, Isometric projections, Isometric scale.
Isometric view of hexahedron (cube), right regular prisms, pyramids, cylinders, cones and spheres, Isometric view of combination of two simple solids, step block.

Conversion of simple isometric drawings into orthographic views: Problems on conversion of Isometric view of simple objects / engineering components into orthographic views.

Number of Hours: 08

**Module-5**

**Computer Network Drawing (For CIE Only):**

2D Network drawing with wired and wireless, Network topology - wired and wireless.
3D Modeling: Raspberry Pi / Arduino boards, Router & switches, IoT devices - Concept of converting to 3D printing format (stl)
Concept of Industrial drawing

Number of Hours: 08

**Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):**

**Textbooks:**


1. K. R. Gopalakrishna, & Sudhir Gopalakrishna: A Textbook of Computer Aided Engineering Drawing, 39th Edition, Subash Stores, Bangalore, 2017
2. Bhatt, N.D., Engineering Drawing: Plane and Solid Geometry, 53rd Edition, Charotar Publishing House Pvt. Limited, 2023.


**Reference books:**


1. S. N. Lal and T. Madhusudhan, Engineering Visualisation, engage Learning India Pvt. Ltd.; First Edition, 2022
2. P.J. Shah, Computer Aided Engineering Drawing, S. Chand Publishing, 2021
3. M. B. Shah & B.C. Rana., Engineering Drawing, Pearson Education, Revised Edition, 2009
4. Frederick E. Giesecke, et al., Technical Drawing with Engineering Graphics, Prentice Hall, 2016


**Web links and Video Lectures (e-Resources):**

- https://nptel.ac.in/courses/112104172
- https://nptel.ac.in/courses/112102304
- https://nptel.ac.in/courses/112105294
- https://www.coursera.org/courses?query=3d%20modeling&utm
- https://www.youtube.com/watch?v=zbqrNg4C98U

**Teaching-Learning Process (Innovative Delivery Methods):**

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

- Flipped Classroom
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching

**Assessment Structure:**

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least 5**0% of 50 marks**, i.e., **25 marks**.
- To pass the **SEE**, a student must score at least 40**% of 50 marks**, i.e., 20 **marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE is at least 45 out of 100 marks**.

**Continuous Internal Evaluation (CIE):**

| **SCHEME FOR INTERNAL ASSESSMENT (IA)** | | |
|---|---|---|
| | **DETAILS** | **MAX. MARKS** |
| **Manual Sketching (25)** | Classwork | 15 |
| | Assignment | 10 |
| **Computer Printout (15)** | Classwork | 15 |
| | **CIE*** | 10 |
| | **TOTAL IA MARKS** | 50 |
| * Continuous Internal Evaluation (CIE) is based on the one test conducted during the end-semester. | | |

**Semester End Examination (SEE):**

| **Scheme of Evaluation for Semester End Examination (SEE)** | | | |
|---|---|---|---|
| Unit | Maximum Marks | Manual Sketching | Computer solution and print out |
| 1 | 10 | 10 | 00 |
| 2 | 20 | 10 | 10 |
| 3 | 20 | 10 | 10 |
| **OR** | | | |
| 4 | 20 | 10 | 10 |
| **Total** | **50** | **30** | **20** |

| QUESTION PAPER PATTERN FOR SEMESTER END EXAMINATION (SEE) | | | | | | |
|---|---|---|---|---|---|---|
| **UNIT** | 1 | | 2 | | 3 | 4 |
| **Max. Marks** | 10 | | 20 | | 20 | 20 |
| **Q. No.** | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 |

NOTE:

1. Each Full question shall cover all the topics of the Unit.
2. Unit 2, Unit 3 and Unit 4 to have both manual sketching and computer solution/print out.
3. Unit 1 have only manual sketching.
4. Model question paper may be referred for distribution of topics in each Full Question.

| **Question no** | **Topics** | **Sketching** | **Drafting** | |
|---|---|---|---|---|
| 1 | Projection of lines | 10 M | ------- | **10 M** |
| | **OR** | | | |
| 2 | Projection of planes | 10 M | ----- | |
| 3 | Projection of solids | 10 M | 10 M | **20M** |
| | **OR** | | | |
| 4 | Projection of solids | 10 M | 10 M | |
| 5 | Isometric projection | 10 M | 10 M | **20 M** |
| | **OR** | | | |
| 6 | Development of solids | 10 M | 10 M | |
| | **Total Marks** | | | **50 M** |

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO1** | **PO1** | **PO12** |
| **CO1** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO2** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO3** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO4** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO5** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not | | | | | | | | | | | | |

| Computer Aided Engineering Drawing for ME Stream | | Semester | I/II |
|---|---|---|---|
| Course Code | 1BCED103C/203C | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 2 :0 :2 : 0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |
| Examination type (SEE) | Theory (Conducted in batches similar to practical's) | | |

**Course Outcomes**

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

**CO 1.** Generate orthographic projections of points, lines, planes, and solids manually and with computer-aided tools.

**CO 2.** Develop the lateral surfaces of solids for real-world applications.

**CO 3.** Draw isometric views and convert isometric drawings to orthographic views.

**CO 4.** Create basic 3D models of engineering components and parts.

**Module-1**

**Introduction:**

Significance of Engineering drawing, BIS Conventions of Engineering Drawing, Free hand sketching of engineering drawing, Scales.

Introduction to Computer Aided Drafting software, Co-ordinate system and reference planes HP, VP, RPP & LPP of 2D/3D environment. Selection of drawing sheet size and scale. Commands and creation of Lines, coordinate points, axes, polylines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet and curves.

**Orthographic Projections of Points, Lines and Planes:**

Introduction to Orthographic projections, Orthographic projections of points in 1$^{st}$ and 3$^{rd}$ quadrants.

Orthographic projections of lines (Placed in First quadrant only as per BIS)

Orthographic projections of planes: triangular, square, rectangular, pentagonal, hexagonal and circular lamina (Placed in First quadrant only using change of position method).

Number of Hours: 08

**Module-2**

**Orthographic Projection of Solids:**

Orthographic projection of right regular solids (Resting on HP only and inclined to both the planes); Prisms, Pyramids, Cylinders & Cones.

Number of Hours: 08

**Module-3**

**Section of Solids:**

Introduction, Section planes, Sectional views: apparent shapes and true shapes, Sections of right regular prisms, pyramids, cylinders and cones resting with their base on HP. (Concepts only and No Problems for practice)

**Development of Lateral Surfaces of Solids:**

Development of lateral surfaces of right regular Prisms, Pyramids, Cylinders & Cones and their frustums and truncations. Problems on applications of development of lateral surfaces like funnels and trays.

Number of Hours: 08

**Module-4**

**Isometric Views:**

Introduction to Isometric views, Isometric projections, Isometric scale.
Isometric view of hexahedron (cube), right regular prisms, pyramids, cylinders, cones and spheres, Isometric view of combination of two simple solids, step block.

Conversion of simple isometric drawings into orthographic views: Problems on conversion of Isometric view of simple objects / engineering components into orthographic views.

Number of Hours: 08

**Module-5**

**Concept of Part Design (For CIE Only):**

3D Modeling: Simple machine parts / engineering components. (Applying material properties and rendering for realistic visualization)
Sheet Metal & Surface Design: Automotive panels, HVAC ducting
Concept of Industrial drawing

Number of Hours: 08

**Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):**

**Textbooks:**

1. K. R. Gopalakrishna, & Sudhir Gopalakrishna: A Textbook of Computer Aided Engineering Drawing, 39th Edition, Subash Stores, Bangalore, 2017
2. Bhatt, N.D., Engineering Drawing: Plane and Solid Geometry, 53rd Edition, Charotar Publishing House Pvt. Limited, 2023.

**Reference books:**

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3. M. B. Shah & B.C. Rana., Engineering Drawing, Pearson Education, Revised Edition, 2009

**Web links and Video Lectures (e-Resources):**

- https://nptel.ac.in/courses/112104172
- https://nptel.ac.in/courses/112102304
- https://nptel.ac.in/courses/112105294
- https://www.coursera.org/courses?query=3d%20modeling&utm
- https://www.classcentral.com/subject/sheet-metal-design?utm

**Teaching-Learning Process (Innovative Delivery Methods):**

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

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- Case-Based Teaching
- Simulation and Virtual Labs
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**Assessment Structure:**

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

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- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE is at least 45 out of 100 marks**.

**Continuous Internal Evaluation (CIE):**

| **SCHEME FOR INTERNAL ASSESSMENT (IA)** | | |
|---|---|---|
| | **DETAILS** | **MAX. MARKS** |
| **Manual Sketching (25)** | Classwork | 15 |
| | Assignment | 10 |
| **Computer Printout (15)** | Classwork | 15 |
| | **CIE*** | 10 |
| | **TOTAL IA MARKS** | 50 |
| * Continuous Internal Evaluation (CIE) is based on the one test conducted during the end-semester. | | |

**Semester End Examination (SEE):**

| **Scheme of Evaluation for Semester End Examination (SEE)** | | | |
|---|---|---|---|
| Unit | Maximum Marks | Manual Sketching | Computer solution and print out |
| 1 | 10 | 10 | 00 |
| 2 | 20 | 10 | 10 |
| 3 | 20 | 10 | 10 |
| **OR** | | | |
| 4 | 20 | 10 | 10 |
| **Total** | **50** | **30** | **20** |

| QUESTION PAPER PATTERN FOR SEMESTER END EXAMINATION (SEE) | | | | | | |
|---|---|---|---|---|---|---|
| **UNIT** | 1 | | 2 | | 3 | 4 |
| **Max. Marks** | 10 | | 20 | | 20 | 20 |
| **Q. No.** | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 |

NOTE:

1. Each Full question shall cover all the topics of the Unit.
2. Unit 2, Unit 3 and Unit 4 to have both manual sketching and computer solution/print out.
3. Unit 1 have only manual sketching.
4. Model question paper may be referred for distribution of topics in each Full Question.

| **Question no** | **Topics** | **Sketching** | **Drafting** | |
|---|---|---|---|---|
| 1 | Projection of lines | 10 M | ------- | **10 M** |
| | **OR** | | | |
| 2 | Projection of planes | 10 M | ----- | |
| 3 | Projection of solids | 10 M | 10 M | **20M** |
| | **OR** | | | |
| 4 | Projection of solids | 10 M | 10 M | |
| 5 | Isometric projection | 10 M | 10 M | **20 M** |
| | **OR** | | | |
| 6 | Development of solids | 10 M | 10 M | |
| | **Total Marks** | | | **50 M** |

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO1** | **PO1** | **PO12** |
| **CO1** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO2** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO3** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO4** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO5** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not | | | | | | | | | | | | |

| Computer Aided Engineering Drawing for ECE Stream | | Semester | I/II |
|---|---|---|---|
| Course Code | 1BCED103D/203D | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 2 :0 :2 : 0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |
| Examination type (SEE) | Theory (Conducted in batches similar to practical's) | | |

**Course Outcomes**

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

**CO 1.** Generate orthographic projections of points, lines, planes, and solids manually and with computer-aided tools.

**CO 2.** Develop the lateral surfaces of solids for real-world applications.

**CO 3.** Draw isometric views and convert isometric drawings to orthographic views.

**CO 4.** Create basic 3D models of electronic components and parts.

**Module-1**

**Introduction:**

Significance of Engineering drawing, BIS Conventions of Engineering Drawing, Free hand sketching of engineering drawing, Scales.

Introduction to Computer Aided Drafting software, Co-ordinate system and reference planes HP, VP, RPP & LPP of 2D/3D environment. Selection of drawing sheet size and scale. Commands and creation of Lines, coordinate points, axes, polylines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet and curves.

**Orthographic Projections of Points, Lines and Planes:**

Introduction to Orthographic projections, Orthographic projections of points in 1$^{st}$ and 3$^{rd}$ quadrants.

Orthographic projections of lines (Placed in First quadrant only as per BIS)

Orthographic projections of planes: triangular, square, rectangular, pentagonal, hexagonal and circular lamina (Placed in First quadrant only using change of position method).

Number of Hours: 08

**Module-2**

**Orthographic Projection of Solids:**

Orthographic projection of right regular solids (Resting on HP only and inclined to both the planes); Prisms, Pyramids, Cylinders & Cones.

Number of Hours: 08

**Module-3**

**Section of Solids:**

Introduction, Section planes, Sectional views: apparent shapes and true shapes, Sections of right regular prisms, pyramids, cylinders and cones resting with their base on HP. (Concepts only and No Problems for practice)

**Development of Lateral Surfaces of Solids:**

Development of lateral surfaces of right regular Prisms, Pyramids, Cylinders & Cones and their frustums and truncations. Problems on applications of development of lateral surfaces like funnels and trays.

Number of Hours: 08

**Module-4**

**Isometric Views:**

Introduction to Isometric views, Isometric projections, Isometric scale.
Isometric view of hexahedron (cube), right regular prisms, pyramids, cylinders, cones and spheres, Isometric view of combination of two simple solids, step block.

Conversion of simple isometric drawings into orthographic views: Problems on conversion of Isometric view of simple objects / engineering components into orthographic views.

Number of Hours: 08

**Module-5**

**Electronic Components Visualisation (For CIE Only):**

3D Modelling: Optical fibre cable with core and cladding, photonic crystal fibers, Antenna: Single element patch antenna, antenna array.
Sheet Metal & Surface Design: PCB Enclosures: Creation of different geometry with slots as per Standards: NMEA-0183, applying material properties for heat sink and water/dust proofing and rendering for realistic visualization.
Concept of Industrial drawing

Number of Hours: 08

**Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):**

**Textbooks:**


1. K. R. Gopalakrishna, & Sudhir Gopalakrishna: A Textbook of Computer Aided Engineering Drawing, 39th Edition, Subash Stores, Bangalore, 2017
2. Bhatt, N.D., Engineering Drawing: Plane and Solid Geometry, 53rd Edition, Charotar Publishing House Pvt. Limited, 2023.


**Reference books:**


1. S. N. Lal and T. Madhusudhan, Engineering Visualisation, engage Learning India Pvt. Ltd.; First Edition, 2022
2. P.J. Shah, Computer Aided Engineering Drawing, S. Chand Publishing, 2021
3. M. B. Shah & B.C. Rana., Engineering Drawing, Pearson Education, Revised Edition, 2009
4. A K Mittal & Kapeel Dev, Electronics Engineering Drawing, Computech Publications Limited, 2025
5. John Frostad, Electronics Drafting, Goodheart-Willcox Pub; 4th Edition, 2010.


**Web links and Video Lectures (e-Resources):**

- https://nptel.ac.in/courses/112104172
- https://nptel.ac.in/courses/112102304
- https://nptel.ac.in/courses/112105294
- https://www.coursera.org/courses?query=3d%20modeling&utm
- https://fiberopticx.com/optical-fiber-cable-structure/
- https://www.newport.com.cn/t/photonic-crystal-fibers

**Teaching-Learning Process (Innovative Delivery Methods):**
The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

- Flipped Classroom
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching

**Assessment Structure:**

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least 5**0% of 50 marks**, i.e., **25 marks**.
- To pass the **SEE**, a student must score at least 40**% of 50 marks**, i.e., 20 **marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE is at least 45 out of 100 marks**.

**Continuous Internal Evaluation (CIE):**

| **SCHEME FOR INTERNAL ASSESSMENT (IA)** | | |
|---|---|---|
| | **DETAILS** | **MAX. MARKS** |
| **Manual Sketching (25)** | Classwork | 15 |
| | Assignment | 10 |
| **Computer Printout (15)** | Classwork | 15 |
| | **CIE*** | 10 |
| | **TOTAL IA MARKS** | 50 |
| * Continuous Internal Evaluation (CIE) is based on the one test conducted during the end-semester. | | |

**Semester End Examination (SEE):**

| **Scheme of Evaluation for Semester End Examination (SEE)** | | | |
|---|---|---|---|
| Unit | Maximum Marks | Manual Sketching | Computer solution and print out |
| 1 | 10 | 10 | 00 |
| 2 | 20 | 10 | 10 |
| 3 | 20 | 10 | 10 |
| **OR** | | | |
| 4 | 20 | 10 | 10 |
| **Total** | **50** | **30** | **20** |

| QUESTION PAPER PATTERN FOR SEMESTER END EXAMINATION (SEE) | | | | | | |
|---|---|---|---|---|---|---|
| **UNIT** | 1 | | 2 | | 3 | 4 |
| **Max. Marks** | 10 | | 20 | | 20 | 20 |
| **Q. No.** | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 |

NOTE:

1. Each Full question shall cover all the topics of the Unit.
2. Unit 2, Unit 3 and Unit 4 to have both manual sketching and computer solution/print out.
3. Unit 1 have only manual sketching.
4. Model question paper may be referred for distribution of topics in each Full Question.

| **Question no** | **Topics** | **Sketching** | **Drafting** | |
|---|---|---|---|---|
| 1 | Projection of lines | 10 M | ------- | **10 M** |
| | **OR** | | | |
| 2 | Projection of planes | 10 M | ----- | |
| 3 | Projection of solids | 10 M | 10 M | **20M** |
| | **OR** | | | |
| 4 | Projection of solids | 10 M | 10 M | |
| 5 | Isometric projection | 10 M | 10 M | **20 M** |
| | **OR** | | | |
| 6 | Development of solids | 10 M | 10 M | |
| | **Total Marks** | | | **50 M** |

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO1** | **PO1** | **PO12** |
| **CO1** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO2** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO3** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO4** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO5** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not | | | | | | | | | | | | |

| Computer Aided Engineering Drawing for EE Stream | | Semester | I/II |
|---|---|---|---|
| Course Code | 1BCED103E/203E | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 2 :0 :2 : 0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |
| Examination type (SEE) | Theory (Conducted in batches similar to practical's) | | |

**Course Outcomes**

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

**CO 1.** Generate orthographic projections of points, lines, planes, and solids manually and with computer-aided tools.

**CO 2.** Develop the lateral surfaces of solids for real-world applications.

**CO 3.** Draw isometric views and convert isometric drawings to orthographic views.

**CO 4.** Create schematic diagrams of Electrical Systems.

**Module-1**

**Introduction:**

Significance of Engineering drawing, BIS Conventions of Engineering Drawing, Free hand sketching of engineering drawing, Scales.

Introduction to Computer Aided Drafting software, Co-ordinate system and reference planes HP, VP, RPP & LPP of 2D/3D environment. Selection of drawing sheet size and scale. Commands and creation of Lines, coordinate points, axes, polylines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet and curves.

**Orthographic Projections of Points, Lines and Planes:**

Introduction to Orthographic projections, Orthographic projections of points in 1$^{st}$ and 3$^{rd}$ quadrants.

Orthographic projections of lines (Placed in First quadrant only as per BIS)

Orthographic projections of planes: triangular, square, rectangular, pentagonal, hexagonal and circular lamina (Placed in First quadrant only using change of position method).

Number of Hours: 08

**Module-2**

**Orthographic Projection of Solids:**

Orthographic projection of right regular solids (Resting on HP only and inclined to both the planes); Prisms, Pyramids, Cylinders & Cones.

Number of Hours: 08

**Module-3**

**Section of Solids:**

Introduction, Section planes, Sectional views: apparent shapes and true shapes, Sections of right regular prisms, pyramids, cylinders and cones resting with their base on HP. (Concepts only and No Problems for practice)

**Development of Lateral Surfaces of Solids:**

Development of lateral surfaces of right regular Prisms, Pyramids, Cylinders & Cones and their frustums and truncations. Problems on applications of development of lateral surfaces like funnels and trays.

Number of Hours: 08

**Module-4**

**Isometric Views:**

Introduction to Isometric views, Isometric projections, Isometric scale.
Isometric view of hexahedron (cube), right regular prisms, pyramids, cylinders, cones and spheres, Isometric view of combination of two simple solids, step block.

Conversion of simple isometric drawings into orthographic views: Problems on conversion of Isometric view of simple objects / engineering components into orthographic views.

Number of Hours: 08

**Module-5**

**Electrical Drawing (For CIE Only):**

2D drawing of switches, sockets, panels, junction boxes, antenna, electric circuits.
Schematic diagrams of Automatic fire alarm, Call bell system, UPS system, Basic power system diagram.
Concept of Industrial drawing

Number of Hours: 08

**Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):**

**Textbooks:**


1. K. R. Gopalakrishna, & Sudhir Gopalakrishna: A Textbook of Computer Aided Engineering Drawing, 39th Edition, Subash Stores, Bangalore, 2017
2. Bhatt, N.D., Engineering Drawing: Plane and Solid Geometry, 53rd Edition, Charotar Publishing House Pvt. Limited, 2023.


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2. P.J. Shah, Computer Aided Engineering Drawing, S. Chand Publishing, 2021
3. M. B. Shah & B.C. Rana., Engineering Drawing, Pearson Education, Revised Edition, 2009
4. Bhattacharya S. K., Electrical Engineering Drawing, New Age International Publishers, Second edition 1998, reprint 2005.


**Web links and Video Lectures (e-Resources):**

- https://nptel.ac.in/courses/112104172
- https://nptel.ac.in/courses/112102304
- https://nptel.ac.in/courses/112105294
- https://www.coursera.org/courses?query=3d%20modeling&utm
- https://elion.co.in/understanding-electrical-drawings-a-beginners-guide/

**Teaching-Learning Process (Innovative Delivery Methods):**

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

- Flipped Classroom
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching

**Assessment Structure:**

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least 5**0% of 50 marks**, i.e., **25 marks**.
- To pass the **SEE**, a student must score at least 40**% of 50 marks**, i.e., 20 **marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE is at least 45 out of 100 marks**.

**Continuous Internal Evaluation (CIE):**

| **SCHEME FOR INTERNAL ASSESSMENT (IA)** | | |
|---|---|---|
| | **DETAILS** | **MAX. MARKS** |
| **Manual Sketching (25)** | Classwork | 15 |
| | Assignment | 10 |
| **Computer Printout (15)** | Classwork | 15 |
| | **CIE*** | 10 |
| | **TOTAL IA MARKS** | 50 |
| * Continuous Internal Evaluation (CIE) is based on the one test conducted during the end-semester. | | |

**Semester End Examination (SEE):**

| **Scheme of Evaluation for Semester End Examination (SEE)** | | | |
|---|---|---|---|
| Unit | Maximum Marks | Manual Sketching | Computer solution and print out |
| 1 | 10 | 10 | 00 |
| 2 | 20 | 10 | 10 |
| 3 | 20 | 10 | 10 |
| **OR** | | | |
| 4 | 20 | 10 | 10 |
| **Total** | **50** | **30** | **20** |

| QUESTION PAPER PATTERN FOR SEMESTER END EXAMINATION (SEE) | | | | | | |
|---|---|---|---|---|---|---|
| **UNIT** | 1 | | 2 | | 3 | 4 |
| **Max. Marks** | 10 | | 20 | | 20 | 20 |
| **Q. No.** | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 |

NOTE:

1. Each Full question shall cover all the topics of the Unit.
2. Unit 2, Unit 3 and Unit 4 to have both manual sketching and computer solution/print out.
3. Unit 1 have only manual sketching.
4. Model question paper may be referred for distribution of topics in each Full Question.

| **Question no** | **Topics** | **Sketching** | **Drafting** | |
|---|---|---|---|---|
| 1 | Projection of lines | 10 M | ------- | **10 M** |
| | **OR** | | | |
| 2 | Projection of planes | 10 M | ----- | |
| 3 | Projection of solids | 10 M | 10 M | **20M** |
| | **OR** | | | |
| 4 | Projection of solids | 10 M | 10 M | |
| 5 | Isometric projection | 10 M | 10 M | **20 M** |
| | **OR** | | | |
| 6 | Development of solids | 10 M | 10 M | |
| | **Total Marks** | | | **50 M** |

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO1** | **PO1** | **PO12** |
| **CO1** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO2** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO3** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO4** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **CO5** | 3 | 2 | 2 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 2 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not | | | | | | | | | | | | |

| INTRODUCTION TO MECHANICAL ENGINEERING | | Semester | I/II |
|---|---|---|---|
| Course Code | 1BEST104D/204D | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3-0-0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 50 |
| Credits | 3 | Exam Hours | 3 |
| Examination type (SEE) | **Theory** | | |

**Course outcomes**

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

1. Recognize the significance of mechanical engineering principles to solve the problems of social relevance.
2. Understand the working of I.C. engines, power transmission elements and future mobility vehicles.
3. Discuss the properties and applications of engineering materials, composite materials and smart materials.
4. Describe the working principles and applications of various manufacturing processes.
5. Explain the advances in mechanical engineering.

**Module-1**

Introduction: Streams in mechanical engineering and their relevance/significance, role of mechanical engineers in solving the real case problems (with examples), careers in mechanical engineering.

Realization of some of the engineering solutions through principles of mechanical engineering(with a schematic diagram):

Energy conversion: Introduction and basic working principles of Pelton Turbine and Centrifugal pump.

Vehicle systems: Identification of parts of vehicle systems such as steering system, brake system, gear system, working principle of Power steering.

Flying machines: Classification, basic parts involved in drone making, working principle of Drones.

Refrigeration and air conditioning principles.

Number of Hours:8

**Module-2**

Engines: Introduction, petrol engine, diesel engines, Working of four Stroke engines, applications.

Insight into Future Mobility: Electric and Hybrid Vehicles, Components of Electric and Hybrid Vehicles. Advantages and disadvantages of EVs and Hybrid vehicles.

Power Transmission systems: Classification of gears, simple & compound gear trains, concepts of automatic and CVT transmission.

Number of Hours:8

**Module-3**

Engineering materials: Introduction, Classification, Ferrous and Non-Ferrous metals: Types, Properties and their applications.

Composite materials: Introduction, Constituents of a composite, Classification, Types of Matrix and Reinforcement materials, Advantages, Disadvantages and Applications of composite materials.

Smart materials: Introduction, Types - Piezoelectric materials, MR fluids, Shape memory alloys and Advantages, Disadvantages and Applications.

Number of Hours:8

**Module-4**

Manufacturing overview, classification of manufacturing processes, process selection criterion.
Principles of Welding, soldering, brazing.
Introduction to machine tools – lathe, drilling and milling machine.
Lathe operations: Turning, facing, knurling,
Drilling machine operations: Drilling, reaming, tapping.
Milling machine operations: End milling, face milling.
Introduction to CNC, components, advantages and applications.
Basic principles of 3D printing.

Number of Hours:8

**Module-5**

**Advances in mechanical engineering**
Automation technology: Definition of automation, types of automation, basic elements of automation.
Mechatronic systems: Definition of mechatronics, elements of mechatronics systems, examples.
Elementary sensors: Working principle and applications of Potentiometer, capacitive sensor and optical encoders.
Integrated system: Need for integration of technologies, ADAS (Advanced Driver Assistance System).

Number of Hours:8

**Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):**

**Textbooks:**


1. Elements of Mechanical Engineering, K R Gopala Krishna, Subhash Publications, 2008
2. An Introduction to Mechanical Engineering, Jonathan Wickert and Kemper Lewis, Third Edition, 2012


**Reference books / Manuals:**


1. Manufacturing Technology- Foundry, Forming and Welding, P.N.Rao Tata McGraw Hill 3rd Ed., 2003.
2. William D. Callister, Materials Science & Engineering, An Introduction, John Wiley & Sons Inc, 2010.
3. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Education; 4th edition, 2017.
4. Robotics, Appu Kuttan KK K. International Pvt Ltd, volume 1
5. Groover M. P.(2008). Automation, production systems, and computer integrated manufacturing, 3rd ed. Prentice Hall.
6. Dr SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A Practical Approach", ETI Labs

**Web links and Video Lectures (e-Resources):**

- https://nptel.ac.in/courses/112104526
- https://nptel.ac.in/courses/112104616
- https://nptel.ac.in/courses/112104769
- https://theconstructor.org/practical-guide/pelton-turbine-parts-working-design-aspects/2894/
- https://www.mechstudies.com/centrifugal-pump/
- https://cfdflowengineering.com/working-principle-and-components-of-drone/
- https://youtu.be/i1ojp09VXHY
- https://www.theengineerspost.com/automatic-transmission/
- https://learnmech.com/continuously-variable-transmission-components-working-types/

**Teaching-Learning Process (Innovative Delivery Methods):**

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

- Flipped Classroom
- Simulation and Virtual Labs
- Partial Delivery of course by Industry experts
- ICT-Enabled Teaching
- Video demonstration

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). The minimum passing mark for the SEE is 35% of the maximum marks (18 marks out of 50).

| **Continuous Internal Evaluation (CIE) (Marks)** | | | | |
|---|---|---|---|---|
| **Test 1** | **Test 2** | **Assignment** | **Group discussion** | **Total** |
| **20** | **20** | **05** | **05** | **50** |

**Semester End Examination (SEE):**

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 3 |
| **CO2** | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 3 |
| **CO3** | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 |
| **CO4** | 3 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 |
| **CO5** | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |
| **Level 3- Highly Mapped, Level 2-Moderately Mapped, Level 1-Low Mapped, Level 0- Not Mapped** | | | | | | | | | | | | |

| Elements of Mechanical Engineering | | Semester | I / II |
|---|---|---|---|
| Course Code | 1BMET105/205 | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P:S) | 3:0:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 3 | Exam Hours | 3 |
| Examination type (SEE) | Theory | | |

**Course Outcomes**

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

1. Analyse the properties of steam, various engineering materials along with their classifications and applications.
2. Illustrate the basic concepts of thermodynamics, internal combustion engines and electric/hybrid vehicles.
3. Demonstrate the working and operations of machine tools and metal joining techniques.
4. Outline the configuration, anatomy, and performance parameters of robots.
5. Apply the concepts of belt and gear drives to solve basic numerical problems related to velocity ratio in gear drives.
6. Discuss the role of computer systems in manufacturing, their contribution to automation, and the applications of 3D printing and AI in mechanical engineering.

**Module-1**

**Engineering materials:** Introduction, Classification, Ferrous and Non-Ferrous metals: Types, Properties and their applications.

**Composite materials:** Introduction, Constituents of a composite, Classification, Types of Matrix and Reinforcement materials, Advantages, Disadvantages and Applications of composite materials in Aerospace and Automobile industries.

**Smart materials:** Introduction, Types - Piezoelectric materials, MR fluids, Shape memory alloys and Advantages, Disadvantages and Applications.

**Nano materials:** Introduction, Types of nano materials, Advantages, Disadvantages and Applications.

Number of Hours: 8

**Module-2**

**Concepts of Thermodynamics:** Work, Energy, Heat, Modes of Heat transfer: Conduction, Convection and Radiation. Steam: Formation of steam, Properties of Steam, Numericals related to the properties of steam.

Introduction to Heat engines and Heat pumps.

**Introduction to Internal Combustion engines:** Working principle of Two stroke and Four stroke engines (SI & CI Engines), No Numericals.

**Electric vehicles and Hybrid vehicles:** Working principles, Electric and Hybrid vehicle components, Brief introduction to energy storage in Electric vehicles.

Number of Hours: 8

**Module-3**

**Machine Tools:**

**Lathe:** Working principle, Specifications, Operations performed – Turning, Facing, Taper turning by swivelling the compound rest, Thread cutting and Knurling.

**Drilling Machine:** Working principle, Specifications, Operations performed – Drilling, Reaming, Boring, Counterboring, Countersinking, Tapping.

**Milling machine:** Working principle, Specifications, Operations performed – Plane milling, End milling, Slot milling, Angular milling.

(Sketches of machine tools not required. Sketches to be used only for explaining the operations).

**Joining Processes:** Introduction, Temporary and Permanent joining methods: Working principle of Soldering, Brazing and Electric Arc welding, Advantages, Limitations and Applications.

Number of Hours: 8

**Module-4**

**Belt drives:** Introduction, Open and Cross belt drives. (No derivations and numericals), Flat belts and V belts.

**Gear Drives:** Types of Gears, Velocity ratio, Gear Trains - Simple and Compound gear trains and Numericals.

**Robotics:** Introduction, Generation of Robots, Asimov's laws of Robots, Robot anatomy - Links and Joints, Types of Robots, Configurations of Robots, Robot motion - Degrees of Freedom, Robot sensors: Tactile, Force, Proximity and Vision sensors, Definition of Work volume, Accuracy, Precision, Repeatability and Payload.

Number of Hours: 8

**Module-5**

**Computer Numerical Control (CNC):** Introduction, Definition of NC and CNC Components of CNC. Definition of CAD, CAM, CAE and CIM.

**Automation:** Definition, Types of Automation, Reasons for Automation.

**Additive manufacturing:** Introduction, Basic principles (Steps in additive manufacturing), Additive manufacturing processes – Photopolymerization technique, Material extrusion technique and Powder based fusion technique, Automotive and Aerospace applications.

**Applications of AI in Mechanical Engineering:** Automobile industry, manufacturing industry and Mechanical design.

Number of Hours: 8

**Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):**

**Textbooks:**


1. K R Gopala Krishna, Elements of Mechanical Engineering, Subhash Publications, 2018.
2. S K Hajra Choudhury and Nirjhar Roy, Elements of Workshop Technology (Vol. I and II), Media Promoters and Publishers Pvt. Ltd., 2016.
3. Ganeshan. V, Internal Combustion Engines, Tata McGraw Hill, 4th Edition, 2012.
4. Rajput R.K, Thermal Engineering, Laxmi Publications (Pvt) Ltd., New Delhi. 6th Edition, 2007.
5. Mikell P. Grover, Automation Production Systems and Computer Integrated Manufacturing, PHI, 2004.
6. Husain Iqbal, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 3rd Edition,

2021.
7. Ian Gibson, David. W. Rosen, Brent Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Springer, 2nd Edition, 2014.
8. Mikell P. Groover and Emory W. Zimmers, CAD/CAM. Zimmer & Groover CAD/CAM, 2007.

**Reference books / Manuals:**

1. Serope Kalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, Fourth Edition, Pearson Education, Asia, 2000.
2. Radha Krishna & S. Subramanian, CAD/CAM/CIM, New Age International Publishers, 2009
3. F.L.Matthews and R.D.Rawlings, Composite materials: Engineering and Science, Woodhead Publishing Ltd. & CRC Press, 2003.
4. Mikell P.Groover and Mitchel Weiss and Roger N.Nagel Nicholas G.Odrey, Industrial Robotics technology, programming and applications, Tata McGraw Hill Edition, 2008

**Web links and Video Lectures (e-Resources):**

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- https://nptel.ac.in/courses/112104616
- https://nptel.ac.in/courses/112104769
- https://venturebeat.com/ai/how-ai-is-impacting-the-automotive-world/
- https://www.vlcsolutions.com/blog/artificial-intelligence-in-manufacturing/
- https://skill-lync.com/blogs/technical-blogs/design-applications-of-machine-learning-and-ai-in-mechanical-engineering
- https://caeassistant.com/blog/ai-in-mechanical-engineering-video/
- https://www.neuralconcept.com/post/how-is-ai-used-in-mechanical-engineering
- https://www.youtube.com/watch?v=MKiiXubKaGM
- https://www.youtube.com/watch?v=_canCYWZPsc
- https://www.youtube.com/watch?v=lQ-MYnyxh7M

**Teaching-Learning Process (Innovative Delivery Methods):**

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

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- Simulation and Virtual Labs
- Partial Delivery of course by Industry experts
- ICT-Enabled Teaching
- Video demonstration

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). The minimum passing mark for the SEE is 35% of the maximum marks (18 marks out of 50).

| Continuous Internal Evaluation (CIE) (Marks) | | | | |
|---|---|---|---|---|
| **Test 1** | **Test 2** | **Assignment** | **Group discussion** | **Total** |
| **20** | **20** | **05** | **05** | **50** |

**Semester End Examination (SEE):**

| QUESTION PAPER PATTERN (SEE) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 3 |
| **CO2** | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 3 |
| **CO3** | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 |
| **CO4** | 3 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 |
| **CO5** | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |
| **Level 3- Highly Mapped, Level 2-Moderately Mapped, Level 1-Low Mapped, Level 0- Not Mapped** | | | | | | | | | | | | |

| Elements of Mechanical Engineering Lab | | Semester | I / II |
|---|---|---|---|
| Course Code | 1BMEL106/206 | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P:S) | 0:0:2 | SEE Marks | 50 |
| Total Hours of Pedagogy | 24 Hours (12-week session) | Total Marks | 100 |
| Credits | 1 | Exam Hours | 3 |
| Examination type (SEE) | **Practical** | | |

**Course Outcomes**

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

1. Perform various operations using lathe and welding machine.
2. Calibrate various measuring devices to achieve accuracy of measurement.
3. Demonstrate angular measurement of a given specimen using appropriate device.
4. Determine the properties and characteristics of fuels and oils.
5. Determine the hardness of materials using hardness testing machine.

**Note:**

1. The laboratory syllabus consists of PART-A and PART-B. While PART-A has 6 conventional experiments, PART-B has 6 typical open-ended experiments. The maximum marks for the laboratory course are 50.
2. Both PART-A and PART-B are considered for CIE and SEE.
3. Students have answer 1(one) question from PART-A and 1(one) question from PART-B.
   a. The questions set for SEE shall be from among the experiments under PART-A. It is evaluated for 35 marks out of the maximum 50 marks.
   b. The open-ended question set for SEE shall be any other open-ended question and not selected from the experiments under PART-A. It shall be evaluated for 20 marks.

**PART – A**

**CONVENTIONAL EXPERIMENTS**

1. Performing facing, plain turning and step turning operations by using a lathe.
2. Performing facing, plain turning and knurling operations by using a lathe.
3. Preparation of welded joints using the arc welding process.
4. Calibration of vernier caliper and micrometer using slip gauges.
5. Determination of the angle of a specimen using a sine bar.
6. Determination of the hardness of materials using hardness testing machine.

## PART – B

## TYPICAL OPEN-ENDED EXPERIMENTS

Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.

1. Comparative study of flash point and fire point of various fuels / oils using the open cup method
2. Comparative study of flash point and fire point of various fuels / oils using the closed cup method
3. Comparative study on viscosity of different base fuels.
4. Investigation of the effect of additives on the viscosity of base fuels.
5. Selection and justification of appropriate joining techniques for given applications
6. Fabrication of a sheet metal part with simple geometry and soldering.

**Suggested Learning Resources: (Textbook / Reference Book/ Manuals):**

**Textbooks:**


1. Amitabh Ghosh and Amit Kumar Mallik, Manufacturing Science, Affiliated East West Press (p) Ltd, New Delhi, 2002
2. Hajara and Choudhary, Workshop Technology Vol. I (2008) & II (2010), Median Promoters & publishers, Bombay.
3. Khanna O. P, Workshop Practice, Vol. I, Dhanpat Rai & Co., 2000.
4. Engineering Metrology, R.K. Jain, Khanna Publishers, Delhi, 2009.


**Reference books / Manuals:**


1. Serope Kalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, Fourth Edition, Pearson Education, Asia, 2000.
2. P.N. Rao, Manufacturing technology--Foundry, Forming and Welding, Tata McGraw Hill Education, 2001.
3. I.C. Gupta, Engineering Metrology, Dhanpat Rai Publications, New Delhi, 2018.
4. Ganeshan. V, Internal Combustion Engines, Tata McGraw Hill, 4th Edition, 2012**.**


**Web links and Video Lectures (e-Resources):**

- https://openoregon.pressbooks.pub/manufacturingprocesses45/chapter/chapter-unit-1-the-engine-lathe/
- https://www.millerwelds.com/resources/article-library/the-fundamentals-of-welding-process-equipment-and-applications
- https://www.youtube.com/watch?v=sbbwJ5p6irc
- https://www.youtube.com/watch?v=TlhGTSDfQxc

**Teaching-Learning Process (Innovative Delivery Methods):**

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

- Flipped Classroom
- Simulation and Virtual Labs
- Video demonstration

**Assessment Structure:**

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. The laboratory test (duration 02 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 20 marks. For both CIE and SEE, the student is required to conduct one experiment each from both Part A and Part B.

| Rubrics for CIE – Continuous Assessment: 30 marks | | | | | |
|---|---|---|---|---|---|
| **Performance Indicators** | **Excellent** | **Good** | **Satisfactory** | **Needs Improvement** | **Poor** |
| **Technical Skills & Procedure (PO1 & PO5) (10)** | Performs operations flawlessly, correct sequence, excellent tool use. (9-10) | Minor errors, generally correct sequence and tool use. (7-8) | Performs task with some errors; needs occasional help. (5-6) | Many errors, requires frequent guidance. (3-4) | Cannot perform task without continuous supervision. (0-2) |
| **Safety Compliance (PO6) (5)** | Strictly follows all safety protocols, proper PPE usage at all times. **(5)** | Follows safety rules, occasional minor lapses. **(4)** | Mostly safe, some reminders needed. **(3)** | Frequent safety violations. **(2)** | Unsafe behavior, ignores safety rules. **(0-1)** |
| **Interaction with the Group (PO8) (5)** | Naturally leads, encourages, and includes all group members. Facilitates communication and ensures tasks are distributed fairly. Respects all opinions. **(5)** | Cooperates well with group members. Communicates clearly, shares the workload, and is a reliable and positive team member. **(4)** | Works alongside others but with limited communication or collaboration. Tends to work in isolation or contributes unevenly to the group effort. **(3)** | Fails to cooperate with the group. Is dismissive of others' ideas or causes friction and disagreement within the team. **(2)** | Refuses to work with the group or actively disrupts the group's ability to complete the experiment. **(1)** |
| **Lab Report (PO9) (10)** | Report is exceptionally well-organized, detailed, and insightful. All data and analysis are accurate. Submitted on time. **(9-10)** | Report is complete, well-organized, and accurate. All required sections are present and data is correctly reported. Submitted on time. **(7-8)** | Report has minor errors in data or analysis, or is missing some minor components. Organization could be clearer. **(5-6)** | Report is incomplete, contains significant errors, is poorly organized, or is submitted late without a valid reason. **(3-4)** | Fails to submit a report, or the submitted work is of completely unacceptable quality and lacks critical information. **(0-2)** |

**Rubrics for SEE / CIE Test:**
**(CIE test -To be conducted for 50 marks and the marks obtained shall be reduced to 20)**
**(SEE-To be conducted for 50 marks)**

| Performance Indicators | Excellent | Good | Satisfactory | Needs Improvement | Poor |
|---|---|---|---|---|---|
| **Execution (PO3 & PO5) (8)/ (40)** | Executes operations accurately with correct parameters; smooth, safe handling of equipment. **(7-8) / (33-40)** | Minor execution errors; mostly correct handling of tools/ machines. **(5-6) / (25-32)** | Acceptable performanc e with some parameter or handling errors. **(3-4) / (17-24)** | Multiple execution errors; needs frequent correction. **(2) / (9-16)** | Unable to perform operation independently. **(0-1)/ (0-8)** |
| **Result and Discussion (PO4) (7)/ (40)** | Presents accurate results; clearly compares with standards; insightful discussion of deviations and causes. **(7-8) / (33-40)** | Accurate results; some useful discussion. **5-6) / (25-32)** | Results mostly correct; discussion basic. **(3-4) / (17-24)** | Results incomplete or partially wrong; weak discussion. **(2) / (9-16)** | Presents accurate results; clearly compares with standards; insightful discussion of deviations and causes. **(0-1)/ (0-8)** |
| **Viva Voce (PO9) (5)/ (20)** | Answers all questions confidently, showing deep conceptual and practical understanding. **(5) / (17-20)** | Answers most correctly; minor conceptual gaps. **(4) / (13-16)** | Answers some but lacks depth. **(3) / (9-12)** | Gives vague or incomplete answers. **(2) / (5-8)** | Unable to answer. **(1) / (0-4)** |

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 50% of 50 marks**, i.e., **25 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., 20 **marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 45 out of 100 marks**.

**Dr. Ambedkar Institute of Technology, Bengaluru-560056**
**B.E. Name of the programme: Mechanical Engineering**
**Scheme of Teaching and Examination effective from the Academic Year 2025 – 26**
**Outcome-Based Education (OBE) and Choice-Based Credit System (CBCS) (Effective from the academic year 2026-27)**

**III SEMESTER**

| Sl. No | Course | Course Code | Course Title | Teaching Department (TD) and Question Paper Setting Board (PSB) | | Teaching & Learning Scheme | | | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | CI | | LI | TW & SL | # TH/S | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | | | L | T | P | SL | | | | | | |
| 1 | ASC | 1BMAT301A | Probability & Statistics | Mathematics Dept. | | 42 | 28 | 0 | 50 | 120 | 3 | 50 | 50 | 100 | 4 |
| 2 | PCC | 1BSCET302 | Mechanics of Materials | Mechanical Engineering Dept. | | 42 | 28 | 0 | 50 | 120 | 3 | 50 | 50 | 100 | 4 |
| 3 | IPCC | 1BMEU303 | Material Science and Metallurgy | Mechanical Engineering Dept. | | 42 | 0 | 28 | 50 | 120 | 3 | 50 | 50 | 100 | **4** |
| 4 | PCC | 1BMET304 | Basic Thermodynamics | Mechanical Engineering Dept. | | 28 | 28 | 0 | 34 | 90 | 3 | 50 | 50 | 100 | **3** |
| 5 | PCC | 1BMET305 | Casting, Forming, and Welding Technology | Mechanical Engineering Dept. | | 42 | 0 | 0 | 48 | 90 | 3 | 50 | 50 | 100 | **3** |
| 6 | PCCL | 1BMEL306 | Computer Aided Machine Drawing | Mechanical Engineering Dept. | | 0 | 0 | 28 | 02 | 30 | 2 | 50 | 50 | 100 | **1** |
| 7 | AEC | 1BMEL307 | Manufacturing Process Laboratory | Mechanical Engineering Dept. | | 0 | 0 | 28 | 02 | 30 | 2 | 50 | 50 | 100 | **1** |
| 8 | SDC | 1BPRJ308 | Community Project (Project-Based Learning) / Societal Project | Respective Engineering Dept. | | 0 | 0 | 0 | 30 | 30 | 2 | 50 | 50 | 100 | **1** |
| 9 | MC | 1BCDN309 | Placement | Placement Cell | | 2 | 0 | 0 | 0 | -- | -- | 50 | -- | 50 | **PP/ NP** |
| 10 | NCMC | 1BNSN310 | National Service Scheme (NSS) | Campus | NSS coordinator | 0 | 0 | 0 | 28 | 28 | -- | 100 | --- | 100 | **PP** |
| | | 1BPEN310 | Physical Education (PE) (Sports and Athletics) | | Physical Education Director | | | | | | | | | | |
| | | 1BYON310 | Yoga | | Yoga Teacher | | | | | | | | | | |
| | | 1BMUN310 | Music | | Music Teacher | | | | | | | | | | |
| | | | | | **Total** | | | | | **658** | | **550** | **400** | **950** | **21** |
| 11 | NCMC | 1BMATDIP311 | Mathematics course for Lateral Entry Students | TD -Maths Dept. | | 14 | 0 | 0 | 14 | 28 | 3 | 100 | --- | 100 | PP |
| | | | | | **Total** | | | | | **686** | | **650** | **400** | **1050** | **21** |

**# TH/S- Total Hours per Semester, TW & SL- Term Work & Self Learning**

**Dr. Ambedkar Institute of Technology, Bengaluru-560056**
**B.E. Name of the programme: Mechanical Engineering**
**Scheme of Teaching and Examination effective from the Academic Year 2025 – 26**
**Outcome-Based Education (OBE) and Choice-Based Credit System (CBCS) (Effective from the academic year 2026-27)**

**IV SEMESTER**

| Sl. No | Course and Course Code | | Course Title | Teaching Department (TD) and Question Paper Setting Board (PSB) | Teaching & Learning Scheme | | | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CI | | LI | # TW & SL | TH/S | Duration in | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | | | | | | | |
| 1 | PCC | 1BMET401 | Fluid Mechanics | Mechanical Engineering Dept. | 56 | 0 | 0 | 64 | 120 | 3 | 50 | 50 | 100 | 4 |
| 2 | IPCC | 1BMEU402 | Machining Processes and Engineering Metrology | Mechanical Engineering Dept. | 42 | 0 | 28 | 50 | 120 | 3 | 50 | 50 | 100 | 4 |
| 3 | PCC | 1BMET403 | Applied Thermodynamics | Mechanical Engineering Dept. | 56 | 0 | 0 | 64 | 120 | 3 | 50 | 50 | 100 | 4 |
| 4 | PCC | 1BMET404 | Kinematics of Machines | Mechanical Engineering Dept. | 56 | 0 | 0 | 64 | 120 | 3 | 50 | 50 | 100 | 4 |
| 5 | PCCL | 1BMEL405 | Computer Aided Design and Simulation Lab | Mechanical Engineering Dept. | 0 | 0 | 28 | 02 | 30 | 2 | 50 | 50 | 100 | 1 |
| 6 | AEC | 1BMEL406 | Energy Conversion Laboratory | Mechanical Engineering Dept. | 0 | 0 | 28 | 02 | 30 | 2 | 50 | 50 | 100 | 1 |
| 7 | BSC | 1BBIT407C | Biology for Engineers | Mechanical Engineering Dept. | 28 | 0 | 0 | 32 | 60 | 3 | 50 | 50 | 100 | 2 |
| 8 | SDC | 1BEP408 | Environmental Science Project | Mechanical Engineering Dept. | 0 | 0 | 0 | 30 | 30 | 3 | 50 | 50 | 100 | 1 |
| 9 | MC | 1BCDN409 | Placement | Placement Cell | 2 | 0 | 0 | 0 | -- | -- | 50 | -- | 50 | PP/ NP |
| 9 | NCMC | 1BNSN410 | National Service Scheme (NSS) | Campus: NSS coordinator | 0 | 0 | 0 | 28 | 28 | -- | 100 | --- | 100 | PP |
| | | 1BPEN410 | Physical Education (PE) (Sports and Athletics) | Physical Education Director | | | | | | | | | | |
| | | 1BYON410 | Yoga | Yoga Teacher | | | | | | | | | | |
| | | 1BMUN410 | Music | Music Teacher | | | | | | | | | | |
| | | | | **Total** | | | | | **658** | | **550** | **400** | **950** | **21** |
| 10 | NCMC | 1BMATDIP411 | Mathematics course for Lateral Entry Students | TD -Maths Dept/ VTU Online (COE). | 14 | 0 | 0 | 14 | 28 | -- | 100 | -- | 100 | PP |
| | | | | **Total** | | | | | **686** | | **650** | **400** | **1050** | **21** |

**# TH/S- Total Hours per Semester, TW & SL- Term Work & Self Learning,**

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Civil Engineering, Mechanical Engineering, Aeronautical Engineering and Industrial Engineering and Management**

**Semester: III** **Scheme: 2025**

| **Course Title** | **PROBABILITY AND STATISTICS** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **1BSCET301** | | | | | | |
| **Course Category** | **ASC (Applied Science Course)** | | | | | | |
| **Teaching - Learning Scheme & Credit** | **L** | **T** | **P** | **S** | **Total** | **Total Teaching Hours** | **Credit** |
| | **03** | **02** | **0** | **4** | **5** | 42+28+50=120 | **4** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |

| **Course Learning Objectives:** |
|---|
| This course is proposed to impart to the students the skills to identify and solve problems in their field of study involving the application of numerical and probability distribution techniques. |

| **SYLLABUS** | **No. of Hours** | **BTLs** |
|---|---|---|
| **UNIT 1** | **10** | **L1-L4** |
| **Statistical techniques:** Curve fitting by method of least squares: $y = ax + b$, $y = ax^2 + bx + c$ and $y = ab^x$. Correlation–Karl Pearson's coefficient of correlation, Regression analysis – lines of regression (without proof), angle between regression lines-problems. | | |
| **SELF-STUDY COMPONENTS:** Rank correlation, Growth modeling. | | |
| **UNIT 2** | **10** | **L1-L4** |
| **Probability Distributions:** Random variables (discrete and continuous), probability mass and density functions. Mathematical expectation and variance. Binomial, Poisson, normal and exponential distributions- only problems | | |
| **SELF-STUDY COMPONENTS:** Geometric and Gamma distributions, Application to transmission errors in noise media. | | |
| **UNIT 3** | **10** | **L1-L4** |
| **Joint Probability Distributions and Markov Chains:** Introduction, Joint probability and Joint distribution of discrete random variables, Markov chains, Classification of Stochastic processes, Probability vector, Stochastic matrix, Regular stochastic matrix, Transition probabilities and Transition probability matrix. | | |
| **SELF-STUDY COMPONENTS:** Joint probability and Joint distribution of continuous random variables. | | |
| **UNIT 4** | **10** | **L1-L4** |
| **Numerical Solutions of Partial Differential Equations:** Solutions of Laplace equation-Gauss-Seidel method, one dimensional heat equation- Bendre-Schmidt method. Wave Equation-Finite difference method. Reynold's number, critical Reynold's number, laminar flow through circular pipe-Hagen Poiseille's equation, laminar flow between parallel and stationary plates. Numerical problems. | | |
| **SELF-STUDY COMPONENTS:** Solutions of Poisson equations, Finite element methods. | | |
| **UNIT 5** | **10** | **L1-L4** |

| |
|---|
| **Calculus of variations:** Variation of a function and a functional, Euler's equation-standard variational problems, Geodesics on a plane surface and hanging cable problems. |
| **SELF-STUDY COMPONENTS:**<br>Isoperimetric problems, Rayleigh Ritz method -problems. |

| **TEXT BOOKS:** | |
|---|---|
| 1. | B. S. Grewal, Higher Engineering Mathematics. Khanna Publishers, New Delhi. |
| 2. | E. Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons. |
| 3. | Glyn James, Advanced modern Engineering Mathematics, Pearson Publications. |
| 4. | S.S. Sastry, Introductory methods of numerical analysis, PHI. |
| 5. | H.C. Taneja, Advanced Engineering Mathematics, Volume I & II, I.K. International Publishing House Pvt. Ltd., New Delhi. |

| **REFERENCE BOOKS:** | |
|---|---|
| 1 | B. V. Ramana, Higher Engineering Mathematics, McGraw–Hill Education.. |
| 2 | Srimanta Pal & Subodh C. Bhunia, Engineering Mathematics, Oxford University Press |
| 3 | C. Ray Wylie, Louis C. Barrett, Advanced Engineering Mathematics, McGraw Hill Book Co., New York |
| 4 | H.K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication |
| **e-LEARNING RESOURCES:** | |
| 1 | http://nptel.ac.in/courses.php?disciplineID=111 |
| 2 | http://www.class-central.com/subject/math(MOOCs) |
| 3 | VTU e-Shikshana Program |
| 2 | VTU EDUSAT Program |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.

**CIE:** The CIE has three components – CIE - theory component, assignment and group activity. Students have to score a minimum of 40% Marks in the total of CIE - theory, assignment and group activity components put together to take SEE.

**SEE:** Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

****Self-Study Component should be not included for SEE & CIE.**

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | **Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)** |
|---|---|---|---|
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **50** | **20** |
| | **TOTAL** | **50** | **20** |

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**Semester: III** **Scheme: 2025**

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Q. No.** | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Apply the Statistical techniques to obtain or fit a curve for the specified data. This helps the students to learn the numerical part of estimating the curve |
| **CO2** | Employ the knowledge of probability models arising in the engineering field using basic concepts of probability, random variables and probability distributions |
| **CO3** | Identify and solve problems involving random variables, probability distributions and Markov chains connected to digital signal processing, information code theory and structural engineering. |
| **CO4** | Apply numerical methods to identify and solve problems related to fluid mechanics, gas dynamics, heat and mass transfer, thermodynamics, vibrations, automatic control systems, kinematics, design etc |
| **CO5** | **Analyze** the basic concepts of calculus of variations, numerical and statistical methods. |

**Mapping of CO's, PO's with PSO's**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| **CO** | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO1 0** | **PO1 1** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 1 | - | - |
| **CO 2** | 3 | 3 | 2 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 1 | - | - |
| **CO 3** | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 1 | - | - |
| **CO 4** | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 1 | - | - |
| **CO 5** | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 1 | - | - |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| **CO** | **WK1** | **WK2** | **WK3** | **WK4** | **WK5** | **WK6** | **WK7** | **WK8** | **WK9** |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| **CO2** | 2 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| **CO3** | 2 | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 |
| **CO4** | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 0 | 0 |
| **CO5** | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 |

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology

**Program: Civil Engineering, Mechanical Engineering, Aeronautical Engineering and Industrial Engineering and Management**

**Semester: III** **Scheme: 2025**

| **Mapping of CO's with Sustainable Development Goals (SDG)**<br>**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/SDG** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** |
| **CO1** | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **CO2** | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **CO3** | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| **CO4** | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **CO5** | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |

**Course Coordinators:**

Dr. Divya Darshini S
Assistant Professor,
Mathematics

Dr. Latha D N
Assistant Professor,
Mathematics

**Heads of Programme**

Shivaprassana G S,
Associate Professor,
Mathematics

**Head of School**

Dr. Jambunath Baligar,
Professor,
Schoolof Basic Sciences
and Humanities, Dr. A.I.T

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology

**Semester: III** **Scheme: 2025**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Title** | **MECHANICS OF MATERIALS** | | | | | | |
| **Course Code** | **1BSCET302** | | | | | | |
| **Course Category** | **PCC (Professional Core Course)** | | | | | | |
| **Teaching - Learning Scheme & Credit** | **L** | **T** | **P** | **S** | **Total** | **Total Hours** | **Credit** |
| | **3** | **1** | **0** | **3** | **3** | **42+28+0+50=120** | **4** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |
| **Common Branches** | **CV/ME/AE/IM** | | | | | | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | Understand the concepts of stress, strain, elastic constants, and deformation behavior of engineering materials under different loading conditions. |
| CLO2 | Analyze biaxial stress systems and determine principal stresses and maximum shear stresses using analytical and graphical methods. |
| CLO3 | Evaluate shear force and bending moment distributions in beams subjected to various loading conditions. |
| CLO4 | Apply the theory of bending and shear stress distribution for the analysis and design of beam sections. |
| CLO5 | Analyze torsional behavior of shafts and stress distribution in thin and thick cylindrical pressure vessels used in engineering applications. |

| **SYLLABUS** | **No. of Hours** | **BTLs** |
|---|---|---|
| **UNIT: 1** | **9** | **L1-L4** |
| **SIMPLE STRESS AND STRAIN**:<br>Definition & types of stresses and strains, Stress strain diagram for brittle and ductile materials - Poisson's ratio & volumetric strain – Elastic constants – relationship between elastic constants and Poisson's ratio – Generalized Hooke's law – Deformation of simple and compound bars, Thermal stresses, Principle of Superposition. | | |
| **SELF-STUDY COMPONENTS:**<br>Analysis of bars of varying cross-sections, Stresses in Composite Sections. | | |
| **UNIT: 2** | **9** | **L1-L4** |
| **BI-AXIAL STRESS SYSTEM:**<br>Introduction, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Stresses on an oblique section of a body subjected to a direct stress in one plane, Stresses on an oblique section of a body subjected to a direct stress in two mutually perpendicular directions – analytical & graphical method - Mohr's circle for plane stress. | | |
| **SELF-STUDY COMPONENTS:**<br>Stresses on an oblique section of a body subjected to a simple shear stress, direct stress in one plane and accompanied by a simple shear stress, direct stresses in mutually perpendicular directions and accompanied by a simple shear stress | | |
| **UNIT: 3** | **8** | **L1-L4** |
| **BENDING MOMENT AND SHEAR FORCES IN BEAMS:**<br>Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed loads, uniformly varying loads, couple and combination of these loads – Point of contra flexure. | | |

**Semester: III** **Scheme: 2025**

| | | |
|---|---|---|
| **SELF-STUDY COMPONENTS:**<br>Load and Bending moment diagrams from shear force diagram, Beams subjected to inclined loads, SF and BM diagrams for inclined beams. | | |
| **UNIT 4** | **8** | **L1-L4** |
| **THEORY OF SIMPLE BENDING:**<br>Assumptions – Derivation of bending equation - Neutral axis – Determination of bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I, T – Design of simple beam sections<br>**SHEAR STRESSES:**<br>Derivation of formula – Shear stress distribution across various beams sections - rectangular, circular, triangular, I, and T sections. | | |
| **SELF-STUDY COMPONENTS:**<br>Bending Stresses in Unsymmetrical sections, Distribution of shear stresses over miscellaneous section. | | |
| **UNIT 5** | **8** | **L1-L4** |
| **TORSION OF CIRCULAR SHAFTS:**<br>Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts.<br>**THICK AND THIN CYLINDERS:**<br>Stresses in thin cylinders, Lame's equation for thick cylinders subjected to internal and external pressures, Changes in dimensions of cylinder (diameter, length and volume), simple numericals. | | |
| **SELF-STUDY COMPONENTS:**<br>Torsion in shaft of varying cross sections, Composite shafts, Shaft couplings, Stresses in thin and thick cylindrical shells.<br>**THEORY OF COLUMNS** – Long column and short column - Euler's formula – Rankine's formula. | | |

| **TEXT BOOKS:** | |
|---|---|
| 1 | "Strength of Materials", R.S. Khurmi, S Chand Publishers, 2019. |
| 2 | "Strength of Materials", S.S. Rattan, Second Edition, Tata McGraw Hill Education India. |
| 3 | "Strength of Materials", S. Ramamrutham, Twentieth Edition, Dhanpat Rai & Sons. |
| 4 | "Strength of Materials", R.K. Bansal, laxmi Publications Pvt. Ltd., New Delhi, 2018. |

| **REFERENCE BOOKS:** | |
|---|---|
| 1 | "Mechanics of Materials", James. M. Gere, Thomson, Fifth edition 2004. |
| 2 | "Mechanics of Materials", in S.I. Units, Ferdinand Beer & Russell Johnstan, TMH. |
| 3 | "Strength of Materials", S.S.Bhavikatti, Vikas Publishing House -1 Pvt. Ltd., 2017 |
| 4 | "Advanced Mechanics of Solids", L S Srinath, McGraw Hill Education India, 2017. |
| **e-LEARNING RESOURCES:** | |
| 1 | Web Links: https://onlinecourses.nptel.ac.in/noc22_ce46/preview |
| 2 | Virtual Lab: https://sm-nitk.vlabs.ac.in/ |

**Semester: III** **Scheme: 2025**

| **Assessment Details both (CIE and SEE)** | | | |
|---|---|---|---|
| The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.<br>**CIE:** The CIE has three components – CIE - theory component, assignment and group activity. Students have to score a minimum of 40% Marks in the total of CIE - theory, assignment and group activity components put together to take SEE.<br>**SEE:** Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.<br>****Self-Study Component should be included CIE under Qsn. No. 2c).** | | | |
| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | **Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)** |
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **50** | **20** |
| | **TOTAL** | **50** | **20** |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Q. No.** | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Understand the concepts of stress, strain, elastic constants, thermal stresses, and determine deformation in simple and composite members subjected to axial loading. |
| **CO2** | Analyze biaxial stress systems and determine principal stresses, principal planes, and maximum shear stresses using analytical methods and Mohr's circle. |
| **CO3** | Construct and interpret shear force and bending moment diagrams for beams subjected to different types of loads. |
| **CO4** | Determine bending and shear stresses in beam sections and design simple beam sections based on strength requirements. |
| **CO5** | Analyze torsional stresses in circular shafts and evaluate stresses and dimensional changes in thin and thick cylinders subjected to pressure loading. |

**Mapping of CO's, PO's with PSO's**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1

| **CO /PO** | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO1 0** | **PO1 1** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | 3 | - | - |
| **CO 2** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | 3 | - | - |
| **CO 3** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | 3 | - | - |
| **CO 4** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | 3 | - | - |

**Semester: III** **Scheme: 2025**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 5** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | 3 | - | - |

| **Mapping of CO's with Knowledge and Attitude Profile (WK)**<br>**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **CO/WK** | **WK1** | **WK2** | **WK3** | **WK4** | **WK5** | **WK6** | **WK7** | **WK8** | **WK9** |
| **CO1** | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | - | - | - | 1 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | - | - | - | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 1 | 1 | - | 1 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | - | 2 |

| **Mapping of CO's with Sustainable Development Goals (SDG)**<br>**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/SDG** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** |
| **CO1** | - | - | - | 3 | - | - | - | - | 2 | - | 1 | - | - | - | - | - | - |
| **CO2** | - | - | - | 2 | - | - | - | - | 3 | - | 2 | 1 | - | - | - | - | - |
| **CO3** | - | - | - | 2 | - | - | - | - | 3 | - | 3 | 2 | 1 | - | - | - | - |
| **CO4** | - | - | - | 2 | - | - | - | - | 3 | - | 3 | 3 | 2 | - | - | - | - |
| **CO5** | - | - | - | 2 | - | - | - | - | 3 | - | 3 | 3 | 2 | - | - | - | 1 |

**Course Coordinators:**

| | | | |
|---|---|---|---|
| Prof. Rajesh Chandra C.,<br>Assistant Professor,<br>Mechanical Engineering | Dr. C. R. Mahesha,<br>Assistant Professor,<br>Industrial Engineering & Management | Prof. Purnima K. B.<br>Assistant Professor,<br>Civil Engineering | Prof. Archana M.<br>Assistant Professor,<br>Aeronautical Engineering |

**Heads of Program:**

| | | | |
|---|---|---|---|
| Dr. Sathish S.,<br>Professor,<br>Mechanical Engineering | Dr. Rajeshwari P.,<br>Professor,<br>Industrial Engineering & Management | Dr. Syed Abu Sayeed Mohammed,<br>Associate Professor,<br>Civil Engineering | Dr. Kumara Thanaiah,<br>Assistant Professor,<br>Aeronautical Engineering |

**Head of School**

Dr. S. Kavitha,
Professor,
School of Core Engineering and Technology, Dr. A.I.T

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: III** **Scheme: 2025**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Title** | **MATERIAL SCIENCE AND METALLURGY** | | | | | | |
| **Course Code** | **1BMEU303** | | | | | | |
| **Course Category** | **IPCC (Integrated Professional Core Course)** | | | | | | |
| **Teaching - Learning Scheme & Credit** | **L** | **T** | **P** | **S** | **Total** | **Total Teaching Hours** | **Credit** |
| | **3** | **0** | **1** | **0** | **4** | **42+0+28+50=120** | **4** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | Know the fundamental science and engineering principles relevant to engineering materials |
| CLO2 | Understand the intricacies involved in characterization, processing and design of materials. |
| CLO3 | Have the necessary theoretical and experimental skills for a pursuit in professional career. |
| CLO4 | Possess an intrinsic knowledge of the significance of different materials, the value of continued learning and environmental / social issues surrounding materials. |
| CLO5 | The student should be able to understand all basic principles involved in the application of materials for different engineering sectors. |

| **SYLLABUS** | **No. of Hours** | **BTLs** |
|---|---|---|
| **UNIT 1** | **8** | **L1-L4** |
| **CRYSTAL STRUCTURES, MECHANICAL BEHAVIOUR AND PLASTIC DEFORMATION :** Introduction to types of crystal structures, imperfection in solids, diffusion, stress-strain diagram showing ductile and brittle behavior of materials, linear and nonlinear elastic behavior and properties, mechanical properties in plastic region, yield strength, offset yield strength, ductility, malleability, ultimate tensile strength, toughness. Simple problems on stress and strain. | | |
| **SELF-STUDY COMPONENTS:** Plastic deformation of single crystal by slip and twinning, strain hardening and strain aging | | |
| **UNIT 2** | **8** | **L1-L4** |
| **FAILURE OF MATERIALS:** Types of fracture, Griffith criteria for brittle fracture, distinguishing features of brittle and ductile fracture. Description of the creep phenomenon with examples, three stages of creep deformation and creep properties. Types of fatigue loading with examples, fatigue properties, fatigue testing and SN diagram. | | |
| **SELF-STUDY COMPONENTS:** Mechanism of fatigue | | |
| **UNIT 3** | **8** | **L1-L4** |
| **SOLIDIFICATION AND PHASE DIAGRAMS:** Mechanism of solidification, homogenous and heterogeneous nucleation, crystal growth, cast metal structures. Solid solutions Hume Rothary rule, substitutional and interstitial solid solutions, intermediate phases and Gibbs phase rule. Types of phase diagrams, construction of equilibrium diagrams, lever rule, and simple problems on phase diagrams. Iron carbon equilibrium diagram, description of phases. | | |
| **SELF-STUDY COMPONENTS:** Construction of equilibrium diagrams involving complete and partial solubility. | | |
| **UNIT 4** | **9** | **L1-L4** |
| **HEAT TREATMENT, FERROUS AND NON-FERROUS ALLOYS:** TTT curves, Annealing and its types, normalizing, hardening, tempering, martempering, austempering, hardenability, surface | | |

| | | |
|---|---|---|
| hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening. Steel and its classification, properties, composition and applications of grey cast iron, malleable iron, Copper alloys-brasses and bronzes. | | |
| **SELF-STUDY COMPONENTS:** Continuous Cooling Transformation curves (CCT), Aluminum alloys-Al-Cu, Al-Si, Al-Zn alloys. | | |
| **UNIT 5** | **9** | **L1-L4** |
| **COMPOSITE MATERIALS:** classification, properties, characteristics, and applications of PMCs, MMCs, CMCs and Carbon-Carbon Composites. **Smart Materials:** Smart materials and types of smart materials–piezo-electric, shape memory alloys, superelasticity, Biological applications of smart materials-materials used as implants in human body. **BIOMATERIALS:** Introduction, Materials used as biomaterials, advantages, disadvantages and applications. | | |
| **SELF-STUDY COMPONENTS:** Aerospace applications of composite materials and smart materials. | | |

| **Material Testing Laboratory** | | |
|---|---|---|
| Exp. No. | List of Experiments | No. of Hours |
| 01 | Determination of Tensile Strength of the given material using UTM. | (14 Slots) 28 |
| 02 | Determination of Compressive Strength of the given material using UTM. | |
| 03 | Determination of Shear Strength of the given material using UTM. | |
| 04 | Determination of Fatigue Strength of the given material. | |
| 05 | Determination of Impact Strength of the given material Impact testing machine (Izod and Charpy Impact Tests) | |
| 06 | Determination of Hardness of the given material using Hardness testing machine (Vicker's, Brinell & Rockwell) | |
| 07 | Determination of Torsion Strength of the given material. | |
| 08 | Bending of beams – Simply Supported (2 Point & 3 Point Bending Tests) | |
| 09 | Non-destructive testing I – Magnetic Particle Inspection | |
| 10 | Non-destructive testing II – Dye Penetrant Test | |
| ***Self-Study Component:*** (Virtual Lab)Direct Shear Test on Mild Steel Rod, Mild Steel Plate, Bending Test on Mild Steel, Tensile & Compression Test on Cast Iron. | | |

| **TEXT BOOKS:** | |
|---|---|
| 1 | Foundations of Materials Science and Engineering, Smith, 4th Edition, McGraw Hill, 2009. |
| 2 | Material science and Engineering and Introduction, William D. Callister, Wiley, 2006. |
| 3 | Materials Science, Shackleford and M. K. Muralidhara, Pearson Publication –2007. |
| 4 | Material Science by V. Raghavan, Fifth Edition, PHI (P) LTD. |
| 5 | Biomaterials, Sujata V. Bhat, Narosa Publishing House, 2002. |

| **REFERENCE BOOKS:** | |
|---|---|
| 1 | The Science and Engineering of Materials, Donald R. Askland and Pradeep.P. Phule, Cengage Learning, 4th |

| | |
|---|---|
| | Ed., |
| 2 | Mechanical Metallurgy, George Ellwood Dieter, McGraw-Hill. |
| 3 | ASM Handbooks, American Society of Metals. |
| 4 | Smart Materials and Structures, M V Gandhi and B S Thompson Chapmen &Hall |
| 5 | Material Science and Engineering (SI Units), R.K. Rajput |
| **e-LEARNING RESOURCES:** | |
| 1 | Videos and Lecture Notes: https://nptel.ac.in/courses/113102080 |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each.
The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.
CIE: The CIE has two components – CIE - theory component and CIE – laboratory component.
Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE.
Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.
****Self-Study Component should be not included for SEE & CIE.**

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
|---|---|---|---|---|
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **30** | | **12** |
| **Laboratory components** | Rubrics for experiment are added, then taken average | **10** | **20** | **08** |
| | **Lab CIE** | **10** | | |
| | **TOTAL** | **50** | | **20** |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Q. No.** | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Differentiate crystal structures, imperfections, diffusion in solids, elastic and plastic properties of metal materials. |
| **CO2** | Analyze the various types of fracture, stages of creep and fatigue failure. |
| **CO3** | Describe mechanism of solidification, cast metal structure and rules for formation of solid solution. |
| **CO4** | Develop a capability to read a binary phase diagram and predict the properties that can be obtained by heat treatment and to know the characteristics and application of ferrous and nonferrous metals. |

| | |
|---|---|
| **CO5** | Know the physical and mechanical properties of composite materials also about the characteristics and applications of smart materials and biomaterials. |

**Mapping of CO's, PO's with PSO's**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 2 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO 2 | 3 | 2 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO 4 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 3 | - | - |
| CO 5 | 3 | 1 | 1 | - | - | 2 | 1 | - | - | - | - | 3 | - | 1 |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| CO2 | 3 | 2 | 3 | 2 | 1 | 0 | 0 | 0 | 0 |
| CO3 | 3 | 1 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| CO4 | 3 | 1 | 3 | 2 | 1 | 0 | 0 | 0 | 0 |
| CO5 | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 0 | 0 |

**Mapping of CO's with Sustainable Development Goals (SDG)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO/SDG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| CO2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 |
| CO3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| CO4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| CO5 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |

**Course Coordinator:**

Dr. Mohan Kumar B.
Assistant Professor
Mechanical Engineering

**Heads of Programme:**

Dr. Sathish S,
Professor,
Mechanical Engineering

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: III** **Scheme: 2025**

| **Course Title** | **BASIC THERMODYNAMICS** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **1BMET304** | | | | | | |
| **Course Category** | **PCC (Professional Core Course)** | | | | | | |
| **Teaching - Learning Scheme & Credit** | **L** | **T** | **P** | **S** | **Total** | **Total Teaching Hours** | **Credit** |
| | **1** | **1** | **0** | **3** | **3** | **28+28+0+34=90** | **3** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | Learn about thermodynamic system and its equilibrium, basic law of zeroth law of thermodynamics |
| CLO2 | Understand various forms of energy - heat transfer and work, Study the first law of thermodynamics. |
| CLO3 | Study the second law of thermodynamics and entropy to solve practical engineering problems |
| CLO4 | Interpret the behavior of pure substances and its application in practical problems |
| CLO5 | Study of Ideal and real gases and evaluation of thermodynamic properties |

| **SYLLABUS** | **No. of Hours** | **BTLs** |
|---|---|---|
| **UNIT 1** | **8** | **L1-L4** |
| **INTRODUCTION AND REVIEW OF FUNDAMENTAL CONCEPTS:** Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive, extensive properties, specific properties, pressure, specific volume, Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer, thermocouples, electrical resistance thermometer. Numerical.<br>**WORK AND HEAT**:<br>Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work: Electrical work. Other types of work. Heat; definition, units and sign convention. Problems. | | |
| **SELF-STUDY COMPONENTS:**<br>Applications of thermodynamics, Modern temperature sensors, Case study of thermodynamic systems used in daily life, Comparison of various temperature measuring instruments. | | |
| **UNIT 2** | **8** | **L1-L4** |
| **FIRST LAW OF THERMODYNAMICS:** Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, Problems.<br>**EXTENSION OF THE FIRST LAW TO CONTROL VOLUME: S**teady flow energy equation (SFEE), Problems. | | |
| | | |

**SELF-STUDY COMPONENTS:**
The Joule Experiment Recreation, Expanding the First Law from a fixed mass (control mass) to flowing fluids (control volume), The **SFEE Component Breakdown**: Create a reference matrix analyzing how the general SFEE simplifies for different engineering devices.

| UNIT 3 | 8 | L1-L4 |
|---|---|---|

**SECOND LAW OF THERMODYNAMICS**:
Limitations of first law of thermodynamics, Thermal reservoir, heat engine and heat pump: Schematic representation, efficiency and COP. Reversed heat engine. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles. Problems.

**ENTROPY:**
Clausius inequality, Statement- proof, Entropy- definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy, entropy as a coordinate. Problems.

**SELF-STUDY COMPONENTS:**
Comparative study of heat engine, refrigerator, and heat pump. Case study on PMM-I and PMM-II with examples. Applications of the Second Law of Thermodynamics in engineering systems. Study and presentation on Carnot cycle and its practical limitations. Practice problems on efficiency, COP, and Carnot efficiency calculations

| UNIT 4 | 9 | L1-L4 |
|---|---|---|

**AVAILABILITY, IRREVERSIBILITY AND GENERAL THERMODYNAMIC RELATIONS**:
Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility. Problems.

**PURE SUBSTANCES**: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagram.

**SELF-STUDY COMPONENTS:**
Case studies of irreversible processes in thermal systems. Phase transformation of water and interpretation of P–V diagrams. Comparative study of triple point and critical point. Interpretation of thermodynamic processes on T–S and H–S diagrams.Practice assignments on availability, irreversibility, and steam properties

| UNIT 5 | 9 | L1-L4 |
|---|---|---|

**IDEAL GASES:**
Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties, Fundamentals of Thermodynamics with AI and ML, Use of AI-based models for prediction of gas properties from pressure, volume and temperature data, Application of AI/ML regression models for predicting thermodynamic properties of ideal gases.

**REAL GASES:**
Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart. Difference between Ideal and real gases, Machine Learning models for predicting real-gas behaviour and thermodynamic properties, Development of simple ML models for predicting heat, work, entropy, efficiency and gas properties.

| **SELF-STUDY COMPONENTS:** |
|---|
| Applications of gas mixture laws in engineering, Industrial applications of air–water vapor mixtures, Comparative study of equations of state, Case studies on high-pressure gas storage and transport. Use of compressibility charts for engineering calculations. |

| **TEXT BOOKS:** | |
|---|---|
| 1 | "Engineering Thermodynamics" by P.K. Nag (7th Edition, 2020). |
| 2 | "A Textbook of Engineering Thermodynamics" by R.K. Rajput (5th Edition, 2016). |
| 3 | "Thermodynamics: An Engineering Approach (Indian Adaptation)" by Yunus A. Çengel, Michael A. Boles, and S. Bhattacharya (9th Edition, 2019) . |
| 4 | "Fundamentals of Engineering Thermodynamics" by E. Rathakrishnan (2nd Edition, 2010). |

| **REFERENCE BOOKS:** | |
|---|---|
| 1 | Thermodynamics: An Engineering Approach by Yunus A. Çengel and Michael A. Boles |
| 2 | Thermodynamics by S.K. Som (2nd Edition, 2011) |
| 3 | Fundamentals of Engineering Thermodynamics by Michael J. Moran and Howard N. Shapiro (9th Edition, 2018 |
| 4 | Fundamentals of Thermodynamics by Claus Borgnakke and Richard E. Sonntag (10th Edition, 2019) |
| **e-LEARNING RESOURCES:** | |
| 1 | Web Links: 1. https://www.youtube.com/watch?v=GjPqDbaSrMo, 2.https://www.google.com/search?q=https://www.youtube.com/playlist%3Flist%3DPLD7E2B0B003254424.. |
| 2 | Virtual Lab: https://www.google.com/search?q=https://www.youtube.com/playlist%3Flist%3DPLD7E2B0B003254424. |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.

**CIE:** The CIE has three components – CIE - theory component, assignment and group activity. Students have to score a minimum of 40% Marks in the total of CIE - theory, assignment and group activity components put together to take SEE.

**SEE:** Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

****Self-Study Component should be not included for SEE & CIE.**

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | **Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)** |
|---|---|---|---|
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **50** | **20** |
| | **TOTAL** | **50** | **20** |

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School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: III** **Scheme: 2025**

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Q. No.** | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Explain fundamentals of thermodynamics and evaluate energy interactions across the boundary of Thermodynamic system. |
| **CO2** | Apply 1st law of thermodynamics to closed and open systems and determine quantity of energy transfers. |
| **CO3** | Evaluate the feasibility of cyclic and non-cyclic processes using 2nd law of thermodynamics. |
| **CO4** | Apply the knowledge of entropy, reversibility and irreversibility to solve numerical problems and interpret the behaviour of pure substances and its applications in practical. |
| **CO5** | Recognize differences between ideal and real gases and evaluate thermodynamic properties of ideal and real gases mixture using various relations. |

**Mapping of CO's, PO's with PSO's**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| **CO** | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO1 0** | **PO1 1** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 0 |
| **CO 2** | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 0 |
| **CO 3** | 3 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 2 | 0 |
| **CO 4** | 3 | 3 | 2 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 2 |
| **CO 5** | 3 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 2 |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| **CO** | **WK1** | **WK2** | **WK3** | **WK4** | **WK5** | **WK6** | **WK7** | **WK8** | **WK9** |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| **CO2** | 3 | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 |
| **CO3** | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 0 | 0 |
| **CO4** | 3 | 3 | 3 | 2 | 1 | 0 | 1 | 0 | 0 |
| **CO5** | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |

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School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: III** **Scheme: 2025**

| **Mapping of CO's with Sustainable Development Goals (SDG)**<br>**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/SDG** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** |
| **CO1** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **CO2** | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **CO3** | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 2 | 0 | 1 | 2 | 2 | 0 | 0 | 0 | 0 |
| **CO4** | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| **CO5** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Course Coordinators:**

Dr. Vinod .K .L,
Assistant Professor,
Mechanical Engineering

**Heads of Programme:**

Dr. Sathish S,
Professor,
Mechanical Engineering

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: III** **Scheme: 2025**

| **Course Title** | **CASTING, FORMING, AND WELDING TECHNOLOGY** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **1BMET305** | | | | | | |
| **Course Category** | **PCC (Professional Core Course)** | | | | | | |
| **Teaching - Learning Scheme & Credit** | **L** | **T** | **P** | **S** | **Total** | **Total Teaching Hours** | **Credit** |
| | **3** | **0** | **0** | **3** | **3** | **42+0+0+48=90** | **3** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | To provide knowledge of various casting process in manufacturing. |
| CLO2 | To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys, also to provide detailed information about the moulding processes. |
| CLO3 | To impart knowledge of various joining process used in manufacturing. |
| CLO4 | To impart knowledge about behaviour of materials during welding, and the effect of process parameters in welding |
| CLO5 | To acquaint with the basic knowledge on fundamentals of metal forming processes and also to study various metal forming processes. |

| **SYLLABUS** | **No. of Hours** | **BTLs** |
|---|---|---|
| **UNIT 1** | **8** | **L1-L4** |
| **INTRODUCTION & BASIC MATERIALS USED IN FOUNDRY**: Introduction to casting process & steps involved. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy.<br>**PATTERNS:** Definition, classification, materials used for pattern, various pattern allowances and their importance.<br>**SAND MOULDING**: Types of base sand, requirement of base sand. Binder, Additive's definition, need and types; preparation of sand moulds. Molding machines- Jolt type, squeeze type and Sand slinger.<br>**STUDY OF IMPORTANT MOULDING PROCESS:** Green sand, core sand, dry sand, sweep mould, CO2 mould, shell mould, investment mould, plaster mould, cement bonded mould. | | |
| **SELF-STUDY COMPONENTS:**<br>Classification of various manufacturing processes. | | |
| **UNIT 2** | **8** | **L1-L4** |
| **CORES**: Definition, need, types. Method of making cores,Concept of gating (top, bottom, parting line, horn gate) and risers (open, blind) Functions and types.<br>**MELTING FURNACES**: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace.<br>**CASTING USING METAL MOULDS**: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes. Casting defects, their causes and remedies. | | |
| **SELF-STUDY COMPONENTS:**<br>Introduction to melting furnaces for foundry | | |

| UNIT 3 | 8 | L1-L4 |
|---|---|---|
| **WELDING PROCESSES**<br>**OPERATING PRINCIPLE, BASIC EQUIPMENT, MERITS AND APPLICATIONS OF**: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding. | | |
| **SELF-STUDY COMPONENTS:**<br>Introduction and classification of welding processes. | | |
| **UNIT 4** | **9** | **L1-L4** |
| **ADVANCE WELDING PROCESSES:** Resistance welding processes, friction welding process friction stir welding (FSW) Diffusion welding,<br>**WELDABILITY**:Concept of weldability of materials; Welding defects and remedies. **ALLIED PROCESSES**: Soldering, Brazing. | | |
| **SELF-STUDY COMPONENTS:**<br>Thermal Effects in Welding (Distortion, shrinkage and residual stresses in welded structures), adhesive bonding. | | |
| **UNIT 5** | **9** | **L1-L4** |
| **METAL FORMING PROCESSES**<br>**INTRODUCTION OF METAL FORMING PROCESS***:* Mechanical behaviour of metals in elastic and plastic deformation, stress-strain relationships, Yield criteria, Hot working, Cold working. **METAL WORKING PROCESSES***:* Fundamentals of metal working, Analysis of bulk forming processes like forging, rolling, extrusion, wire drawing by slab method.<br>**OTHER SHEET METAL PROCESSES***:*Sheet metal forming processes (Die and punch assembly,Blanking, piercing, bending etc., Compound and Progressive die) | | |
| **SELF-STUDY COMPONENTS:**<br>Application to tensile testing, train rate and temperature in metal working, High Energy rate forming processes. | | |

| **TEXT BOOKS:** | |
|---|---|
| 1 | Ghosh, A. and Mallik, A. K., (2017), Manufacturing Science, East-West Press. |
| 2 | Parmar R. S., (2007), Welding Processes and Technology, Khanna Publishers. |
| 3 | Little R. L. – ‘Welding and Welding Technology’ – Tata McGraw Hill Publishing Company Limited, New Delhi – 1989 |
| 4 | Grong O. – ‘Metallurgical Modelling of Welding’ – The Institute of Materials – 1997 – 2nd Edition |

| **REFERENCE BOOKS:** | |
|---|---|
| 1 | Kou S. – ‘Welding Metallurgy’ – John Wiley Publications, New York – 2003 – 2nd Edition. |
| 2 | Principles of foundry technology, 4th edition, P L Jain, Tata McGraw Hill, 2006. |
| 3 | Serope Kalpakjian and Steven R. Schmid – ‘Manufacturing Engineering and Technology’ – Prentice Hall – 2013 – 7th Edition |
| 4 | Advanced Welding Processes technology and process control, John Norrish, Wood Head Publishing, 2006. |
| **e-LEARNING RESOURCES:** | |

| | |
|---|---|
| 1 | Fundamentals of Manufacturing Processes: Comprehensive coverage of casting, metal forming, and joining processes. (https://nptel.ac.in/courses/112107144) |
| 2 | Fundamental of Welding Science and Technology: Detailed modules on fusion welding, solid-state welding, and weldability of metals, highly relevant for Units 3 and 4. (https://nptel.ac.in/courses/112105212) |
| 3 | Principles of Metal Forming Technology: Covers stress-strain relationships, yielding, and bulk/sheet metal forming processes for Unit 5. (https://nptel.ac.in/courses/112106153) |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.

**CIE:** The CIE has three components – CIE - theory component, assignment and group activity. Students have to score a minimum of 40% Marks in the total of CIE - theory, assignment and group activity components put together to take SEE.

**SEE:** Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

****Self-Study Component should be not included for SEE & CIE.**

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | **Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)** |
|---|---|---|---|
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **50** | **20** |
| | **TOTAL** | **50** | **20** |

**QUESTION PAPER PATTERN (SEE)**

| **Q. No.** | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** |
|---|---|---|---|---|---|---|---|---|---|---|
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Core, Gating, Riser system and to use Jolt, Squeeze, and Sand Slinger Moulding machines |
| **CO2** | Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces. Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings. |
| **CO3** | Understand the Solidification process and Casting of Non-Ferrous Metals. |
| **CO4** | Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes etc. used in manufacturing. |
| **CO5** | Describe the methods of different joining processes and thermal effects in joining process |

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School of Core Engineering & Technology
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**Mapping of CO's, PO's with PSO's**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 1 | - | - | 2 | - | 1 | - | - | - | - | 3 | - | - |
| CO 2 | 3 | 2 | - | - | 1 | - | 1 | - | - | - | - | 2 | - | - |
| CO 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO 4 | 3 | 1 | - | - | 2 | - | 1 | - | - | - | - | 3 | - | - |
| CO 5 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 3 | - | - |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | 3 | - | - | 2 | - | - | - |
| CO2 | - | - | 3 | 2 | - | 1 | - | - | - |
| CO3 | 2 | - | 3 | - | - | - | - | - | - |
| CO4 | - | - | 3 | - | - | 3 | - | - | - |
| CO5 | 1 | - | 3 | 2 | - | 1 | - | - | - |

**Mapping of CO's with Sustainable Development Goals (SDG)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO/SDG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | 3 | - | - | - | 2 | 3 | - | - | 1 | - | - | - | - | - |
| CO2 | - | - | - | 3 | - | - | - | 2 | 3 | - | - | 2 | - | - | - | - | - |
| CO3 | - | - | - | 3 | - | - | - | 1 | 3 | - | - | 2 | - | - | - | - | - |
| CO4 | - | - | - | 3 | - | - | - | 2 | 3 | - | - | 1 | - | - | - | - | - |
| CO5 | - | - | - | 3 | - | - | - | 2 | 3 | - | - | 2 | - | - | - | - | - |

**Course Coordinator:**

Dr. M Mahadevaswamy
Associate Professor,
Mechanical Engineering

**Heads of Programme:**

Dr. Sathish S,
Professor,
Mechanical Engineering

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: III** **Scheme: 2025** **Academic Year: 2026-27**

| **Course Title** | **COMPUTER AIDED MACHINE DRAWING** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **1BMEL306** | | | | | | |
| **Course Category** | **PCCL (Professional Core Course Laboratory)** | | | | | | |
| **Teaching - Learning Scheme & Credit** | **L** | **T** | **P** | **S** | **Total** | **Total Teaching Hours** | **Credit** |
| | **0** | **0** | **28** | **2** | **30** | **30** | **1** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | To apply drawing conventions and link design content |
| CLO2 | To sketch appropriate sectional views to communicate information about machine parts |
| CLO3 | To sketch different thread forms to understand thread terminology |
| CLO4 | To sketch different joints using principles of rivets |
| CLO5 | To create geometric models of mechanical parts and assemblies using CAD tool showing all parts |

| **Dra No.** | **Details of Drawing** | **No. of hours** | **BTLs** |
|---|---|---|---|
| | **UNIT 1** | | |
| **1** | **Introduction to Solid Work 3D Tools: Introduction** to tools, and Sketching, Assembly modelling tools.<br>***Self-learning:*** Create Geometric Shapes, Basic part modelling, | **10** | **L1-L4** |
| **2** | **Sections of Solids:** Sectioning, Sectional views, representation of section plane, hatching, sectioning of engineering objects when the axis is inclined to one plane and parallel<br>***Self-learning:*** the other plane of projection – square, pentagonal, hexagonal prisms and pyramids, cylinder & cone. | | **L1-L4** |
| | **UNIT 1I** | | |
| **3** | **Thread Forms:** Thread terminology, sectional view of threads, ISO Metric (Internal & External), BSW (Internal & External), Square and Acme, Sellers thread<br>***Self-learning:*** American Standard Thread, Helical thread inserts | **10** | **L1-L4** |
| **4** | **Rivets:** Single and double riveted lap joints, butt joints with single/double cover straps (chain and zigzag, using snap head rivets).<br>***Self-learning:*** Learn the technical differences between blind rivets, solid rivets, and self-piercing rivets (SPR) through Fictiv's Guide | | **L1-L4** |
| **5** | **Assembly of Joints using 2D Environment:** Cotter Joint (socket & spigot), Knuckle Joint (pin joint)<br>***Self-learning:*** Geometric dimensions and tolerancing Gauging and measurement | | **L1-L4** |
| **6** | **Assembly of Couplings using 2D Environment:** Flanged coupling, universal coupling<br>***Self-learning:*** Geometric dimensions and tolerancing functional datum applications | | **L1-L4** |
| | **UNIT 1II** | | |
| **7** | **Assembly of Lifting Devices (with GD&T) using 3D Environment:** Screw Jack (Bottle Type)<br>***Self-learning:*** Geometric dimensions and tolerancing functional datum applications | | **L1-L4** |

| | | | |
|---|---|---|---|
| **8** | **Assembly of I.C. Engine Components (with GD&T) using 3D Environment:** Connecting Rod<br>***Self-learning:*** Assembly of Lathe Tail stock | **8** | **L1-L4** |
| **9** | **Assembly of Bearings (with GD&T) using 3D Environment:** Plummer Block<br>***Self-learning:*** Assembly of Ramsbottom safety valve | | **L1-L4** |

| **TEXT BOOKS:** | |
|---|---|
| 1 | Solid works 2020 and Engineering Graphics by Randy H Shih, SDC Publications, 2020 |

| **WEB LINKS** | |
|---|---|
| 1 | https://grabcad.com/library/software/solidworks |
| 2 | https://my.solidworks.com/training/catalog |
| 3 | https://www.solidprofessor.com/tutorials/solidworks |

**Assessment Details both (CIE and SEE)**

**CONTINUOUS INTERNAL EVALUATION (CIE)**

CIE has a maximum of 50 marks

1. All the drawings should be drawn in the class using Solid edge software. Sheet sizes should be A4.
2. All sheets must be submitted at the end of the class by taking printouts.
3. CIE Marks is finalized by conducting a test at the end of 10th week of the semester
4. **CIE Marks (50) = Evaluation of Record (Sketch -15 and Printout -15) + Test (20)**

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | **TOTAL MARKS** |
|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | |
| UNIT | 1 | | 2 | | 3 | | |
| MARKS | 10 | | 10 | | 30 | | **50** |
| 1. Two full questions (each of 10 Marks from Unit I and Unit II) are to be set from each unit.<br>2. Two full questions (each of 30 Marks from Unit III) are to be set from unit III. | | | | | | | |
| 3. Student shall answer totally three full questions selecting one full question from each unit. | | | | | | | |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | To select appropriate dimensions, tools to create parts. |
| **CO2** | To sketch the sectional views to analyse the interior of the machine assembly |

| | |
|---|---|
| **CO3** | Create the thread forms, rivets and joints assembly using CAD tool. |
| **CO4** | Create the assembly of machine parts using CAD tool. |

**Mapping of CO's, PO's with PSO's**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | 3 | - | - | 3 | - | - | - |
| **CO2** | - | - | 3 | - | - | 2 | - | - | - |
| **CO3** | - | - | 2 | - | 2 | 3 | - | - | - |
| **CO4** | - | - | 2 | - | 3 | 3 | - | - | - |

**Mapping of CO's with Sustainable Development Goals (SDG)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO/SDG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | 3 | - | - | - | - | 3 | - | - | 1 | - | - | - | - | - |
| **CO2** | - | - | - | 3 | - | - | - | - | 3 | - | - | 1 | - | - | - | - | - |
| **CO3** | - | - | - | 3 | - | - | - | - | 3 | - | - | 2 | - | - | - | - | - |
| **CO4** | - | - | - | 3 | - | - | - | - | 3 | - | - | 2 | - | - | - | - | - |

**Course Coordinators:**

Dr. M Rajesh
Assistant Professor,
Mechanical Engineering

**Heads of Programme:**

Dr. Sathish S,
Professor,
Mechanical Engineering

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: III** **Scheme: 2025** **Academic Year: 2026-27**

| **Course Title** | **MANUFACTURING PROCESS LABORATORY** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **1BMEL307** | | | | | | |
| **Course Category** | **AEC (Ability Enhancement Course Laboratory)** | | | | | | |
| **Teaching - Learning Scheme & Credit** | **L** | **T** | **P** | **S** | **Total** | **Total Teaching Hours** | **Credit** |
| | **0** | **0** | **28** | **2** | **30** | **30** | **1** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | To understand the methods for determining the compression, shear, and tensile strength of molding sand using a universal sand testing machine |
| CLO2 | To learn the procedures for conducting permeability tests, and determining the grain fineness number and clay content of sand mixtures |
| CLO3 | To acquire knowledge on measuring the hardness of molds and cores using a hot air oven. |
| CLO4 | To gain practical skills in preparing various shapes of molds with and without patterns, and observing metal casting demonstrations |
| CLO5 | To understand the principles and applications of non-destructive testing methods such as Visual, Magnetic Particle, Dye Penetrant, and Leak Testing |

| **Syllabus** | |
|---|---|
| **PART: A - SAND TESTING** | |
| 1 | To determine compression strength of a given molding sand specimen using universal sand testing machine. |
| 2 | To determine shear strength of a given molding sand specimen using universal sand testing machine. |
| 3 | To determine tensile strength of a given molding sand specimen using universal sand testing machine. |
| 4 | Conduct a permeability test on a given sand specimen to determine permeability of sand using permeability meter. |
| 5 | To determine grain fineness number of a given sand using sieve shaker. |
| 6 | To determine clay content in a given sand mixture using clay stirrer. |
| 7 | To determine hardness of a mold using hot air oven. |
| **PART: B - FOUNDRY MODELS** | |
| 1 | Preparation of different shape of molds without using a patterns. |
| 2 | Preparation of different shape of molds with using a patterns. |
| 3 | Preparation of a casting (Aluminum or cast iron-Demonstration only) |
| 4 | **NON DESTRUCTIVE TESTING FOR FORGING CASTING AND WELDING**<br>Visual, Magnetic Particle, Dye Penetrant and Leak Testing. |

| **Teaching & Learning Process** (Innovative Delivery Methods): | |
|---|---|
| 1 | Active Learning Techniques |
| 2 | Problem-Based Learning (PBL) |
| 3 | Team-Based Learning (TBL) |
| 4 | Hands-On Experiments and Simulations |

| **TEXT BOOKS:** | |
|---|---|
| 1 | R.S. Parmar, "Welding Processes and Technology", Khanna Publishers. |
| 2 | P.L. Jain, "Principles of Foundry Technology", Tata McGraw Hill. |

| **REFERENCE BOOKS:** | |
|---|---|
| 1 | Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", Pearson. |
| 2 | Amitabh Ghosh and Asok Kumar Mallik, "Manufacturing Science", East-West Press. |
| 3 | J. Prasad and C. G. Krishnadas Nair, "Non-Destructive Test and Evaluation of Materials", Tata McGraw Hill. |
| **e-LEARNING RESOURCES:** | |
| 1 | Virtual Labs (Ministry of Education): Metal Casting and Welding virtual simulations (vlabs.ac.in). |
| 2 | Videos and Lecture Notes: http://www.nptel.ac.in |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each.
The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.
CIE: The CIE has two components – CIE - theory component and CIE – laboratory component.
Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE.
Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.
****Self-Study Component should be not included for SEE & CIE.**

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
|---|---|---|---|
| **Laboratory components** | Rubrics for each experiment are added, then taken average | **30** | **20** |
| | **Lab CIE** | **20** | |
| | **TOTAL** | **50** | **20** |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Determine the compression, shear, and tensile strength of molding sand specimens using a universal sand testing machine. |
| **CO2** | Evaluate the permeability, grain fineness number, and clay content of given sand mixtures |
| **CO3** | Measure the hardness of molds and cores prepared using a hot air oven |
| **CO4** | Prepare different shapes of sand molds with and without patterns, and interpret the basic casting process. |
| **CO5** | Apply non-destructive testing methods including visual, magnetic particle, dye penetrant, and leak testing on manufacturing components. |

**Mapping of CO's, PO's with PSO's**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 2 | - | 2 | - | - | - | - | 2 | - | - | 3 | - | - |
| CO 2 | 3 | 2 | - | 2 | - | - | - | - | 2 | - | - | 3 | - | - |
| CO 3 | 3 | 2 | - | 1 | - | - | - | - | 2 | - | - | 3 | - | - |
| CO 4 | 3 | 1 | 2 | 1 | - | 2 | - | - | 3 | - | - | 3 | 2 | - |
| CO 5 | 3 | 3 | 1 | 3 | 2 | 2 | - | - | 2 | - | - | 3 | 2 | - |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | 3 | - | - | 3 | - | - | - |
| CO2 | - | - | 3 | - | - | 3 | - | - | - |
| CO3 | - | - | 3 | - | - | 2 | - | - | - |
| CO4 | - | - | 3 | - | 1 | 3 | - | - | - |
| CO5 | - | - | 3 | 2 | - | 3 | - | - | - |

**Mapping of CO's with Sustainable Development Goals (SDG)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO/SDG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - | - | - | - | - |
| CO2 | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - | - | - | - | - |
| CO3 | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - | - | - | - | - |
| CO4 | - | - | - | 3 | - | - | - | 1 | 3 | - | - | 1 | - | - | - | - | - |
| CO5 | - | - | - | 3 | - | - | - | 2 | 3 | - | - | 2 | - | - | - | - | - |

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: III** **Scheme: 2025** **Academic Year: 2026-27**

**Course Coordinators:**

Dr. M Mahadevaswamy
Associate Professor
Mechanical Engineering

**Heads of Programme:**

Dr. Sathish S,
Professor,
Mechanical Engineering

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology

**Semester: IV** **Scheme: 2025**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Title** | **FLUID MECHANICS** | | | | | | |
| **Course Code** | **1BMET401** | | | | | | |
| **Course Category** | **PCC (Professional Core Course)** | | | | | | |
| **Teaching - Learning** | **L** | **T** | **P** | **S** | **Total** | **Total Hours** | **Credit** |
| **Scheme & Credit** | **4** | **0** | **0** | **3** | **4** | **56+0+0+64=120** | **4** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |
| **Common Branches** | **CV/ME/AE/IEM** | | | | | | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | Explain various properties related to fluid mechanics. |
| CLO2 | Determine hydrostatic force and Centre of pressure on plane and curved surfaces, locate met Centre and Meta centric height of floating bodies. |
| CLO3 | Summarize different types of pressure measurement devices. |
| CLO4 | Apply laws of conservation of momentum, mass and energy to fluid flow systems and explain the measurement of fluid flow parameters. |
| CLO5 | Interpret compressibility of gases in terms of Mach number. |

| **SYLLABUS** | **No. of Hours** | **BTLs** |
|---|---|---|
| **UNIT 1** | **10** | **L1-L4** |
| **PROPERTIES OF FLUID:**<br>Introduction, classification of fluids, properties of fluids, viscosity, surface tension, capillarity, vapor pressure, cavitation phenomenon. Numerical problems. Fluid statics: Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Numerical problems. | | |
| **SELF-STUDY COMPONENTS:**<br>Practical applications of fluid properties, apply fluid statics principles to engineering systems and Analyze pressure measurement systems. | | |
| **UNIT 2** | **10** | **L1-L4** |
| **SUBMERGED BODIES**:<br>Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid. Related numerical problems.<br>**BUOYANCY**:<br>Buoyancy, center of buoyancy, metacenter and metacentric height, conditions of equilibrium of floating and submerged bodies, determination of metacentric height experimentally and theoretically. Numerical problems. | | |
| **SELF-STUDY COMPONENTS:**<br>Importance of hydrostatic pressure distribution on engineering structures, Analyse hydrostatic forces acting on Reservoir walls and Swimming pool walls and Applications of Buoyancy in Ocean Engineering. | | |
| **UNIT 3** | **12** | **L1-L4** |
| **FLUID KINEMATICS:**<br>Types of fluid flow, continuity equation in 2Dand 3D (Cartesian Coordinates only), velocity and acceleration, Numerical problems.<br>**FLUID DYNAMICS:** | | |

| | | |
|---|---|---|
| Introduction, Equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and from Euler's equation, limitations of Bernoulli's equation. Numerical problems.<br>**FLUID FLOW MEASUREMENTS:**<br>Applications of Bernoulli's equation, venturi meter, orifice meter, pitot-tube, vertical orifice and V-notch. Numerical problems. | | |
| **SELF-STUDY COMPONENTS:**<br>Identify the type of flow occurring in real engineering systems, industrial applications of flow measurement and applications of Bernoulli's Principle in Aerospace engineering. | | |
| **UNIT 4** | **12** | **L1-L4** |
| **FLOW THROUGH PIPES**:<br>Introduction, major and minor losses through pipes. Darcy's and Chezy's equation for loss of head due to friction in pipes. HGL and TEL. Numerical problems.<br>**LAMINAR FLOW AND VISCOUS EFFECTS**:<br>Reynold's number, critical Reynold's number, laminar flow through circular pipe-Hagen Poiseille's equation, laminar flow between parallel and stationary plates. Numerical problems. | | |
| **SELF-STUDY COMPONENTS:**<br>Fluid Flow in Oil and Gas Industries, Blood Flow Analysis Using Fluid Mechanics and Water Distribution Networks. | | |
| **UNIT 5** | **12** | **L1-L4** |
| **FLOW PAST IMMERSED BODIES:**<br>Introduction, drag, lift, expression for lift and drag, boundary layer concept, displacement, momentum AND ENERGY THICKNESS. NUMERICAL PROBLEMS.<br>**COMPRESSIBLE FLOW:**<br>Introduction – stagnation properties relationship, velocity of sound in a fluid, Mach number, Mach cone, propagation of pressure waves in a compressible fluid. Numerical problems.<br>**INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS (CFD):**<br>Necessity, limitations, philosophy behind CFD, applications; Commercial software's available for CFD analysis. | | |
| **SELF-STUDY COMPONENTS:**<br>Evaluate aerodynamic performance of engineering components, Aerodynamic Design of Electric Vehicles and Supersonic and Hypersonic Flight. | | |

| **TEXT BOOKS:** | |
|---|---|
| 1 | A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units), Dr. R.K. Bansal, Laxmi Publications (P) Limited, Revised 9th Edition, 2010. |
| 2 | Fluid Mechanics: Fundamentals and Applications (SI Units), Yunus A. Cengel, JohnM.Cimbala. McGraw-Hill Publications (SIE), 3rd Edition, 2014. |

| **REFERENCE BOOKS:** | |
|---|---|
| 1 | Hydraulics and Fluid Mechanics including Hydraulic Machines, Dr. P.N. Modi and S.M. Seth, Rajsons Publications Private Limited, Standard Book House, 2009. |
| 2 | Fluid Mechanics, Frank M. White, McGraw-Hill Publications (SIE), 7th Edition, 2011. |
| 3 | A Text Book of Fluid Mechanics, R K Rajput, S Chand Publishers, 1998. |
| **e-LEARNING RESOURCES:** | |
| 1 | Fluid Mechanics: Mechanical Engineering Handbook, Kreith,F, Berger, S.A, et. al., Ed. Frank Kreith, Boca Raton: CRC Press LLC, 1999. |

| | |
|---|---|
| 2 | Videos and Lecture Notes: http://www.nptel.ac.in |

| **Assessment Details both (CIE and SEE)** | | | |
|---|---|---|---|
| The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.<br>**CIE:** The CIE has three components – CIE - theory component, assignment and group activity. Students have to score a minimum of 40% Marks in the total of CIE - theory, assignment and group activity components put together to take SEE.<br>**SEE:** Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.<br>****Self-Study Component should be included in CIE under Question No. 2c).** | | | |
| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | **Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)** |
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **50** | **20** |
| | **TOTAL** | **50** | **20** |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Q. No.** | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Understand how a fluid is classified and define various properties of a fluid; understand Pascal's law and explain various types of manometers; and solve related numerical problems |
| **CO2** | Explain the total pressure and Centre of pressure acting on submerged surfaces; understand the concept of buoyancy, metacenter and metacentric height of floating and submerged bodies; and solve related numerical problems |
| **CO3** | Describe the types of fluid flow and understand the continuity, Euler and Bernoulli's equation; solve numerical problems related to fluid kinematics and dynamics; application of Bernoulli's equation. |
| **CO4** | Discuss Darcy and Chezy equations; describe Reynolds number and understand the derivation of flow through circular pipe, laminar flow between parallel and stationary plates; and solve related numerical problems |
| **CO5** | Understand the terms related to fluid flow past an immersed body; explain boundary layer, displacement, momentum and energy thickness; understand the relationship of stagnation properties applicable to compressible flow. |

**Mapping of CO's, PO's with PSO(Civil)'s**

**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1

| **CO /PO** | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO1 0** | **PO1 1** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | - | - | - | 2 | 1 | 1 | 1 | - | 1 | 2 | 3 |

**Semester: IV** **Scheme: 2025**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 2** | 3 | 3 | 2 | - | - | - | 2 | 1 | 1 | 1 | - | 1 | 2 | 3 |
| **CO 3** | 3 | 3 | 3 | - | - | - | 2 | 1 | 1 | 1 | - | 1 | 2 | 1 |
| **CO 4** | 3 | 3 | 3 | - | - | - | 2 | 1 | 1 | 1 | - | 1 | 2 | 1 |
| **CO 5** | 3 | 3 | 3 | - | - | - | 2 | 1 | 1 | 1 | - | 1 | 2 | 2 |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | 1 | - | - | - | 2 |
| **CO2** | 2 | 2 | 2 | 1 | 1 | - | - | - | 2 |
| **CO3** | 2 | 2 | 2 | 1 | 1 | - | - | - | 2 |
| **CO4** | 2 | 2 | 2 | 1 | 1 | - | - | - | 2 |
| **CO5** | 2 | 2 | 2 | 1 | 1 | - | - | - | 2 |

**Mapping of CO's with Sustainable Development Goals (SDG)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1

| CO/SDG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | - | 2 | - | - | 3 | - | - | 3 | - | 3 | - | - | - | - | - | - |
| **CO2** | 1 | - | 2 | - | - | 3 | - | - | 3 | - | 3 | - | - | - | - | - | - |
| **CO3** | 1 | - | 2 | - | - | 3 | - | - | 3 | - | 3 | - | - | - | - | - | - |
| **CO4** | 1 | - | 2 | - | - | 3 | - | - | 3 | - | 3 | - | - | - | - | - | - |
| **CO5** | 1 | - | 2 | - | - | 3 | - | - | 3 | - | 3 | - | - | - | - | - | - |

**Course Coordinators:**

Byregowda K C,
Assistant Professor,
Mechanical Engineering

**Heads of Program:**

Dr. Sathish S.
Professor,
Mechanical Engineering

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: IV** **Scheme: 2025**

| **Course Title** | **MACHINING PROCESSES AND ENGINEERING METROLOGY** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **1BMEU402** | | | | | | |
| **Course Category** | **IPCC (Integrated Professional Core Course)** | | | | | | |
| **Teaching - Learning Scheme & Credit** | **L** | **T** | **P** | **S** | **Total** | **Total Teaching Hours** | **Credit** |
| | **3** | **0** | **1** | **0** | **4** | **42+0+28+50=120** | **4** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools. . |
| CLO2 | To introduce students to different machine tools to produce components having different shapes and sizes. |
| CLO3 | To develop the knowledge on mechanics of machining process and effect of various parameters on machining. |
| CLO4 | To understand the basic principles of measurements |
| CLO5 | To enrich the knowledge pertaining to gauge , comparator and angular measurement |

| **SYLLABUS** | **No. of Hours** | **BTLs** |
|---|---|---|
| **UNIT 1** | **8** | **L1-L4** |
| **MECHANICS OF METAL CUTTING:** Introduction to Metal cutting: Orthogonal and oblique cutting. Classification of cutting tools: single, and multipoint; tool signature for single point cutting tool. Mechanics of orthogonal cutting; chip formation, shear angle and its significance, Merchant circle diagram. Numerical problems. Cutting tool materials and applications. Introduction to basic metal cutting machine tools: Lathe- Parts of lathe machine, | | |
| **SELF-STUDY COMPONENTS:**<br>Study different lathe accessories of lathe Machine and various operations carried out on lathe. Kinematics of lathe. Turret and Capstan lathe. | | |
| **UNIT 2** | **8** | **L1-L4** |
| **MILLING, SHAPING, DRILLING AND GRINDING:** Milling Machines: up milling & down milling, classification of milling machines, constructional features (Column and Knee and vertical milling machine), milling cutter nomenclature, various milling operations, calculation of machining time. Indexing: Need of indexing Simple, compound and differential indexing calculations. Simple numerical on indexing. Shaping, Slotting and Planning Machines Tools: Driving mechanisms of Shaper, Slotter and Planer. Operations done on Shaper, Planer & Slotter Difference between shaping and planning operations. Drilling Machines: Constructional features (Radial & Bench drilling Machines), operations, types of drill & drill bit nomenclature. Calculation of machining time. Grinding: Grinding operation, | | |
| **SELF-STUDY COMPONENTS:**<br>Classification of grinding processes: cylindrical, surface &centerless grinding | | |
| **UNIT 3** | **8** | **L1-L4** |
| **ADVANCED MACHINING PROCESS**: Importance and classification of advanced machining process; Process principal, process parameters, and application of: - Abrasive Jet Machining (AJW), Water Jet Machining (WJM), Abrasive Water Jet Machining (AWJM); Ultrasonic Machining | | |

| | | |
|---|---|---|
| (USM);Electrical Discharge Machining (EDM); Wire Electrical Discharge Machining (WEDM); Electro Chemical Machining (ECM). Laser Beam Machining (LBM), Electron Beam Machining (EBM), and Plasma Arc Machining (PAM). Hybrid Machining Process: Importance of hybrid machining process; Process principal, process parameters, and application of: - Electrochemical Discharge Machining (ECDM), | | |
| **SELF-STUDY COMPONENTS:** Ultrasonic Assisted Electric Discharge Machining (UAEDM), Electrochemical Discharge Grinding (EDG), Powder Assisted Electric Discharge Machining (PAEDM). | | |
| **UNIT 4** | **9** | **L1-L4** |
| **MEASUREMENTS AND METROLOGY:** Introduction to metrology & measurements, definition, objectives and classification of metrology, standards of length- wave length standard, sub division of standards, numerical problems on length calibration. Line & End Standards: Line and end standard, slip gauges, wringing phenomena, numerical problems on slip gauges. Systems of Limits, Fits & Tolerance: Definition of tolerance, tolerance specification in assembly, principle of interchangeability and selective assembly, limits of size, | | |
| **SELF-STUDY COMPONENTS:** Indian standards, concepts of limits of size and tolerances, cost v/s tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation. | | |
| **UNIT 5** | **9** | **L1-L4** |
| **GAUGES AND COMPARATORS :** Classification of gauges, Taylor's principle, design of GO, NO GO gauges, wear allowance on gauges, types of gauges- plain plug gauges, ring gauges, snap gauge, limit gauge, simple problems. Comparators: Introduction to comparators, classification, characteristics, systems of displacement amplification in mechanical comparators, Reed type, Sigma comparator, Zeiss ultra-optimeter, Solex air gauge, ultrasonic gauges, LVDT. | | |
| **SELF-STUDY COMPONENTS:** Angular Measurements: Bevel protractor, sine bar, angular gauges, numerical on building of angles. | | |

| **MACHINING PROCESSES AND ENGINEERING METROLOGY LABORATORY** | | |
|---|---|---|
| Exp. No. | List of Experiments | No. of Hours |
| 01 | Operations and One Job each on shaping/milling machine | (14 Slots) 28 |
| 02 | Simple operations and One Job on the drilling and grinding machine | |
| 03 | Angular measurements: - Measurement of angle using Bevel Protractor | |
| 04 | Calibration of Load cell with standard weights. | |
| 05 | Calibration of Thermocouple with standard thermometer. | |
| 06 | Various parameter measurement using profile projector | |
| 07 | Study of tool maker's microscope – use at shop floor applications. | |
| 08 | Study of flatness, concave and convexity using optical flats. | |
| ***Self-Study Component:*** | | |
| | | |

| **TEXT BOOKS:** | |
|---|---|
| 1 | Chapman W. A. J., Workshop Technology, Viva books (P) Ltd |
| 2 | HMT, Production Technology, Tata McGraw-Hill |
| 3 | Engineering Metrology and Measurements, N.V. Raghavendra, l. Krishnamurthy, oxford university press 4. Galyer J.F.W., Schotbolt C.R., Metrology for Engineers, ELBS. |

| | |
|---|---|
| 4 | Chapman W. A. J., Workshop Technology, Viva books (P) Ltd |

| **REFERENCE BOOKS:** | |
|---|---|
| 1 | Acharkan. N., Machine Tool Design Vol. 1 to 4, MIR Publication |
| 2 | Chernov, Machine Tools, MIR Publication. |
| 3 | HajraChoudary, Elements of workshop technology, Vol I & II, Media Publishers. |
| 4 | Acharkan. N., Machine Tool Design Vol. 1 to 4, MIR Publication |
| **e-LEARNING RESOURCES:** | |
| 1 | NOC:Metal Cutting and Machine tools - nptel online courses archive.nptel.ac.in › courses |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each.
The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.
CIE: The CIE has two components – CIE - theory component and CIE – laboratory component.
Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE.
Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.
****Self-Study Component should be not included for SEE & CIE.**

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
|---|---|---|---|---|
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **30** | | **12** |
| **Laboratory components** | Rubrics for experiment are added, then taken average | **10** | **20** | **08** |
| | **Lab CIE** | **10** | | |
| | **TOTAL** | **50** | | **20** |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Q. No.** | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Analyze the mechanics of metal cutting, tool signature, and understand the construction and kinematics of lathe machines. |
| **CO2** | Describe the constructional features, driving mechanisms, and calculate machining time for milling, drilling, shaping, and grinding operations |
| **CO3** | Evaluate the principles, process parameters, and applications of various advanced and hybrid machining processes. |

| | |
|---|---|
| **CO4** | Apply the basic principles of metrology, standards of length, and design concepts of limits, fits, and tolerances. |
| **CO5** | Select and utilize appropriate gauges, mechanical comparators, and optical instruments for linear and angular measurements. |

**Mapping of CO's, PO's with PSO's**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 3 | - | - | - | - | - | - | - | - | 2 | 3 | 0 | 0 |
| **CO 2** | 2 | 3 | - | - | - | - | - | - | - | - | 2 | 3 | 0 | 0 |
| **CO 3** | 2 | 1 | - | 2 | 2 | - | - | - | - | - | - | 3 | 0 | 0 |
| **CO 4** | 3 | - | 2 | - | - | - | - | - | - | - | 2 | 3 | 0 | 0 |
| **CO 5** | 2 | - | - | 2 | 3 | - | - | - | - | - | - | 3 | 0 | 0 |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | - | 3 | - | - | 2 | - | - | - |
| **CO2** | - | 2 | 3 | - | - | 3 | - | - | - |
| **CO3** | - | - | 3 | 3 | - | 2 | - | - | - |
| **CO4** | - | - | 3 | - | 2 | 2 | - | - | - |
| **CO5** | - | - | 3 | 2 | - | 3 | - | - | - |

**Mapping of CO's with Sustainable Development Goals (SDG)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO/SDG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - | - | - | - | - |
| **CO2** | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - | - | - | - | - |
| **CO3** | - | - | - | 3 | - | - | - | - | 3 | - | - | 2 | - | - | - | - | - |
| **CO4** | - | - | - | 3 | - | - | - | - | 3 | - | - | 2 | - | - | - | - | - |
| **CO5** | - | - | - | 3 | - | - | - | - | 3 | - | - | 2 | - | - | - | - | - |

**Course Coordinator:**

Dr. Preethi K.
Assistant Professor
Mechanical Engineering

**Heads of Programme:**

Dr. Sathish S,
Professor,
Mechanical Engineering

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: IV** **Scheme: 2025**

| **Course Title** | **APPLIED THERMODYNAMICS** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **1BMET403** | | | | | | |
| **Course Category** | **PCC (Professional Core Course)** | | | | | | |
| **Teaching - Learning** | **L** | **T** | **P** | **S** | **Total** | **Total Hours** | **Credit** |
| **Scheme & Credit** | **4** | **0** | **0** | **3** | **3** | **56+0+0+64=120** | **4** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | To relate the fundamentals of thermodynamics to different Ideal thermodynamics cycles and understating of practical Performance characteristics of IC Engines. |
| CLO2 | To describe the various thermodynamic power cycles which use air and vapour as the working fluid and developing efficiency equations. |
| CLO3 | To apply the fundamental definition and equations to derive various thermodynamic variables for solving numerical problems. |
| CLO4 | To understand the thermodynamic analysis of Reciprocating Air compressor converts mechanical motion into pressurized energy for practical applications. |
| CLO5 | To relate the fundamental and theoretical understanding of Refrigeration cycles and Air Conditioning Psychrometric Analysis. |

| **SYLLABUS** | **No. of Hours** | **BTLs** |
|---|---|---|
| **UNIT 1** | **12** | **L1-L4** |
| **AIR STANDARD CYCLES -** Definition, Assumptions, Air standard Efficiency, Mean Effective Pressure, Carnot's' Cycle, Working of Otto cycle and Diesel cycles with Piston cylinder Arrangements, P-V Diagrams, Derivation of Efficiency and Mean Effective Pressure of Otto Cycle, Diesel Cycle and Dual Combustion cycle, p - V and T- S diagrams. Numerical Problems.<br><br>**TESTING AND PERFORMANCE OF IC ENGINES** – Combustion of SI and CI engines, Detonation and factors affecting detonation; Basic Measurements – engine speed, fuel consumption, Air Consumption, Exhaust Smoke, IP, BP, FP Measurements, Heat Balance Sheet. Numerical Problems. | | |
| **SELF-STUDY COMPONENTS:**<br>Combustion Thermodynamics, Stoichiometric Air, Air-Fuel Ratios, Exhaust Gas Analysis, Work and heat transfers of various thermodynamic processes, p -V and T- S diagrams, Alternate Fuels. Different types of Dynamometers, Valve timing Diagrams of IC Engines. | | |
| **UNIT 2** | **12** | **L1-L4** |
| **GAS TURBINE CYCLES (Brayton cycles) -** Introduction; Assumptions, Analysis of simple Gas Turbine Cycle, Derivation for the Efficiency, Actual Cycle; Methods to improve the performance of gas turbine plant – Regenerative Gas Turbine Cycle,<br>Derivation for the Efficiency; Reheat Gas Turbine Cycle; Gas Turbine Cycle With Intercooling; Gas Turbine Cycle With Reheat, Regeneration and Intercooling, - Working and Expressions for the Efficiency. Numerical problems<br><br>**AIR CRAFT GAS TURBINE ENGINES -** Gas turbine cycles for jet propulsions, Working of ram jet engine, Pulse jet engine, Turbo jet engine, Turboprop engine, Comparisons of various propulsive devices, Jet Propulsion – Introduction to jet propulsion, Numerical problems. | | |
| **SELF-STUDY COMPONENTS:**<br>Gas Dynamics: Review of the speed of sound, Mach number, and isentropic flow relations, Inlets and Nozzles: Operations of subsonic and supersonic diffusers, converging-diverging nozzles combustion | | |

chambers, Compressors: Working principles of axial and centrifugal compressors, Turbines: Impulse and reaction turbines, and turbine blade cooling method.

| UNIT 3 | 12 | L1-L4 |
|---|---|---|

**VAPOUR POWER CYCLES** - Introduction; Carnot vapor power cycle; Rankine cycle; actual vapour power cycle; Comparison of Rankine and Carnot cycles; Mean temperature of heat addition; Effect of Pressure and Superheating on Rankine cycles. Numerical problems. Numerical problems.

**PRACTICAL VAPOUR POWER CYCLES** Methods of improving the thermal efficiency of vapor power plant; Reheat Rankine cycle; Ideal and practical regenerative Rankine cycle; Reheat-regenerative cycle; feed water heaters; Numerical problems.

**SELF-STUDY COMPONENTS:**
Steam table learning, understanding of Mollier's Chart, Steam nozzles - Flow of steam through nozzles, Shape of nozzles, effect of friction, Critical pressure ratio, Supersaturated flow.

| UNIT 4 | 10 | L1-L4 |
|---|---|---|

**RECIPROCATING AIR COMPRESSORS** - Introduction; Working principle, Clearance Volume, P-V diagram and derivation of work input of a single stage reciprocating air compressor with and without Clearance Volume; Adiabatic, Isothermal And Mechanical Efficiencies; Free Air Delivery (FAD), Volumetric Efficiency and derivation of volumetric efficiency, Numerical problems.

**MULTISTAGE RECIPROCATING AIR COMPRESSOR** - Intercooling, Saving in work, Derivations for Work done, Optimum intermediate pressure and Conditions Minimum work for compression; Numerical problems.

**SELF-STUDY COMPONENTS:**
Applications of Reciprocating Air Compressor, Key Advantages, Single Acting and Double Acting Reciprocating Air Compressor.

| UNIT 5 | 10 | L1-L4 |
|---|---|---|

**REFRIGERATION CYCLES** - Introduction; Units of refrigeration, COP; Reversed Carnot cycle; Vapour compression refrigeration cycle p – H, and T – S Diagrams ; Deviation of actual cycle from ideal cycle; Effect of change in operating conditions on the performance of vapour compression cycle, Numerical problems; Vapour absorption refrigeration system, Steam jet refrigeration system; Numerical problems.

**PSYCHROMETRY** - Definitions of terms related to Psychometric – Wet Bulb Temperature, Dry Bulb Temperature, Dew Point Temperature, Specific humidity, Relative humidity, Enthalpy, Analysis of Psychrometric chart. Summer Air Conditioning System and Winter Air Conditioning System for Hot and Dry and Hot and Humid Conditions. Numerical problems.

**SELF-STUDY COMPONENTS:**
Selection, Properties of refrigerant; Gas cycle refrigeration-Bell Coleman cycle. Listing of Different Refrigerants and their Desirable Properties. Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams.

**TEXT BOOKS:**


| | |
|---|---|
| 1 | "Basic and Applied Thermodynamics" by P .K. Nag, Tata McGraw Hill, 2nd Edi. 2009 |
| 2 | "Internal Combustion Engines", 4th Edition V Ganeshan. Tata McGraw Hill, 2012. |
| 3 | "A Textbook of Engineering Thermodynamics" R K Rajput, Sixth Edition, Laxmi Publications, 2020. |
| 4 | "Gas Turbines" by V Ganesan, Tata Mc Graw Hill, 2004. |

| **REFERENCE BOOKS:** | |
|---|---|
| 1 | "Thermodynamics an engineering approach", by Yunus A. Cenegal and Michael A. Boles. Tata McGraw hill Pub. Sixth edition, 2008 |
| 2 | "Thermodynamics for engineers, Kenneth" A. Kroos and Merle C. Potter, Cengage Learning, 2016 |
| 3 | "Principles of Engineering Thermodynamics" , Michael J,Moran, Howard N. Shapiro, Wiley, 8th Edition |
| **e-LEARNING RESOURCES:** | |
| 1 | Videos and Lecture Notes: http://www.nptel.ac.in |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.

**CIE:** The CIE has three components – CIE - theory component, assignment and group activity. Students have to score a minimum of 40% Marks in the total of CIE - theory, assignment and group activity components put together to take SEE.

**SEE:** Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

****Self-Study Component should be included in CIE under Question No. 2c).**

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | **Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)** |
|---|---|---|---|
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **50** | **20** |
| | **TOTAL** | **50** | **20** |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Q. No.** | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Understand, Sketch and draw thermodynamic cycles to solve for various parameters by applying the basic principles of thermodynamics for Air Standard Cycles. |
| **CO2** | Evaluate the performance parameters by measuring, testing and drawing heat balance sheet. |
| **CO3** | Understand simple and practical Steam plant cycles, Evaluation of Efficiency by referring data sheets and Charts. |
| **CO4** | Understand the thermodynamic analysis of reciprocating air compressor and evaluate the performance in single and multistage. |
| **CO5** | Understand the principles and applications of refrigeration systems and Analyze air-conditioning processes using the principles of Psychrometry and Evaluate cooling and heating loads in an Air Conditioning System |

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: IV** **Scheme: 2025**

**Mapping of CO's, PO's with PSO(Civil)'s**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1

| CO /PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 3 | 0 | 0 |
| CO 2 | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 3 | 0 | 0 |
| CO 3 | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 3 | 0 | 0 |
| CO 4 | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 3 | 0 | 0 |
| CO 5 | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 3 | 0 | 0 |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | - | - | - | - | - | - |
| CO2 | 3 | 3 | 3 | - | - | 2 | - | - | - |
| CO3 | 3 | 3 | 3 | 2 | - | - | - | - | - |
| CO4 | 3 | 3 | 3 | - | - | - | - | - | - |
| CO5 | 3 | 3 | 3 | 2 | - | - | - | - | - |

**Mapping of CO's with Sustainable Development Goals (SDG)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1

| CO/SDG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | 3 | - | - | 3 | - | 2 | - | - | - | - | - | - | - | - | - |
| CO2 | - | - | 3 | - | - | 3 | - | 2 | - | - | 2 | 2 | - | - | - | - | - |
| CO3 | - | - | 3 | - | - | 3 | - | 2 | - | - | 2 | - | - | - | - | - | - |
| CO4 | - | - | 3 | - | - | 2 | - | 3 | - | - | 2 | - | - | - | - | - | - |
| CO5 | - | - | 3 | - | - | 2 | - | 2 | - | - | 2 | 2 | - | - | - | - | - |

**Course Coordinators:**

Dr. Vishwanath M M
Assistant Professor,
Mechanical Engineering

**Heads of Program:**

Dr. Sathish S.
Professor,
Mechanical Engineering

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: IV** **Scheme: 2025**

| **Course Title** | **KINEMATIC OF MACHINES** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **1BMET404** | | | | | | |
| **Course Category** | **PCC (Professional Core Course)** | | | | | | |
| **Teaching - Learning** | **L** | **T** | **P** | **S** | **Total** | **Total Hours** | **Credit** |
| **Scheme & Credit** | **4** | **0** | **0** | **3** | **3** | **56+0+0+64=120** | **4** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | To understand the foundational concepts of machines, kinematic links, pairs, and mechanisms alongside their practical engineering applications. |
| CLO2 | To expose students to a diverse range of mechanisms, straight-line motion devices, steering gears, and universal velocity joints. |
| CLO3 | To impart skills to analyze the position, velocity and acceleration of mechanisms and synthesis of mechanism by analytical and graphical method |
| CLO4 | To familiarize higher pairs like cams and principles of cams design |
| CLO5 | To study the relative motion analysis and design of gears, gear trains |

| **SYLLABUS** | **No. of Hours** | **BTLs** |
|---|---|---|
| **UNIT 1** | **12** | **L1-L4** |

**MECHANISMS, KINEMATIC PAIRS, AND INVERSIONS:** Structure of a machine, distinction between a machine and a mechanism. Kinematic link/element, classification of links (rigid, flexible, fluid). Kinematic pairs and their classifications based on type of relative motion (sliding, turning, rolling, screw, spherical) and type of contact (lower pair, higher pair).

**CONSTRAINED MOTION:** Types of constrained motion (completely, incompletely, and successfully constrained motion). Kinematic chains, mechanisms, structures, and degrees of freedom of planar mechanisms.

**MOBILITY CRITERIA AND INVERSIONS:** Grubler's criterion, mobility criteria for planar mechanisms, and equivalent mechanisms. Grashof's (Groshoff's) criteria for link configurations and types of four-bar mechanisms. Complete structural analysis of kinematic inversions: Inversions of the quadric cycle/four-bar chain, inversions of the single slider-crank chain, and inversions of the double slider-crank chain (including Oldham's coupling).

**SPECIALIZED LINKAGE MECHANISMS:** Quick-return motion mechanisms (Drag link mechanism, Whitworth mechanism, and Crank and slotted lever mechanism). Straight-line motion mechanisms: Exact straight-line mechanisms (Peaucellier's mechanism) and Approximate straight-line mechanisms (Robert's mechanism). Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism

**KINEMATICS OF ADVANCED LINKAGES AND GRAPHICAL VELOCITY ANALYSIS**: Toggle mechanism, pantograph, geometric condition for correct steering, Davis steering gear mechanism, and Ackerman steering gear mechanism. Hooke's Joint (Universal Joint): Single Hooke's joint, Double Hooke's joint, polar velocity diagrams, and the mathematical derivation for the ratio of shaft velocities.

**SELF-STUDY COMPONENTS:**

Industrial Automation via Intermittent and Variable Velocity Mechanical Systems. Investigate the modern engineering design parameters and structural performance limitations of the Geneva Wheel mechanism when implemented in automated packaging lines, or analyze the rotational acceleration variations in a single Hooke's joint under high angular misalignment.

| **UNIT 2** | **12** | **L1-L4** |
|---|---|---|

**VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS (ANALYTICAL METHOD):** Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method. Freudenstein's equation for four bar mechanism and slider crank mechanism. Function Generation for four bar mechanism.

**CORIOLIS COMPONENT OF ACCELERATION:** Structural environments producing Coriolis acceleration. Mathematical derivation of the magnitude and precise graphical determination of the directional orientation of Coriolis's component of acceleration.

**LINK DYNAMICS**: Evaluation of angular velocity (omega) and angular acceleration (alpha) of driven links, and the structural calculation of the velocity of rubbing at pinned joints.

.

**SELF-STUDY COMPONENTS:** Kinematics of Multi-Link Mechanical Suspension Systems. Apply the Instantaneous Center (I-Center) method to map out and analyze the roll-center migration and virtual swing-arm behavior of a double-wishbone automotive suspension system during chassis roll.

| **UNIT 3** | **12** | **L1-L4** |
|---|---|---|

**VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS (GRAPHICAL METHOD)**: Graphical Vector Diagrams: Relative velocity and relative acceleration analysis of planar mechanisms using graphical vector polygons. Velocity and acceleration analysis applied to a standard four-bar mechanism and a single slider-crank mechanism.

**INSTANTANEOUS CENTER METHOD:** Definition of Instantaneous Center of Rotation (I-Center), classifications of I-centers (fixed, permanent, and virtual). Kennedy's Theorem (Three-centers-in-line theorem). Graphical determination and localization of all I-centers for common planar mechanisms. Calculation of linear and angular velocities using the I-center approach.

**GEOMETRIC SHORTCUTS**: Klein's Construction for the simultaneous determination of velocity and acceleration parameters of a single slider-crank mechanism without structural vector polygons

**SELF-STUDY COMPONENTS:** Analytical determination of velocity and acceleration parameters for the single slider-crank and four-bar mechanisms. Verification of graphical vector polygon results using computational tools like MATLAB or basic CAD kinematics simulations.

| **UNIT 4** | **10** | **L1-L4** |
|---|---|---|

**CAMS AND FOLLOWERS:** Classification & Nomenclature: Broad industrial classification of cams (radial, cylindrical, wedge) and types of followers (knife-edge, roller, flat-faced, spherical; inline and offset configurations). Comprehensive definition of cam nomenclature: Base circle, pitch curve, prime circle, trace point, pressure angle, pitch point, pitch circle, and lift/stroke.

**FOLLOWER MOTION ANALYSIS:** Detailed construction of displacement , velocity , and acceleration mathematical curves for explicit follower motion profiles:

- Uniform velocity motion
- Simple Harmonic Motion (SHM)
- Motion with uniform acceleration and deceleration (UARM / Retardation)

**CAM PROFILE LAYOUT & SYNTHESIS:** Geometric construction and drafting layout of a disc cam profile driving an inline or offset knife-edge follower, roller follower, and flat-faced follower.

***Self-Study Component:*** Dynamics and Boundary Jerk in High-Speed Valve trains. Mathematically analyze the acceleration profiles of uniform velocity and SHM to determine why they produce infinite "jerk" (shock forces) at motion boundaries, and evaluate why Cycloidal motion profiles are universally preferred for high-speed Internal Combustion Engine (ICE) valve operations.

| **UNIT 5** | **10** | **L1-L4** |
|---|---|---|

**SPUR GEARS & GEAR TRAINS:** Spur Gears and Tooth Kinematics: Gear terminology and nomenclature (pitch circle, addendum, dedendum, module, circular pitch, diametral pitch, pressure angle, clearance). Conjugate action, mathematical proof of the Fundamental Law of Gearing, and tooth profiles (Involute and Cycloidal). Path of contact, arc of contact, and the mathematical derivation of the contact ratio of a spur gear pair.

**INTERFERENCE MITIGATION**: The phenomenon of interference in involute gears. Practical methods of avoiding interference. Mathematical derivation of the conditions and expressions for the minimum number of teeth required on a gear and pinion to avoid interference.

**GEAR TRAINS**: Configurations and speed ratios of simple gear trains and compound gear trains.

**EPICYCLIC GEAR TRAINS**: Architectural configuration and working principles of planetary/epicyclic gear systems. Comprehensive calculation of velocity ratios using both the Algebraic Method and the Tabular Method. Advanced torque, efficiency, and power calculations in epicyclic gear trains, including the evaluation of holding/fixing torques for differential systems.

**SELF-STUDY COMPONENTS:**

Epicyclic Differential Dynamics. Mathematically analyze the internal speed distribution, planetary speed variations, and torque split of an automotive planetary differential gear train when a vehicle undergoes an asymmetric cornering maneuver.

| **TEXT BOOKS:** | |
|---|---|
| 1 | Sadhu Singh, Theory of Machines: Kinematics and Dynamics*, Pearson Education, Third Edition, 2019. |
| 2 | G. Ambekar, Mechanism and Machine Theory, PHI Learning Private Limited, 2009 |

| **REFERENCE BOOKS:** | |
|---|---|
| 1 | Rattan S.S, Theory of Machines, Tata McGraw-Hill Publishing Company Limited, Fourth Edition, 2014. |
| 2 | Michael M. Stanisic, Mechanisms and Machines: Kinematics, Dynamics, and Synthesis, Cengage Learning, 2016. |
| **e-LEARNING RESOURCES:** | |
| 1 | Videos and Lecture Notes: http://www.nptel.ac.in |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.

**CIE:** The CIE has three components – CIE - theory component, assignment and group activity. Students have to score a minimum of 40% Marks in the total of CIE - theory, assignment and group activity components put together to take SEE.

**SEE:** Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

****Self-Study Component should be included in CIE under Question No. 2c).**

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | **Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)** |
|---|---|---|---|
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **50** | **20** |
| | **TOTAL** | **50** | **20** |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Q. No.** | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: IV** **Scheme: 2025**

| |
|---|
| 1. Two full questions (each of 20 Marks) are to be set from each unit. |
| 2. Student shall answer five full questions selecting one full question from each unit. |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Demonstrate foundational knowledge of kinematic linkages, joints, pairs, and their relative motion profiles. |
| **CO2** | Understand, identify, and sketch the distinct structural inversions of four-bar, single-slider, and double-slider mechanisms. |
| **CO3** | Analyze the displacement, velocity, and acceleration profiles of links and joints of planar mechanisms using graphical, analytical vector-loop, and synthesis techniques. |
| **CO4** | Design and perform kinematic motion analysis of cam-follower arrangements and geometrically synthesize cam profiles for diverse engineering applications. |
| **CO5** | Evaluate the geometric parameters, conjugate tooth actions, law of gearing, and physical limits of tooth interference for standard spur gears. Compute gear train speed ratios, internal torque/power distributions for simple, compound, and epicyclic planetary systems. |

**Mapping of CO's, PO's with PSO(Civil)'s**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1

| **CO /PO** | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO1 0** | **PO1 1** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO 2** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO 3** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO 4** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO 5** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1

| **CO/WK** | **WK1** | **WK2** | **WK3** | **WK4** | **WK5** | **WK6** | **WK7** | **WK8** | **WK9** |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | - | 3 | - | - | - | - | - | - |
| **CO2** | 2 | - | 3 | - | - | - | - | - | - |
| **CO3** | 2 | 3 | 3 | - | - | 2 | - | - | - |
| **CO4** | - | 2 | 3 | 2 | 3 | - | - | - | - |
| **CO5** | - | 3 | 3 | 2 | 2 | - | - | - | - |

| **Mapping of CO's with Sustainable Development Goals (SDG)**<br>**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/SDG** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** |
| **CO1** | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - | - | - | - | - |
| **CO2** | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - | - | - | - | - |
| **CO3** | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - | - | - | - | - |
| **CO4** | - | - | - | 3 | - | - | - | - | 3 | - | - | 2 | - | - | - | - | - |
| **CO5** | - | - | - | 3 | - | - | - | - | 3 | - | - | 2 | - | - | - | - | - |

**Course Coordinators:**

Dr. Jayanth. H
Assistant Professor,
Mechanical Engineering

**Heads of Program:**

Dr. Sathish S.
Professor,
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Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**

**Semester: IV** **Scheme: 2025** **Academic Year: 2026-27**

| **Course Title** | **COMPUTER AIDED DESIGN AND SIMULATION LAB** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **1BMEL405** | | | | | | |
| **Course Category** | **PCCL (Professional Core Course Laboratory)** | | | | | | |
| **Teaching - Learning Scheme & Credit** | **L** | **T** | **P** | **S** | **Total** | **Total Teaching Hours** | **Credit** |
| | **0** | **0** | **28** | **2** | **30** | **30** | **1** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | To Create drawings and models using software |
| CLO2 | To Create solid models using sketching, extruding |
| CLO3 | Gaining a working knowledge of CAD solid modeling |
| CLO4 | Theoretical concepts of engineering graphics, including orthographic projection, auxiliary views and sectioning, |
| CLO5 | General dimensioning and tolerance, and geometric dimensioning and tolerance. |

| **UNIT No.** | **Syllabus** | **No. of hours** | **BTLs** |
|---|---|---|---|
| **1** | **SURFACE MODELING** | **04** | **L4** |
| | (i) Create semi-finished bottom casing of a smart Phone using surface tools.<br>(ii) Create semi-finished top casing of a mouse using surface tools. A mouse is a pointing device that functions by detecting two dimensional motion relative to its supporting surface. | | |
| **2** | **SIMULATION** | **04** | **L4** |
| | Static analysis of L shaped Cantilever Beam-<br>(i) Determine displacement due to elongation<br>(ii) Determine displacement and elongation due to bending<br>(iii) Modal analysis of L shaped cantilever Beam | | |
| **3** | **SHEET METAL DESIGN** | **04** | **L4** |
| | (i) Create a sheet metal body required for a SMPS (Switch Mode Power Supply) in a computer<br>(ii) Create a Sheet Metal Hopper Design | | |
| **4** | **WELDMENT** | **02** | **L4** |
| | (i) Create industrial steel frame using weldment<br>(ii) Create a piping structure using weldment | | |

| **TEXT BOOKS AND LEARNING SOURCES** | |
|---|---|
| 1 | https://www.sdcpublications.com/Textbooks/Machining-Simulation-Using-SOLIDWORKS- |

| | |
|---|---|
| | CAM/ISBN/978-1-63057-570-0/ |
| 2 | https://www.sdcpublications.com/Textbooks/Hands-On-Introduction-SOLIDWORKS-2023/ISBN/978-1-63057-555-7/ |
| 3 | https://www.youtube.com/watch?v=lnJTfrqYfMU |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each.
The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.
CIE: The CIE has two components – CIE - theory component and CIE – laboratory component.
Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE.
****Self-Study Component should be not included for SEE & CIE.**

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
|---|---|---|---|
| **Laboratory components** | Rubrics for each experiment are added, then taken average | **30** | **20** |
| | **Lab CIE** | **20** | |
| | **TOTAL** | **50** | **20** |

**Assessment Details (SEE)**

| **Sl. No.** | **Particulars** | **Max Marks** | **Break up Max. Marks** | |
|---|---|---|---|---|
| | | | **Write up** | **Modelling** |
| Q 1 | Any one from either from Unit 1 or Unit 2 | 25 | 5 | 20 |
| Q 2 | Any one from either from Unit 3 or Unit 4 | 15 | 5 | 10 |
| Q 3 | **Viva Voice** | 10 | - | - |
| **Total** | | **50** | | |

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering**
**Semester: IV** **Scheme: 2025** **Academic Year: 2026-27**

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Ability to create features complex faces and edges |
| **CO2** | Use Base Flange, Extruded Cut, Sketched Bend and Edit Material commands |
| **CO3** | Create weldment using software for industrial frames |
| **CO4** | Able to conduct static and dynamic analyses for mechanical components |

**Mapping of CO's, PO's with PSO's**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | 3 | - | 3 | 3 | - | - | - |
| **CO2** | - | - | 2 | - | 3 | 3 | - | - | - |
| **CO3** | - | - | 2 | - | 3 | 3 | - | - | - |
| **CO4** | 2 | 3 | 3 | - | 2 | 3 | - | - | - |

**Mapping of CO's with Sustainable Development Goals (SDG)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO/SDG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - | - | - | - | - |
| **CO2** | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - | - | - | - | - |
| **CO3** | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - | - | - | - | - |
| **CO4** | - | - | - | 3 | - | - | - | - | 3 | - | - | 3 | - | - | - | - | - |

**Course Coordinators:**

Dr. M Rajesh
Assistant Professor,
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**Heads of Programme:**

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**Program: Mechanical Engineering**

**Semester: III** **Scheme: 2025** **Academic Year: 2026-27**

| **Course Title** | **ENERGY CONVERSION LABORATORY** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **1BMEL406** | | | | | | |
| **Course Category** | **AEC (Ability Enhancement Course Laboratory)** | | | | | | |
| **Teaching - Learning Scheme & Credit** | **L** | **T** | **P** | **S** | **Total** | **Total Teaching Hours** | **Credit** |
| | **0** | **0** | **28** | **2** | **30** | **30** | **1** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 03 Hrs** | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | To conduct tests on oils to determine flash, fire points and viscosity. |
| CLO2 | To determine calorific value of a given fuel. |
| CLO3 | To plot the valve timing diagram of 2-stroke and 4-stroke IC engine. |
| CLO4 | To calculate the area of an irregular shape using planimenter. |
| CLO5 | To conduct performance test on petrol and diesel IC engine and evaluate the power produced and efficiencies. |
| CL06 | To conduct Morse test on 4-stroke multi cylinder engine to determine the utility of heat input and draw heat balance sheet. |

| **Syllabus** | |
|---|---|
| **PART: A - MINOR EXPERIMENTS** | |
| 1 | Determination of Calorific value of a given gaseous fuels using Boys Gas Calorimeter |
| 2 | Determination of Kinematic and Dynamic Viscosity of lubricating oil using Redwood's, and Saybolt's Viscometer. |
| 3 | Valve Timing diagram of a 4- Stroke Diesel Engine. |
| 4 | To measure the area of two-dimensional, irregular shapes on a flat surface like a map or blueprint Using Planimeter. |
| **PART: B - MAJOR EXPERIMENTS** | |
| 1 | To Conduct the Performance Tests on Four stroke Diesel Engine Calculations of IP, BP, Thermal efficiencies, SFC, FP and plot the Characteristics Curves using Hydraulic Dynamometer. |
| 2 | To Conduct the Performance Tests on Four stroke Diesel Engine Calculations of IP, BP, Thermal efficiencies, SFC, FP and plot the Characteristics Curves using Electrical Dynamometer. |
| 3 | To Conduct the Performance Tests on Four stroke Diesel Engine Calculations of IP, BP, FP Heat Looses and Draw the heat |
| 4 | To Conduct the Performance Tests on Four stroke Petrol Engine Calculations of IP, BP, Thermal efficiencies, SFC, FP and plot the Characteristics Curves. |
| 5 | To Conduct the Performance Tests on Four stroke Petrol Engine Calculations of IP, BP, FP Heat Looses and Draw the heat balance sheet |
| 6 | To Estimate the Friction Power of a Multi Cylinder Diesel Engine Using Morse test Method |

| **Teaching & Learning Process** (Innovative Delivery Methods): | |
|---|---|
| 1 | Active Learning Techniques |
| 2 | Problem-Based Learning (PBL) |
| 3 | Team-Based Learning (TBL) |
| 4 | Hands-On Experiments and Simulations |

| **REFERENCE BOOKS:** | |
|---|---|
| 1 | "Internal Combustion Engines", 4th Edition V Ganeshan. Tata McGraw Hill, 2012. |
| 2 | "Internal Combustion Engines Fundamentals", John B Heywood, 1st Edition, Tata McGraw Hill, 2017. |
| 3 | "A Textbook of Engineering Thermodynamics" R K Rajput, Sixth Edition, Laxmi Publications, 202. |
| **e-LEARNING RESOURCES:** | |
| 1 | Videos and Lecture Notes: http://www.nptel.ac.in |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each.
The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.
CIE: The CIE has two components – CIE - theory component and CIE – laboratory component.
Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE.
Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.
****Self-Study Component should be not included for SEE & CIE.**

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
|---|---|---|---|
| **Laboratory components** | Rubrics for each experiment are added, then taken average | **30** | **20** |
| | **Lab CIE** | **20** | |
| | **TOTAL** | **50** | **20** |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Conduct basic tests on lubricating oil like fire, flash, cloud and pour points along with viscosity. |
| **CO2** | Determine calorific values of all types of fuels |

| | |
|---|---|
| **CO3** | Plot internal combustion engine valve timing diagrams and areas of irregular shapes. |
| **CO4** | Able to conduct performance tests, draw heat balance sheet and plot Characteristics curve of I C Engines |

**Mapping of CO's, PO's with PSO's**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO 2** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO 3** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |
| **CO 4** | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | - | - | 3 | - | - | - |
| **CO2** | 3 | - | 3 | - | - | 3 | - | - | - |
| **CO3** | - | 2 | 3 | - | - | 3 | - | - | - |
| **CO4** | 2 | 2 | 3 | - | - | 3 | - | - | - |

**Mapping of CO's with Sustainable Development Goals (SDG)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO/SDG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | 3 | - | - | - | - | 2 | - | - | - | - | - | - | - | - |
| **CO2** | - | - | - | 3 | - | - | 3 | - | 2 | - | - | - | - | - | - | - | - |
| **CO3** | - | - | - | 3 | - | - | - | - | 2 | - | - | - | - | - | - | - | - |
| **CO4** | - | - | - | 3 | - | - | 3 | - | 3 | - | - | 2 | - | - | - | - | - |

**Course Coordinators:**

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**Heads of Programme:**

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School of Core Engineering & Technology
**Program: Mechanical Engineering, Industrial Engineering & Management (IEM)**

**Semester: IV** **Scheme: 2025**

| **Course Title** | **BIOLOGY FOR ENGINEERS** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **1BBIT407C** | | | | | | |
| **Course Category** | **BSC (Professional Core Course)** | | | | | | |
| **Teaching - Learning Scheme & Credit** | **L** | **T** | **P** | **S** | **Total** | **Total Teaching Hours** | **Credit** |
| | **2** | **0** | **0** | **2** | **3** | **28+0+0+32=60** | **02** |
| **CIE Marks: 50** | **SEE Marks: 50** | | **Total Max. Marks: 100** | | | **Duration of SEE: 02 Hrs** | |

| **Course Learning Objectives:** | |
|---|---|
| CLO1 | Explain fundamental biological principles, biological systems relevant to engineering applications. |
| CLO2 | Explain bio-inspired and biomimetic principles and their applications to engineering materials, mechanisms and systems. |
| CLO3 | Illustrate biomimetic strategies used in mechanical and interdisciplinary engineering applications. |
| CLO4 | Evaluate the potential of selected bio-inspired approaches for innovative and sustainable engineering solutions. |
| CLO5 | Evaluate sustainability, regulatory and safety aspects and propose biologically informed solutions for simple engineering case studies. |

| **SYLLABUS** | **No. of Hours** | **BTLs** |
|---|---|---|
| **UNIT 1** | **05** | **L1-L4** |
| **BIOMOLECULES AND THEIR APPLICATIONS:**<br>**Biomolecules:** Carbohydrates, Amino acids and Proteins, Lipids- classification, functions.<br>**Carbohydrates** (cellulose-based water filters, PHA and PLA as bioplastics),<br>**Nucleic acids** (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics–DNA fingerprinting), **Proteins** (Proteins as food–whey protein and meat analogs, Plant based proteins), **Lipids** (biodiesel, cleaning agents/detergents, construction and pavement)<br>**Enzymes:** Enzymes, properties and classification. Mechanism of enzyme action. Enzymes and their application in Industry. Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching). | | |
| **SELF-STUDY COMPONENTS:**<br>Cellulose-based water filters –low-cost rural water purification. **Biodiesel** –comparison of biodiesel with fossil diesel in terms of emissions and efficiency. **Bioplastics (PHA and PLA)** –real-world applications in packaging and medical devices (sutures, implants). | | |
| **UNIT 2** | **05** | **L1-L4** |
| **MOLECULAR MACHINES AND BIOSENSORS:**<br>Molecular Machines and Motors, The F0F1-ATP Synthase Motors, The Bacterial Flagellar Motor. Cytoskeleton: Microtubules, Microfilaments, and Intermediate Filaments, Biosensors, Types of Biosensors, Glucose Biosensors, Bio-detectors: Biosensor Detection of Pollutants, Biosensor in Food Industry. | | |
| **SELF-STUDY COMPONENTS:**<br>ATP synthase rotary mechanism (video/animation-based self-study). Wearable biosensors and continuous glucose monitoring systems. Emerging biosensor applications in environmental monitoring | | |

**Semester: IV** **Scheme: 2025**

| UNIT 3 | 06 | L1-L4 |
|---|---|---|

**HUMAN ORGAN SYSTEMS AND BIO DESIGNS:**

**Brain as a CPU System:** Architecture of the Central Nervous System and Peripheral Nervous System, Electroencephalography (EEG), Robotic Arms for Prosthetics, Engineering Solutions for Parkinson's Disease.

**Eye as a Camera System:** Architecture of Rod and Cone Cells, Optical Corrections, Cataract, Lens Materials, Bionic Eye.

**Heart as a Pump System:** Architecture, Electrical Signalling and ECG Monitoring, Heart-related Issues, Pacemakers, Defibrillators.

**Lungs as Purification System:** Architecture, Gas Exchange Mechanisms, Spirometry, Chronic Obstructive Pulmonary Disease, Ventilator, Heart-Lung Machine.

**Kidney as a Filtration System:** Architecture, Mechanism of Filtration, Chronic Kidney Disease, Dialysis.

**SELF-STUDY COMPONENTS:**
Artificial pancreas and insulin-delivery systems. Cochlear implants (ear as a signal-processing system). Comparative study of dialysis vs. kidney transplant engineering challenges

| UNIT 4 | 06 | L1-L4 |
|---|---|---|

**NATURE-BIOINSPIRED MATERIALS AND MECHANISMS:**
Echolocation and its Engineering Applications - Ultrasonography and Sonar; Photosynthesis and its Engineering Applications - Photovoltaic Cells and Bionic Leaves; Bird Flight and Navigation - Aircrafts and GPS Applications; Lotus Leaf Effect - Superhydrophobic and Self-Cleaning Surfaces; Plant Burrs - Bioinspired Velcro Fasteners; Shark Skin - Bioinspired Friction-Reducing Swimsuit; Kingfisher Beak - Bioinspired Bullet Train Design.

**SELF-STUDY COMPONENTS:**
Gecko-inspired dry adhesives. Termite mound-inspired passive building ventilation. Whale fin (tubercle) inspired wind turbine blade design.

| UNIT 5 | 06 | L1-L4 |
|---|---|---|

**TRENDS IN BIOENGINEERING:**

**BIOPRINTING TECHNIQUES AND MATERIALS:** Introduction to 3D printing and Bioprinting, Techniques in Bioprinting, Materials used in Bioprinting, 3D Printing of Ear, 3D Printed Foods. Electrical Tongue and Electrical Nose in Food Science, Bioimaging and Artificial Intelligence for Disease Diagnosis, Self-healing Bio-concrete.

**Bone and Skin:** Viscoelasticity in bone, bone fractures, mechanical properties of bone, skeletal muscles in the body, the structure of muscles, passive muscles, activating muscles, applications of exoskeletal.

**SELF-STUDY COMPONENTS:**
Organ-on-chip technology. CRISPR-based diagnostic tools. Wearable exoskeletons for rehabilitation

**TEXTBOOKS:**


| | |
|---|---|
| 1 | **Biology for Engineers**, Arthur T Johnson, 2nd Ed., CRC Press, 2018. |
| 2 | **Biology for Engineers, - Fundamentals and Applications** Thyagarajan S, Selvamurugan N, Rajesh M P, Nazeer R A, Richard W Thilagaraj W, Barathi S, and Jaganathan M K, Tata McGraw-Hill, 2018. |
| 3 | **Biology for Engineers**, Dr.Rajendra Singh C.,Dr.N Shankar Rao, IBOP Physics Facilitators, JIRS, Bangalore,2023. |

**Semester: IV** **Scheme: 2025**

| **REFERENCE BOOKS:** | |
|---|---|
| 1 | **Wastewater Treatment and Reuse: Theory and Design Examples Qasim, S. R., and Zhu, G., CRC Press, 2018. ISBN: 978-1138386703. (useful supplementary reference for design examples).** |
| 2 | **Biology: A global approach,**N.A.Campbell,J.B. Reece,L.Urry,M.L.Cain and S A.Wasserman**,**Wiley Precise Textbook series,1st edition, Pearson Education Ltd,2018. |
| **e-LEARNING RESOURCES:** | |
| 1 | •NPTEL — Environmental Biotechnology / Wastewater Treatment lecture series, National Programme on Technology Enhanced Learning (NPTEL), IITs/NITs — online video lectures and course notes, available at NPTEL portal. (Access date: insert date when you cite). |
| 2 | https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009 |
| 3 | https://www.futurelearn.com/courses/biology-basic-concepts |
| 4 | Videos and Lecture Notes: http://www.nptel.ac.in |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.

**CIE:** The CIE has three components – CIE - theory component, assignment and group activity. Students have to score a minimum of 40% Marks in the total of CIE - theory, assignment and group activity components put together to take SEE.

**SEE:** Theory Semester End Exam (SEE) is conducted for 50 marks (2 Hours duration) and reduced to 50 Marks.

****Self-Study Component should be not included for SEE & CIE.**

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max. Marks** | **Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)** |
|---|---|---|---|
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **50** | **20** |
| | **TOTAL** | **50** | **20** |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Q. No.** | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

| **Course Outcomes:** After the completion of the course, the student will be able to: | |
|---|---|
| **CO1** | Elucidate the basic biological concepts via relevant industrial applications and case studies. |
| **CO2** | Evaluate the principles of design and development, for exploring novel bioengineering projects. |
| **CO3** | Corroborate the concepts of biomimetics for specific requirements. |

**Semester: IV** **Scheme: 2025**

| | |
|---|---|
| **CO4** | Think critically towards exploring innovative biobased solutions for socially relevant problems. |
| **CO5** | Collaborate interdisciplinary Engineering design thinking for open end projects. |

**Mapping of CO's, PO's with PSO's**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| **CO2** | 3 | 2 | 3 | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 3 | 1 | 3 |
| **CO3** | 2 | 2 | 1 | 3 | 3 | 0 | 1 | 0 | 1 | 1 | 0 | 2 | 3 | 1 |
| **CO4** | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 0 | 1 | 1 | 0 | 3 | 2 | 2 |
| **CO5** | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 2 | 2 | 1 | 3 | 2 | 3 |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 0 | 2 | 1 | 0 | 0 | 1 | 0 | 1 |
| **CO2** | 2 | 0 | 2 | 3 | 2 | 1 | 1 | 1 | 2 |
| **CO3** | 2 | 1 | 2 | 2 | 1 | 3 | 0 | 1 | 1 |
| **CO4** | 2 | 1 | 2 | 3 | 2 | 2 | 1 | 1 | 2 |
| **CO5** | 1 | 0 | 1 | 2 | 2 | 2 | 3 | 3 | 3 |

**Mapping of CO's with Sustainable Development Goals (SDG)**
**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO/SDG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 |
| **CO2** | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 2 | 0 | 1 | 0 | 1 | 0 | 0 |
| **CO3** | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| **CO4** | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| **CO5** | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 3 | 2 | 2 | 0 | 1 | 0 | 1 |

**Course Coordinators:**

Dr. Ravish D.K,
Professor,
Electronics and Telecommunication Engineering

Dr. Ambedkar Institute of Technology, Bengaluru - 560056
School of Core Engineering & Technology
**Program: Mechanical Engineering, Industrial Engineering & Management (IEM)**

**Semester: IV** **Scheme: 2025**

**Heads of Programme:**

| | |
|---|---|
| Dr. Sathish S,<br>Professor,<br>Mechanical Engineering | Dr. Rajeshwari P.<br>Professor,<br>Industrial Engineering<br>and Management (IEM) |

**Head of School**

Dr. S Kavitha,
Professor,
School of Core Engineering and Technology, Dr. A.I.T

**Dr.Ambedkar Institute of Technology, Bengaluru-560056**
**Outcome Based Education(OBE) and Choice Based Credit System**
**B.E. Name of the programme: Mechanical Engineering**
**Tentative Scheme of Teaching and Examination effective from the Academic Year 2026-27**

**V SEMESTER**

| Sl. No | Course and Course Code | | Course Title | Teaching Department (TD) and Question Paper Setting Board (PSB) | Teaching Hours /Week | | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical/ Drawing | Self - Study | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | S | | | | | |
| 1 | HSMS | MET501 | Management & Entrepreneurship | Mechanical | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| 2 | IPCC | MEU502 | Fluid Mechanics | Mechanical | 3 | 0 | 2 | | 03 | 50 | 50 | 100 | 4 |
| 3 | PCC | MET503 | Design of Machine Elements | Mechanical | 4 | 0 | 0 | | 03 | 50 | 50 | 100 | 4 |
| 4 | PCCL | MEL504 | Design Lab | Mechanical | 0 | 0 | 2 | | 03 | 50 | 50 | 100 | 1 |
| 5 | PEC | MET505x | Professional Elective Course - I | Mechanical | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| 6 | PROJ | MEM506 | Mini Project | Mechanical | 0 | 0 | 4 | | 03 | 100 | | 100 | 2 |
| 7 | AEC | RMT507 | Research Methodology and IPR | EEE department | 2 | 2 | 0 | | 02 | 50 | 50 | 100 | 3 |
| 8 | MC | CVT508 | Environmental Studies | TD: CV PSB: CV | 2 | 0 | 0 | | 02 | 50 | 50 | 100 | 2 |
| 9 | HS | CDN509 | Aptitude and Verbal Ability Skills | Placement Cell | 2 | 0 | 0 | | -- | 50 | -- | 50 | PP/ NP |
| 10 | MC | NSN510 | National Service Scheme (NSS) | NSS coordinator | 0 | 0 | 2 | | | 100 | --- | 100 | PP/ NP |
| | | PEN510 | Physical Education (PE) (Sports and Athletics) | Physical Education Director | | | | | | | | | |
| | | YON510 | Yoga | Yoga Teacher | | | | | | | | | |
| | | | | | | | | Total | | 500 | 300 | 800 | 22 |

PCC: Professional Core Course, PCCL: Professional Core Course laboratory, UHV: Universal Human Value Course, MC: Mandatory Course (Non-credit), AEC: Ability Enhancement Course, SEC: Skill Enhancement Course, L: Lecture, T: Tutorial, P: Practical, S= Self-Study CIE: Continuous Internal Evaluation, SEE:Semester End Evaluation. K : The letter in the course code indicates common to al the stream of Engineering. PROJ: Project /Mini Project. PEC: Professional Elective Course

**Professional Elective Course - I 22XXT505x**

| | | | |
|---|---|---|---|
| **MET505A** | **Inspection and Quality Control** | **MET505C** | **Advanced Welding Technology** |
| **MET505B** | **Composite Materials & Manufacturing** | **MET505D** | **Mechatronics and Microprocessors** |
| | | | |

**Professional Core Course (IPCC):** Refers to Professional Core Course Theory Integrated with practicals of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

**National Service Scheme /Physical Education/Yoga:** All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first Week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the Degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of Degree.

**Mini-project work:** Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or amultidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

**CIE procedure for Mini-project:**

**(i) Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

**(ii) Interdisciplinary:** Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

**No SEE component for Mini-Project.**

**Professional Elective Courses (PEC):** A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of Engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

**Dr.Ambedkar Institute of Technology, Bengaluru-560056**
**Outcome Based Education(OBE) and Choice Based Credit System**
**B.E. Name of the programme: Mechanical Engineering**
**Tentative Scheme of Teaching and Examination effective from the Academic Year 2026-27**

**VI SEMESTER**

| Course and Course Code | | Course Title | Teaching Department (TD) and Question Paper Setting Board (PSB) | Teaching Hours /Week | | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory Lecture | Tutorial | Practical/ Drawing | Self - Study | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | L | T | P | S | | | | | |
| IPCC | MEU601 | Computer-Aided Design And Manufacturing | Mechanical | 3 | 0 | 2 | -- | 03 | 50 | 50 | 100 | 4 |
| PCC | MET602 | Operations Research | Mechanical | 4 | 0 | 0 | -- | 03 | 50 | 50 | 100 | 4 |
| PEC | MET603x | Professional Elective Course - II | Mechanical | 3 | 0 | 0 | -- | 03 | 50 | 50 | 100 | 3 |
| OEC | MET604x | Open Elective Course-I | Any Dept. | 3 | 0 | 0 | -- | 03 | 50 | 50 | 100 | 3 |
| PROJ | MEP605 | Major Project Phase I | Mechanical | 0 | 0 | 4 | -- | 03 | 100 | -- | 100 | 2 |
| PCCL | MEL606 | Numerical Applications for Mechanical Engineering Lab | Mechanical | 0 | 0 | 2 | -- | 03 | 50 | 50 | 100 | 1 |
| AEC/SDC | MET607x OR MEL607x | Ability Enhancement Course/ Skill Development Course V | Mechanical | If the course is offered as a Theory | | | | 01 | 50 | 50 | 100 | 1 |
| | | | | 1 | 0 | 0 | -- | | | | | |
| | | | | If course is offered as a practical | | | | | | | | |
| | | | | 0 | 0 | 2 | -- | | | | | |
| HS | CDN608 | Analytical and Reasoning Skills | Placement Cell | 2 | 0 | 0 | -- | -- | 50 | -- | 50 | PP/ NP |
| | NSN609 | National Service Scheme (NSS) | NSS coordinator | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MC** | **PEN609** | **Physical Education (PE) (Sports and Athletics)** | **Physical Education Director** | **0** | **0** | **2** | | | **100** | **---** | **100** | **PP/ NP** |
| | **YON609** | **Yoga** | **Yoga Teacher** | | | | | | | | | |
| | | | | | | | | **Total** | **500** | **300** | **800** | **18** |

**PCC**: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical, **S**= Self-Study, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **K :** The letter in the course code indicates common to all the stream of Engineering. **PROJ**: Project /Mini Project. **PEC**: Professional Elective Course. **PROJ**: Project Phase -I, **OEC**: Open Elective Course.

| **Professional Elective Course - II : 22XXT603x** | | | |
|---|---|---|---|
| **MET603A** | **Mechanical Vibrations** | **MET603C** | **Turbo Machines** |
| **MET603B** | **Experimental Stress Analysis** | **MET603D** | **Internal Combustion Engines** |
| **Open Elective Course - I 22XXT604x** | | | |
| **MET604A** | **Composite Materials** | **MET604C** | **Engineering Economics** |
| **MET604B** | **Energy and Environment Engineering** | **MET604D** | **Product Design And Development** |

| **Ability Enhancement Course / Skill Enhancement Course-V 22XXT607x OR 22XXL607x** | | | |
|---|---|---|---|
| **MET607A** | **INTRODUCTION TO INTERNET OF THINGS** | **MEL607B** | **Computer Aided Design and Simulation Lab** |
| | | | |

| |
|---|
| **Professional Core Course (IPCC):** Refers to Professional Core Course Theory Integrated with practicals of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governingthe Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23<br>**National Service Scheme /Physical Education/Yoga:** All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education(PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first Week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the Degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of Degree. |
| **Professional Elective Courses (PEC):** A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of Engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall<br>not be applicable to cases where the admission to the program is less than 10. |
| **Open Elective Courses:**<br>Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they canopt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under theguidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition<br>shall not be applicable to class where the admission to the program is less than 10. |
| **Project Phase-I :** Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work. |
| |

**ADMISSION YEAR : 2023-24 ACADEMIC YEAR: 2026-27**
**SEMESTER : FIFTH**

| Course Title | **MANAGEMENT AND ENTREPRENEURSHIP** | |
|---|---|---|
| Sub.Code:**MET501** | No. of Credits:**03 = 3:0:0 (L-T-P)** | No. of Lecture Hours/Week:**03** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100** | Total No. of Contact Hours**: 40 Hrs.** |
| Category | **HSMS** | |
| Pre-requisites | **Elements of Mechanical Engineering** | |

**COURSE OBJECTIVES:**

1. To impart the knowledge about the Management concepts, evolution and Management functions.
2. To familiarize the student on Entrepreneurship and Entrepreneurial process.
3. To understand the role of SSI in economic development and gain an insight of funding agencies.
4. To have a clear understanding of concept of project, preparation of project & its screening.

| # | CONTENTS | Hrs |
|---|---|---|
| **UNIT-1** | **MANAGEMENT** | **08** |
| | Introduction- Meaning, characteristics of management, functions of Management- POSDCORB, Levels and Skills of Management, Roles of Managers Management as science or an art or profession, Development of management thought -**Early management approaches (in brief)**- Psychological, Bureaucratic, Scientific theory and Administrative theory and Human Relations Movement, **Modern management approaches (in brief)**- Behavioral, Systems, Quantitative, and Contingency approach.<br>**FUNCTIONS OF MANAGEMENT- PART I:**<br>**PLANNING:** Types of Plans: Single use & Standing plans, Steps in Planning process. **ORGANIZING:** Types of organization (Line, Staff, Line & Staff, Matrix and Committee form) Departmentation (Functional, Product, Process, Territorial and Customer), MBO and MBE. | |
| **UNIT-2** | **FUNCTIONS OF MANAGEMENT – PART II** | **08** |
| | **STAFFING:** Sources of recruitment, Process of selection, **DIRECTING:** ***Leadership*****:** Definition, Leadership styles - Autocratic, Democratic, Charismatic, Laissez faire and Participative, ***Motivation:***– Definition, Maslow, Herzberg & McGregor's Theory X & Y. ***Communication***– Definition, types, communication process and barriers of communication, ***CO-ORDINATION*****:** importance, **CONTROLLING:** steps in controlling, **REPORTING**: importance, **BUDGETTING**: importance<br>***Case study discussion with respect to Indian context.*** | |
| **UNIT-3** | **ENTREPRENEUR** | **08** |

| | | |
|---|---|---|
| | Definition & Meaning, Characteristics, types of entrepreneurs- Imitative, Innovative, Fabian and drone and Others, Intrapreneur- meaning, Difference between Entrepreneurs, Intrapreneur & Manager, Stages in Entrepreneurial process, barriers to entrepreneurs, Role of Entrepreneurs in economic development and Business Plan.<br><br>**Rural entrepreneurship**– Definition, challenges & opportunities.<br>**Women Entrepreneurs** – Definition, challenges, and Institutional support to Women Entrepreneurs in India.<br>**Family Business:** Meaning and Definition, types of family business and reasons for failure of family business.<br>**Corporate Social Responsibility**- Meaning, definition and benefits.<br><br>***Case study discussion with respect to Indian context.***<br>***Activity: Profile of successful entrepreneur and Writing Business plan*** | |
| **UNIT-4** | **MSME** | **08** |
| | Definition of MSME (latest). **SMALL SCALE INDUSTRY**: Meaning, and definition, Characteristics, steps to start SSI, role of SSI in economic development, problems faced by SSI. Introduction to GATT, WTO &LPG, Sources of financing (brief), Forms of ownership - Sole proprietorship, Hindu Undivided Family, Partnership, and Cooperative.<br>**Institutional Support**: ***Central level Institutions*** – NBMSME, KVIC, NSIC, SIDBI, Indian Institute of Entrepreneurship (IIE), EDI and NABARD. S***tate level Institutions***- DIC, KSFC, KIADB, TECSOK.<br>**STARTUP COMPANIES**-Meaning and Challenges. Make in India concept and MUDRA Bank Initiative.<br>***Activity for students: Schemes for startup companies.*** | |
| **UNIT-5** | **PREPARATION OF PROJECT** | 08 |
| | Project- Meaning, Classification of project, Project identification, Project selection, Project Appraisal, Project implementation. Project Report –Outline, Feasibility Study-Financial, Technical, Marketing, and Social Feasibility Study, PESTLE Analysis for Project and errors in preparation of project report.<br>***Activity for students*: *Preparation of project report*** | |

**TEXT BOOKS:**


1. Entrepreneurship and Management- S Nagendra and V S Manjunath- Pearson Publication 4 /e,2009.
2. Principles of Management – PC Tripathi, and P N Reddy – Tata MacGrawHill.
3. Entrepreneurship Development – Poornima M Charanthimath Pearson Education 2nd Edition.


**REFERENCE BOOKS:**


1.Dynamics of Entrepreneurial Development and Management-Vasant Desai-Himalaya Publishing House. Latest edition.

2. Entrepreneurship and management - Shashi k Gupta- Kalyani publishers, Latestedition.
3.Financial Management- Shashi k Gupta- Kalyani publishers, Latestedition.

**COURSE OUTCOMES:** After completion of the course, students will be able to:

**CO1:** The students will gain domain knowledge on management concepts, evolution, management functions.

**CO2:** The students will be able to gain domain knowledge on Entrepreneurship, entrepreneurial process

**CO3:** The students will get an in depth knowledge of entrepreneurial process & contribute to the betterment of the society.

**CO4:** Students will be able to identify business opportunities & design a project report.

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 1 | 0 | 1 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 1 | 0 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 0 | 1 | 0 | 2 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : FIFTH**

| | | |
|---|---|---|
| Course Title | **FLUID MECHANICS** | |
| Sub.Code:**MEU502** | No. of Credits:**04 = 3:0:2 (L-T-P)** | No. of Lecture Hours/Week:**03**<br>No. of Practical hours/week :**02** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ SEE=40+5+5+50=100** | **Total No of Contact Hours: 40 + 10 Lab Slots** |
| Category | **IPCC** | |
| Pre-requisites | **Physics, Mathematics** | |

**COURSE OBJECTIVES:**

1. Explain various properties related to fluid mechanics.
2. Determine hydrostatic force and centre of pressure on plane and curved surfaces, locate met centre and Meta centric height of floating bodies.
3. Summarize different types of pressure measurement devices..
4. Apply laws of conservation of momentum, mass and energy to fluid flow systems and explain the measurement of fluid flow parameters.
5. Interpret compressibility of gases in terms of Mach number.

| # | CONTENTS | Hrs. |
|---|---|---|
| **UNIT-1** | **PROPERTIES OF FLUID** | **8L+2P** |
| | Introduction, classification of fluids, properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pressure, cavitation phenomenon. Numerical problems. Fluid statics: Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Numerical problems. | |
| **UNIT-2** | **SUBMERGED BODIES AND BUOYANCY** | **8L+2P** |
| | **Submerged bodies**: Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid. Related numerical problems.<br>**Buoyancy**: Buoyancy, center of buoyancy, metacentre and metacentric height, conditions of equilibrium of floating and submerged bodies, determination of metacentric height experimentally and theoretically. Numerical problems. | |
| **UNIT-3** | **FLUID KINEMATICS AND DYNAMICS** | **8L+2P** |
| | **Fluid kinematics:** Types of fluid flow, continuity equation in 2Dand 3D (Cartesian Coordinates only), velocity and acceleration, Numerical problems.<br>**Fluid dynamics:** Introduction, Equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and also from Euler's equation, limitations of Bernoulli's equation. Numerical problems. | |
| **UNIT-4** | **FLUID FLOW MEASUREMENTS AND FLOW THROUGH PIPES** | **8L+2P** |
| | **Fluid flow measurements:** Applications of Bernoulli's equation, venturimeter, orifice meter, pitot-tube, vertical orifice, V-notch and rectangular notches, Numerical problems. Navier-stoke's Equation.<br>**Flow through pipes:** Introduction, major and minor losses through pipes. Darcy's and Chezy's equation for loss of head due to friction in pipes. HGL and TEL. Numerical problems.<br>**Laminar flow and viscous effects:** Reynold's number, critical Reynold's number, laminar flow through circular pipe-Hagen Poiseille's equation, | |

| | | |
|---|---|---|
| | laminar flow between parallel and stationary plates. Numerical problems. | |
| **UNIT-5** | **FLOW PAST IMMERSED BODIES AND COMPRESSIBLE FLOW** | **8L+2P** |
| | **Flow past immersed bodies:** Introduction, drag, lift, expression for lift and drag, boundary layer concept, displacement, momentum and energy thickness. Numerical problems.<br>**Compressible flow:** introduction – stagnation properties relationship, velocity of sound in a fluid, mach number, mach cone, propagation of pressure waves in a compressible fluid. Numerical problems.<br>**Introduction to Computational Fluid Dynamics (CFD):** Necessity, limitations, philosophy behind CFD, applications; Commercial softwares available for CFD analysis. | |

| **Fluid Mechanics (FM) LABORATORY** | **Hrs. 24** |
|---|---|
| 1) Impact of jet on vanes - Determination of coefficient of impact of water jet onflat vane, inclined vane and hemispherical vane.<br>2) Orifice meter – Determination of coefficient of discharge (Calibration oforifice meter)<br>3) Venturimeter – Determination of coefficient of discharge (Calibration ofventurimeter)<br>4) V- notch – Determination of coefficient of discharge (Calibration of V notch)<br>5) Flow through a pipe - Determination of major losses.<br><br>**I.** Performance testing, plotting the characteristic curves and determination of unit quantities and specific speed of<br>1) Pelton turbine<br>2) Francis turbine<br>3) Kaplan turbine<br><br>**II.** Performance testing, plotting the characteristic curves and determination of specific speed of<br>4) Single stage centrifugal pump<br>5) Multi stage centrifugal pump<br><br>**III.** Coefficient of discharge and percentage slip of a reciprocating pump. | |

**TEXT BOOKS**

1. A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units), Dr. R.K. Bansal, Laxmi Publications (P) Limited, Revised 9th Edition,, 2010.

2. Fluid Mechanics: Fundamentals and Applications (SI Units),Yunus A. Cengel, JohnM.Cimbala. McGraw-Hill Publications (SIE), 3rd Edition, 2014.

**REFERENCE BOOKS**

1. Hydraulics and Fluid Mechanics including Hydraulic Machines, Dr. P.N. Modi and S.M. Seth, Rajsons Publications Private Limited, Standard Book House, 2009.

2. Fluid Mechanics, Frank M. White, McGraw-Hill Publications (SIE), 7th Edition, 2011.

3. A Text Book of Fluid Mechanics, R K Rajput, S Chand Publishers , 1998.

**e-LEARNING RESOURCES**

1. Fluid Mechanics: Mechanical Engineering Handbook, Kreith,F, Berger, S.A, et. al., Ed. Frank Kreith, Boca Raton: CRC Press LLC, 1999.

2. Videos and Lecture Notes: http://www.nptel.ac.in

**MASSIVE OPEN ONLINE COURSES (MOOCs):**

Students are encouraged to visit http:// www.nptel.ac.in (http:// www.swayam.gov.in) and register for the following MOOCs: Fluid Mechanics (8 Week Course; July-Oct)

**COURSE OUTCOMES: on completion of the course, student should be able to:**

**CO1:** Understand how a fluid is classified and define various properties of a fluid; understand Pascal's law and explain various types of manometers; and solve related numerical problems (RBTL 1, 2, 3)

**CO2:** Explain the total pressure and centre of pressure acting on submerged surfaces; understand the concept of buoyancy, metacentre and metacentric height of floating and submerged bodies; and solve related numerical problems (RBTL 1, 2, 3)

**CO3:** Describe the types of fluid flow and understand the continuity, Euler and Bernoulli's equation; solve numerical problems related to fluid kinematics and dynamics (RBTL 1, 2, 3)

**CO4:** Explain different types of flow measuring devices; understand the minor and major losses; discuss Darcy and Chezy equations; describe Reynolds number and understand the derivation of flow through circular pipe, laminar flow between parallel and stationary plates; and solve related numerical problems (RBTL 1, 2, 3)

**CO5**: Understand the terms related to fluid flow past an immersed body; explain boundary layer, displacement, momentum and energy thickness; understand the relationship of stagnation properties applicable to compressible flow; explain Mach number and Mach cone; 23 24 and solve related numerical problems (RBTL 1, 2, 3).

| **Assessment Details both (CIE and SEE)** |
|---|
| The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.<br><br>**CIE:** The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE.<br><br>Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks. |

| CONTINUOUS INTERNAL EVALUATION (CIE) | | Max Marks | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) | |
|---|---|---|---|---|
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **30** | **12** | |
| **Laboratory components** | **Lab components:** Rubrics for each lab component are added, then taken average | **10** | **20** | **08** |
| | **Lab CIE** | **10** | | |
| | **TOTAL** | **50** | **20** | |

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 1 |
| **CO2** | 3 | 3 | 2 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 1 |
| **CO3** | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 1 |
| **CO4** | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 1 |
| **CO5** | 3 | 3 | 3 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 1 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| QUESTION PAPER PATTERN (SEE) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : FIFTH**

| | | |
|---|---|---|
| Course Title | **DESIGN OF MACHINE ELEMENTS** | |
| Sub.Code:**MET503** | No. of Credits:**4 = 4:0:0 (L-T-P)** | No. of Lecture Hours/Week:**04** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100** | **Total No of Contact Hours: 52** |
| Category | **PCC** | |
| Pre-requisites | **Mechanics of Materials, Material Science and Metallurgy** | |

**COURSE OBJECTIVES:**

1. To familiarize the various steps involved in the Design Process.
2. To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
3. To learn to use standard practices and standard data.
4. To learn to use catalogues and standard machine components.

| | CONTENTS | Hrs |
|---|---|---|
| **UNIT-1** | **STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS** | **11** |
| | Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame - Factor of safety - theories of failure – Design based on strength and stiffness –Concepts of reliability based design - stress concentration – Design for finite and infinite life under variable loading. | |
| **UNIT -** | **ENERGY STORING ELEMENTS AND ENGINE COMPONENTS** | **11** |
| | **SPRINGS**: Introduction, classification of springs, stresses in helical coil springs of circular sections, deflection equation, and energy stored in springs and problems on helical coil springs, buffer springs, concentric springs- advantages, applications and design of concentric springs, springs under fluctuating loads. Leaf Springs, advantages and applications, nipping, stresses in leaf springs, semi elliptical leaf spring. Numerical, Design of Engines Components Connecting Rods and crank shafts. | |
| **UNIT -** | **TEMPORARY AND PERMANENT JOINTS** | **10** |

| | | |
|---|---|---|
| | **PRESSURE VESSELS:** Introduction, Purpose, and Unfired Pressure Vessels at Hydroelectric Facilities, Inspection of Unfired Pressure Vessels, Frequency of Inspections, Inspector qualifications, Pre-Inspection Activities, Inspection Procedure, External Inspection, Thickness Survey, Stress Analysis, Internal Inspection, Non Destructive Testing, and Pressure Testing. theory of bonded joints<br>**RIVETED JOINTS**: Types, rivet materials, Modes of failures of riveted joints, Strength Equations – efficiency of riveted joints, Joint Efficiency, Boiler Joints, Lozenge Joints, Riveted Brackets, Eccentrically riveted joints and Numerical problems.<br>**WELDED JOINTS:** Types, Strength of butt and fillet welds, eccentrically loaded welded joints and Numerical problems. | |
| **UNIT- 4** | **DESIGN OF GEARS** | **10** |
| | Design of Gears: Basic details of gears, classification of gears, Lewis equation, form factor, Introduction to Spur, Helical, Bevel and Worm Gears, Speed ratios and number of teeth-Force analysis -Tooth loads – Dynamic, Wear effects, Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears. | |
| **UNIT- 5** | **BEARINGS** | **10** |
| | Introduction to Lubricant theories, Angular contact ball bearings., Sliding contact and rolling contact bearings -Hydrodynamic journal bearings, Petroff's Equations, McKee's Eqn., Summerfield Number, Raimondi & Boyd graphs, -- Design of Journal bearings, Selection of ball and roller ,Seals and Gaskets | |

**TEXT BOOKS:**


1. Joseph Shigley,Charles Mischke,Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8th Edition, Tata McGraw-Hill, 2008.
2. Bhandari V, "Design of Machine Elements", 3rd Edition, Tata McGraw-Hill Book Co, 2010.


**DESIGN DATA HANDBOOK:**


2. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed.
3. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication


**REFERENCE BOOKS:**


1. Machine Design**,** Robert L. Norton, Pearson Education Asia, 2001.
2. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design",4th Edition, Wiley, 2005
3. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill Book Co.(Schaum's Outline), 2010
4. Design of Machine Elements, M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.
5. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, TMH, New Delhi, Special Indian Edition, 2008.
6. Fundamentals of Machine Component Design, Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007.
7. Fundamentals of Machine Elements - Hawrock, Jacobson Mcgraw Hill
8. Machine Design - Patel, Pandya, Sikh, Vol. - I & II, C.
9. Fundamentals of MachineElements B.J. Hamrock, and S.R. Schmid TMH.
10. The Mechanical Design Process. D.G. Ullman, TMH, New Delhi, 2008.

**Note**: (Use of Lingaiah Design Data Book is permitted in the University examination)

| **COURSE OUTCOMES:** On completion of the course, students will be able to: |
|---|
| **CO1:** Demonstrate understanding of various design considerations |
| **CO2:** Apply basic principles of machine design |
| **CO3:** Design machine elements on the basis of strength concept |
| **CO4:** Use design data books and various standard codes of practices and acquire skill in preparing production drawings pertaining to various designs. |
| **CO5:** Upon completion of this course, the students can able to successfully design machine Components for suitable applications. |

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 1 | 3 | 3 |
| **CO2** | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 3 | 2 | 3 | 2 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 1 | 3 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |
| 3.Design Data Hand Book is permitted | | | | | | | | | | |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : FIFTH**

| Course Title | **DESIGN LABORATORY** | |
|---|---|---|
| Sub.Code:**MEL504** | No. of Credits:**1 = 0:01:2 (L-T-P)** | No. of Practical Hours/Week**:02** |
| Exam Duration: **03** Hrs. | **CIE+SEE =50+50** | **Total No of Contact Hours: 26** |
| Category | **PCCL** | |
| Pre-requisites | **Design of Machine Elements** | |

**COURSE OBJECTIVES:**

1. The main objective of this lab is to expose the student of mechanical engineering to various experimental techniques in order to prepare them for their professional career (Industrial and or R&D). The equipment's / instrumentation proposed are expected to provide the students a lot of insight into various experimental techniques in general and those connected with major mechanical systems in particular.
2. The experiment sequence is arranged in such a way to facilitate to introduce the students to engineering fundamentals, to develop their abilities to design experiments, and to motivate them to learn computer applications for data analysis.

| SL No. | CONTENTS | Hrs |
|---|---|---|
| **PART A** | 1. Experimental prediction of natural frequency of compound pendulum, prediction of equivalent simple pendulum system.<br>2. Experimental prediction of natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel with or without damping and Torsional Vibration.<br>3. Experimental prediction of natural frequencies, and nodal points for single rotor and two-rotor vibratory system, and comparison with theoretical results<br>4. Experimental and theoretical investigation of whirling of shaft (i.e. . comparison of experimental and theoretical natural frequency and justification of discrepancy between experiment and theory)<br>5.Determination of Fringe constant of Photo elastic material using (a) Circular disc subjected to diametric compression (b) Pure bending specimen (four point bending).(c) Tensile specimen.<br>6.Determination of stress concentration using Photo elasticity for simple components like circular disk with circular hole under diametrical compression, | **18** |
| **PART B** | 1. Determination of centrifugal force, power, effort, range speed sensitiveness of Porter/ Watt /Hartnel Governor. (Only one or more).<br>2. Determination of Principal Stresses and strains young's modulus in a member to tensile/combined loading using Strain rosettes.<br>3. Experiments on Gyroscope. | **08** |

**REFERENCE BOOKS :**

1. Advanced Mechanics of solids, L. S. Srinath, Tata Mc. Graw Hill, 2003
2. Theory of Elasticity, S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972
3. Theory of Elasticity, Dr. Sadhu Singh, Khanna Publications, 1988
4. Elasticity, Theory, Applications &Numericals, Martin H Sadd, Elsevier. 2005 4. Applied Elasticity, Seetharamu & Govindaraju, Interline Publishing

**COURSE OUTCOMES:** On completion of the course, student should be able to:

CO1: To exposure the students get to the modern design experimental techniques and instrumentation.

CO2: Understand the essence of kinetics and dynamics through experiments.

CO3: Visualize the stresses developed in an object through photo elasticity implementation of concept of stress concentration in design.

CO4: Have potential to design the experimentation as per need.

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 2 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 3 | 1 |
| **CO2** | 3 | 3 | 2 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 3 | 1 |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 3 | 1 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **SCHEME OF EXAMINATION** | |
|---|---|
| One questions from Part A | 15 Marks (05 Write up +10) |
| One questions from Part B | 25 Marks (05 Write up +20) |
| Viva Voce | 10 Marks |
| **TOTAL** | **50 Marks** |

Change of experiment is not permitted if change of experiment permitted, that experiment is evaluated for 50% marks of allotted marks.

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : FIFTH**

| Course Title | **INSPECTION AND QUALITY CONTROL (PROFESSIONAL ELECTIVE COURSES – I)** | |
|---|---|---|
| Sub.Code:**MET505A** | No. of Credits:**03 = 3:0:0 (L-T-P)** | No. of Lecture Hours/Week**:03** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ Asmt +GA +SEE=40+5+5+50=100** | Total No.of Contact Hours:**40** |
| Category | **PEC** | |
| Pre-requisites | **Engineering Mathematics** | |

**COURSE OBJECTIVES:**

1. The student should learn different inspection procedures, objectives in industry and economic aspects.
2. To impart definition of quality, components, concepts and different approaches followed like quality circles, cost of quality and economic considerations in quality.
3. To impart knowledge on various quality standards followed.
4. To impart fundamentals of statistical quality control charts, and process capability.
5. To impart different sampling techniques and reliability.

| # | CONTENTS | Hrs. |
|---|---|---|
| **UNIT-1** | **INDUSTRIAL INSPECTION and CONCEPT OF QUALITY IN ENGINEERING** | **08** |
| | **Industrial inspection:** Objectives and functions of inspection in industry, types of inspection, production / inspection interaction, organization for industrial inspection, inspection procedures, economic aspect of inspection.<br>**Concept of Quality in Engineering:** Meaning and significance of quality; essential components of quality; phases or elements for building quality; evolution of the concepts of quality; spiral of progress of quality; quality cost, hidden quality costs; economic models of quality costs, changing scope of quality activities. | |
| **UNIT-2** | **QUALITY MANAGEMENT SYSTEMS , QUALITY CONTROL FUNCTION and ASPECTS OF SPECIFICATION AND TOLERANCES** | **08** |
| | **Quality Control Function:** Inspection versus quality control techniques, quality planning activities, organization for quality control. Fundamentals of statistical quality control, Juran's quality trilogy.<br>**Aspects Of Specification And Tolerances:** Aspects of Specification and Tolerances: purpose of specification and tolerances, effect of careless setting of specification limits, setting realistic tolerances, statistical tolerancing, statistical theorem, Precision. Reproducibility and Accuracy, Simple numerical problems. | |
| **UNIT-3** | **CONTROL CHARTS** | **07** |
| | **Control Charts: Basics of Control Chart:** Variability, Kinds of variations, Types of errors, Control limits specification limits and Natural Tolerance limits, Charts for variables and attributes, application of control charts for averages, range, standard deviation, Interpretation of X-bar and R Charts- cyclic patterns, mixture, shift, trend and stratification, fraction defectives (p Chart) and number of non-conformities per unit (c Chart), process capability analysis and simple numerical problems. | |
| **UNIT-4** | **ACCEPTANCE SAMPLING & RELIABILITY** | **08** |

| | | |
|---|---|---|
| | **Acceptance Sampling:** Elementary concepts, sampling by attributes, single, double and multiple sampling plans, construction and use of operating characteristic curves and problems on single sampling plan.<br>**Reliability:** Reliability engineering, rectification processes in industries, practical activity – quality report building, reliability function, failure rate, mean time between failures (MTBF), mean time to failure (MTTF), mortality curve, useful life availability, maintainability, system effectiveness and simple numerical problems on reliability, MTBF and MTTF. | |
| **UNIT-5** | **QUALITY TOOLS AND SYSTEMS & TOTAL QUALITY MANAGEMENT** | **08** |
| | **Quality Management Systems:** Introduction to various quality standards - ISO 9000, BIS.<br>**Quality Tools:** Ishikawa's seven quality tools; Quality Circles; Quality system economics.<br>**Total Quality Management (TQM)** – definition, objectives, philosophy, and total productive maintenance (TPM) – definition, objectives, principles, implementation of TPM. Difference between TQM and TPM. | |

**TEXT BOOKS**


1. Juran, J. M. and Gryna, F. M., Quality Planning & Analysis, Tata McGraw Hill, New Delhi (1995).
2. Grant, E. L., Statistical Quality Control, McGraw Hill International, New York (2005).
3. Charles E Ebling, An introduction to reliability and maintainability engineering, Tata McGraw-Hill Education, 2004 – Maintainability (Engineering).


**REFERENCE BOOKS**


1. Feignbaum, A. V., Total Quality Control, McGraw Hill International, New York (1991).
2. Besterfield, D.H., Total Quality Management, Pearson Education Asia, New Delhi (2003)


**COURSE OUTCOMES:** On completion of the course, student should be able to:

**CO1:** Gain a knowledge on industrial inspection activity and concept of quality in engineering.

**CO2:** Understand various quality systems, quality control function, specification and tolerances prevalent in industry.

**CO3:** Construct various control charts based on data available in an industrial production, can also dwell upon the status of a process whether in control or out of control and find number of defectives.

**CO4:** Carry out sampling, reliability techniques with an industrial application.

**CO5:** Learn about applying different quality tools and total quality management.

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 1 | 3 | 1 | 0 | 0 | 2 | 1 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 1 | 3 | 1 | 0 | 0 | 1 | 1 | 2 | 1 |
| **CO3** | 3 | 3 | 2 | 1 | 3 | 1 | 0 | 0 | 2 | 1 | 2 | 2 |
| **CO4** | 3 | 2 | 3 | 1 | 3 | 1 | 0 | 0 | 2 | 1 | 2 | 2 |
| **CO5** | 3 | 3 | 2 | 1 | 3 | 1 | 0 | 0 | 2 | 1 | 2 | 2 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : FIFTH**

| | | |
|---|---|---|
| Course Title | **COMPOSITE MATERIALS & MANUFACTURING (PROFESSIONAL ELECTIVE COURSES – I)** | |
| Sub.Code:**MET505B** | No. of Credits:**03 = 3:0:0 (L-T-P)** | No. of Lecture Hours/Week**:03** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100** | Total No.of Contact Hours:**40** |
| Category | **PEC** | |
| Pre-requisites | **Material Science** | |

**Course learning objectives:**

1. This subject introduces different types of composite materials to the students
2. Students are introduced to different properties of composite materials
3. Students get to know the different applications of these materials

| # | CONTENTS | Hrs |
|---|---|---|
| **UNIT-1** | **INTRODUCTION TO COMPOSITES** | **08** |
| | **Fundamentals of composites -** need for composites – Enhancement of properties - classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – Particle reinforced composites, Fibre reinforced composites. Applications of various types of composites in aerospace, automotive, medical, sports, marine industry. | |
| **UNIT-2** | **PROCESSING OF POLYMER MATRIX COMPOSITES** | **08** |
| | **Polymer matrix resins** – Thermosetting resins, thermoplastic resins – Reinforcement fibres – Rovings – Woven fabrics – Non woven random mats – various types of fibres. Advantages and Limitations of PMC's PMC processes - Hand lay-up processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics (GFRP). | |
| **UNIT-3** | **PROCESSING OF METAL MATRIX COMPOSITES** | **08** |
| | **Characteristics of MMC**, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC, Limitations of MMC, Metal Matrix, Reinforcements – particles – fibres. Effect of reinforcement - Volume fraction – Rule of mixtures. Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting, Recycling of Metal Matrix Composites | |
| **UNIT-4** | **PROCESSING OF CERAMIC MATRIX COMPOSITES** | **08** |
| | Engineering ceramic materials – properties – advantages – limitations – Monolithic ceramics - Need for CMC – Ceramic matrix - Various types of Ceramic Matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing). | |

| UNIT-5 | ADVANCES IN COMPOSITES | 07 |
|---|---|---|
| | **Carbon / carbon composites** – Advantages of carbon matrix – limitations of carbon matrix Carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol gel technique. Composites for aerospace applications.<br>**Nanocomposites:** Polymer Nano Composites – Types, Nano reinforcements, Applications, Metal Matrix Nano Composites – Types, Nano reinforcements, Applications, Ceramic Nano Composites - Types, Nano reinforcements, Applications 3D Printing of Composites : Introduction to 3D printing, 3D Printing of Polymer and Metal Matrix Composites, Applications of 3D Printed composites | |

**TEXT BOOKS**

1. Mathews F.L. and Rawlings R.D., Composite materials: Engineering and Science, Chapman and Hall, London, England, 1st edition, 1994.
2. Chawla K.K., Composite materials, Springer – Verlag, 1987
3. M. Balasubramanian, Composite materials and Processing, CRC Press, 2014

**REFERENCE BOOKS**

1. Clyne T.W. and Withers P.J., Introduction to Metal Matrix Composites, Cambridge University Press, 1993.
2. Strong A.B., Fundamentals of Composite Manufacturing, SME, 1989.
3. Sharma S.C., Composite materials, Narosa Publications, 2000.
4. Short Term Course on Advances in Composite Materials, Composite Technology Centre, Department of Metallurgy, IIT- Madras, December 2001.
5. Manoj Kumar Buragohain, Composite Structures: Design, Mechanics, Analysis, Manufacturing, and Testing; CRC Press, 2017
6. Srinivasan K; Composite Material: Production Properties Testing; Narosa Publishers; 2009.
7. Autar K Kaw, Mechanics of Composite Materials, CRC, Taylor & Francis Group, 2006.
8. R.K.Everret & R.J. Arsenault Metal matrix composite Academic press.

**COURSE OUTCOMES**: On completion of the course, student should be able to:

**CO1**: Knowledge about composites and its applications
**CO2**: Understand the various processing methods of polymer matrix composites
**CO3**: Enhance awareness on intricate knowledge on metal matrix composites
**CO4**: Familiarize with the basics of ceramic matrix composites processing
**CO5**: Knowledge on the recent advances in composites

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 1 | 3 | 3 |
| **CO2** | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 3 | 2 | 3 | 2 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 1 | 3 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| QUESTION PAPER PATTERN (SEE) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : FIFTH**

| Course Title | **ADVANCED WELDING TECHNOLOGY (PROFESSIONAL ELECTIVE COURSES – I)** | |
|---|---|---|
| Sub.Code:**MET505C** | No. of Credits:**03 = 3:0:0 (L-T-P)** | No. of Lecture Hours/Week**:03** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100** | Total No.of Contact Hours:**40** |
| Category | **PCC** | |
| Pre-requisites | **Manufacturing Processes** | |

**COURSE OBJECTIVES**

1. To understand the working principle, advantages, disadvantages of arc, gas and thermit welding, types of weld joints, heat effects weld ability, preheating and post heating.
2. The student gains information on different solid-state and underwater welding processes.
3. To understand the power beam welding, brazing, soldering and thermal cutting processes.
4. To understand the welding metallurgy and weld ability.
5. To understand the Weldment inspection and testing codes governing welding inspection.

| # | CONTENTS | Hrs. |
|---|---|---|
| **UNIT 1** | **INTRODUCTION OF WELDING:** | **08** |
| | Classification of welding processes, energy sources used in welding, types of fusion welds: working principle, process variables, advantages, limitations and applications of electro slag and electro gas welding, resistance spot welding, gas welding, plasma arc welding and thermit welding. And types of joints, Design considerations, Heat effects, and Weld ability and join ability. Elements and construction of welding symbols. Preheating and interpass heating, post weld heating, heating processes, post heat treatments, insulation of heated joints. Simple Problems. | |
| **UNIT 2** | **ADVANCED WELDING PROCESSES:** | **08** |
| | Working principle, process variables, advantages, limitations and applications of Forge welding, Forge-seam welding, cold welding, roll welding, friction welding and Inertia welding, friction stir welding, ultrasonic welding, diffusion welding and explosion welding. Introduction to wet and dry under water welding & cutting Introduction, welding techniques, difficulties and advantages of welding in space. | |
| **UNIT 3** | **HIGH ENERGY BEAM WELDING PROCESSES, BRAZING, SOLDERING AND THERMAL CUTTING:** | **07** |
| | Working principle, process variables, advantages, limitations and applications of Electron beam and Laser beam welding Weld joint preparation and temperature control, checks prior to weld joint preparation, joint preparation checks, preheating and inter pass heating, post weld heating, heating processes, post heat treatments, insulation of heated joints.<br>Introduction, brazing, soldering, various techniques, their advantages, limitations and applications; brazing & soldering consumables. Oxy Acetylene cutting- | |

| | | |
|---|---|---|
| | working principle, metal powder cutting, introduction to oxygen/air / plasma / metal arc cutting arc cutting and gouging; advantages, limitations and applications of various techniques. | |
| **UNIT 4** | **WELDING METALLURGY AND WELDABILITY:** | **08** |
| | Principle of solidification of weld metal, modes of solidification, effect of welding parameters on weld structure, grain refinement principle of weld metal, method of weld metal refinement, inoculation, arc pulsation, external excitation. Thermal cycles, prediction of peak temperature, pre heat and cooling rate, Heat affected zone and weld metal: Transformations in HAZ of steel, factors affecting changes in microstructure and mechanical properties of HAZ, reactions in weld pool- gas metal reaction, slag metal reaction. Weld ability of carbon steel, stainless steel & aluminum. Hot & cold cracking phenomenon, weld defects, causes and their remedies. Welding of Cu, Al, Ti and Ni alloys – processes, difficulties, microstructures, defects and remedial measures. | |
| **UNIT 5** | **WELDMENT INSPECTION AND TESTING CODES GOVERNING WELDING INSPECTION:** | **08** |
| | Structural welding code; ASME boiler and pressure vessel code, spot examination of welded joints, duties of the inspector, ASTM standards, API standards. Magnetic particle and Radiographic inspection. Magnetic particle inspection, types of magnetizing currents, demagnetization, interpretation of patterns, on-relevant indications, radiographic sources, detectable discontinuities.<br>Chemical, Metallurgical, and Mechanical testing of weldments. Comparison of destructive and non-destructive tests, chemical tests, forms of corrosion, testing for corrosion resistance, metallographic tests. Visual and liquid penetrate inspection. Selection of NDT method, relationship of welding processes, discontinuities and inspection methods, visual inspection prior to, during and after welding, liquid penetrate test. | |

**TEXT BOOKS:**


1. S.V.Nadkarni, "Modern Arc Welding Technology", Oxford & IBH.
2. R.Little, "Welding Technology, TMH. WELDING CODES AND STANDARDS ME-9111 L T P.
3. Welding metallurgy by Sindo Kou, Welding metallurgy, 2nd Edition Nov. 2002, Wiley


**REFERENCE BOOKS:**


1. H.B.Cary, "Modern Arc Welding Technology", Englewood Cliffs, Prentice Hall.
2. Leonard P Connor, Welding Hand book, Volume I-III, AWS.
3. Metals Hand book, Volume 6, American Society of Metals.
4. Dave Smith, "Welding skills and technology", McGraw Hill.
5. Parmer R. S., 'Welding processes and Technology", Khanna Publishers, 1997
6. Robert W Messler, Jr. "Principles of welding, Processes, physics, chemistry and metallurgy", Wiley,2004.
7. Larry Jeffus, " Welding Principles and Applications" Fifth edition, Thomson,2002
8. Christopher Davis, 'Laser Welding - A Practical Guide', Jaico Publishing House, 1994.
9. Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processing, ASM,2007
10. Lancaster J F, "Metallurgy of welding", Allen and Unwin Co.

11. Larry J and Jeffus L, "Welding Principles and Applications", 5th edition, Delmer Publications.

**COURSE OUTCOMES:** On completion of the course, student should be able to;

**CO1:** Understand the mechanism, working principle and process characteristics of different 1.arc, gas and thermit welding, types of weld joints, heat effects weld ability, preheating and post heating.

**CO2:** Have in depth knowledge on working principle, process characteristics of friction, friction stir, ultrasonic, explosion welding and diffusion bonding and under water welding technique.

**CO3:** Describe the mechanism, working principle and process characteristics of high energy beam welding, **s**oldering and brazing and thermal cutting.

**CO4:** Understand welding metallurgy, weld ability of different metals, hot& cold cracking phenomenon, weld defects and their causes and remedies.

**CO5:** Understand the weldment inspection and testing codes governing welding inspection

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 2 | 3 | 1 | 2 | 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| **CO2** | 2 | 3 | 2 | 1 | 2 | 0 | 0 | 1 | 1 | 2 | 1 | 1 |
| **CO3** | 3 | 3 | 2 | 1 | 2 | 0 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO4** | 2 | 3 | 3 | 1 | 2 | 0 | 0 | 1 | 1 | 2 | 0 | 1 |
| **CO5** | 3 | 2 | 3 | 1 | 2 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : FIFTH**

| Course Title | **MECHATRONICS AND MICROPROCESSORS (PROFESSIONAL ELECTIVE COURSES – I)** | |
|---|---|---|
| Sub.Code:**MET505D** | No. of Credits:**03 = 3:0:0 (L-T-P)** | No. of Lecture Hours/Week**:03** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100** | Total No.of Contact Hours:**40** |
| Category | **PEC** | |
| Pre-requisites | **Engineering Physics, TOM** | |

**Course objective:**

1. Substantiate the need for interdisciplinary study in technology education.
2. Understand the evolution and development of Mechatronics as a discipline.
3. Define various types of transducers used and understand analog to digital converter and Vice versa.
4. Applications of microprocessors in various systems and to know the functions of each Element.
5. Describe the operation of mechanical, electrical pneumatic and hydraulic actuators.
6. Identify main parts, hardware forms and internal architecture of PLC, Architecture of 8086.

| # | CONTENTS | Hrs |
|---|---|---|
| **UNIT-1** | **INTRODUCTION TO MECHATRONIC SYSTEMS** | **08** |
| | Measurement and control systems Their elements and functions, Microprocessor based controllers-engine management system, automatic camera and automatic washing machine, Modelling, Mechanical system, Electrical system, Fluid system and Thermal system , Modelling electrical motor, Modelling chamber filled with Fluid, Modeling pneumatic actuator. | |
| **UNIT-2** | **ACTUATORS AND MECHANISM** | **08** |
| | Actuators Types and application areas, Electro mechanical Actuators, Dc motor, AC motor, Stepper motor, Fluid power actuator, piezo electric actuator, magnetostrictive actuator, Mechanical components in mechatronics, force, friction and lubrication, materials, mechanical behaviour of materials, mechanisms used in mechatronics, lever and four bar mechanisms, bearing, belt, chain, cam, slider crank, clutches etc. Signal Conditioning: Introduction to signal conditioning. The operational amplifier. | |
| **UNIT-3** | **REVIEW OF TRANSDUCERS AND SENSORS** | **08** |
| | Definition and classification of transducers. Definition and classification of sensors. Principle of working of and applications of light sensors, proximity sensors – magnetic switch, eddy current type, pneumatic type, ultrasonic type and Hall effect sensors, Computing elements in mechatronics, analog computer, timer, analog to digital converter, digital to analog converter, digital computer, microprocessor and its architecture, micro-controllers, programming logic controllers, their basic structures, mnemonics. | |
| **UNIT-4** | **INTRODUCTION TO MICROPROCESSORS** | **08** |

| | | |
|---|---|---|
| | Evolution of Microprocessor, Organization of Microprocessors (Preliminary concepts), basic concepts of programming of microprocessors. Review of concepts - Boolean algebra, Logic Gates and Gate Networks, Binary & Decimal number systems, memory representation of positive and negative integers, maximum and minimum integers. Conversion of real, numbers, floating point notation, representation of floating point numbers, accuracy and range in floating point representation, overflow and underflow, addition of floating point numbers, character representation. Central Processing Unit of Microprocessors**:** Introduction, timing and control unit basic concepts, Instruction and data flow, system timing, examples of INTEL 8086 and 4004 register organization. | |
| **UNIT-5** | **DATA WORD REPRESENTATION** | **07** |
| | Data word representation. Basic elements of control systems 808SA processor architecture terminology such as CPU, memory and address, ALU, assembler data registers, Fetch cycle, write cycle, state, bus, interrupts. Micro Controllers. Difference between microprocessor and micro controllers. Requirements for control and their implementation in microcontrollers. Classification of micro controllers. Organization & Programming of Microprocessors**:** Introduction to organization of INTEL 8086-Data and Address buses, Instruction set & programming of 8086. | |

**TEXTBOOKS:**


1. A Kuttan, "Introduction to Mechatronics, Oxford University Press, 2010.
2. Alciatore & Histand, "Introduction to Mechatronics & Measurement Systems, 4e", McGrawHill Education, 2014.
3. M Jouaneh, "Fundamentals of Mechatronics", Cengage Learning, 2013.
4. W. Bolton, "Mechatronics", Pearson Education, Second Edition, 1999.Bradley
5. D. A., Dawson D., Buru N.C. and. Loader A.J, "Mechatronics", Chapman and Hall, 1993


**REFERENCE BOOKS:**


1. Dan Necsulesu, "Mechatronics", Pearson Education Asia, 2002 (Indian Reprint).
2. Nitaigour Premchand Mahadik, "Mechatronics", McGraw-Hill Education, 2015.
3. Lawrence J. Kamm, "Understanding Electro – Mechanical Engineering, An Introduction to Mechatronics", Prentice – Hall of India Pvt., Ltd., 2000.
4. Ramachandran K. P., Vijayaraghavan G. K., Balasundaram M.S. "Mechatronics: Integrated Mechanical Electronic Systems", Wiley.
5. Nitaigour Premchand Mahalik., Mechatronics principle, concept and applications. Tata McGraw- Hill Publishing company limited, New Delhi.


## COURSE OUTCOMES

**CO1:** To understand the basic concepts of synergy between mechanical and electronic engineering concepts

**CO2:** To study various fundamental sensors required in automotive, aircraft etc used inall modes of transportation

**CO3:** To study the miniature electrical motors required in operation various mechanicalmachine components

**CO4:** To control the flow of current in required direction used in many applications

**CO5:** To write the architecture of various microprocessor which is applied in computational machine

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 0 | 0 | 1 | 0 | 3 |
| **CO2** | 3 | 3 | 2 | 1 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 2 |
| **CO3** | 3 | 3 | 2 | 1 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : FIFTH**

| Course Title | **MINI - PROJECT** | |
|---|---|---|
| Sub.Code:**MEM506** | No. of Credits:**02 = 0:0:4 (L-T-P)** | **No. of contact hours/week : 04** |
| Exam Duration:**03** Hrs. | **Max. Marks: CIE = 100** | Total No.of Contact Hours:**39** |
| Category | **PROJ** | |

**COURSE OBJECTIVES:**

1. To instill an atmosphere in students to find a working situation and discover the workable area.
2. To insure a transition from planned laboratory course to planning one independently.

| **CONTENTS** |
|---|
| **FABRICATION, MODELING & ANALYSIS** |
| Students have to make simple projects with fabrication related to mechanical projects on a mini scale and/or projects using modeling and analysis tools project related to realistic problems of mechanical stream. |

**COURSE OUTCOMES:** On completion of the course, student should be able to:

**CO1:** Literature review on national and international journals and define the problem.

**CO2:** Design Experiments scientifically / Perform Numerical Analysis / Develop Analytical models to Interpret the Results and Prepare quality document

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COS/POS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO2** | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

**SCHEME OF EXAMINATION (CIE)**

1. Departments shall constitute a Departmental Project Review Committee (internal guide + faculty) to review the project at the middle of the semester.
2. Internal guide alone shall evaluate the project at the end of the semester for a maximum of 70 marks.
3. Project Review Committee shall evaluate the project at the end of the semester for a maximum of 30 marks.

| **SCHEME OF EVALUATION (CIE)** | | | |
|---|---|---|---|
| **Guide (MAX MARKS)** | **PROJECT REVIEW COMMITTEE** | | |
| | **PARTICULARS** | **(MAX MARKS)** | **TOTAL MARKS** |
| **70** | Relevance of topic | **10** | **100** |
| | Oral presentation | **10** | |
| | Viva Voce | **10** | |
| | **TOTAL** | **30** | |

## GUIDELINES FOR PREPARING PROJECT REPORT

1. Project reports should be typed neatly only on one side of the paper with 1.5 or double line spacing on an A4 size bond paper (210 x 297 mm).
2. **The margins should be:** Left – 1.25″, Right – 1″, Top and Bottom – 0.75″.
3. The total number of reports to be prepared are
   i) A copy to the department library
   ii) A copy to the concerned guide(s)
   iii) Two copies to the sponsoring agency
   iv) Candidate's copy.
4. Before taking the final printout, the approval of the **concerned guide(s) is mandatory** with suggested corrections, if any, to be incorporated.
5. For making copies dry tone Xerox is suggested. Every copy of the report must contain Inner title page (White) Outer title page with a plastic cover Certificate in the format enclosed both from the college and the organization where the project is carried out.
6. An **abstract (synopsis)** not exceeding 100 words, indicating salient features of the work. (NB: four copies of the abstract are to be submitted to the Department on the date of submission separately)
7. The organization of the report should be as follows
   i) Inner title page
   ii) Abstract or Synopsis
   iii) Acknowledgments
   iv) Table of Contents
   v) List of table & figures (optional)
   vi) Usually numbered in roman
   vii) Chapters (to be numbered in Arabic) containing Introduction-, which usually specifies the scope of work and its importance and relation to previous work and the present developments, Main body of the report divided appropriately into chapters, sections and subsections.
   viii) The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc.
   ix) The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their

headings must be left justified with section number and its heading in font size 16 and subsection and its heading in font size 14. The body or the text of the report should have font size 12.

x) The figures and tables must be numbered chapter wise for e.g.: Fig. 2.1 Block diagram of a serial binary adder, Table 3.1 Primitive flow table, etc.

xi) The last chapter should contain the summary of the work carried, contributions if any, their utility along with the scope for further work.

xii) **Reference OR Bibliography:** The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order in the following format.

**For textbooks –** A.V. Oppenheim and R.W. Schafer, Digital Signal Processing, Englewood, N.J., Prentice Hall, 3 Edition, 1975.

**For papers** – Devid, Insulation design to combat pollution problem, Proc of IEEE, PAS, Vol 71, Aug 1981, pp 1901-1907.

8. Only SI units are to be used in the report. Important equations must be numbered in decimal form for e.g.

$$V = IZ \quad \ldots\ldots\ldots\ldots (3.2)$$

All equation numbers should be right justified.

9. The project report should be brief and include descriptions of work carried out by others only to the minimum extent necessary. Verbatim reproduction of material available elsewhere should be strictly avoided. Where short excerpts from published work are desired to be included, they should be within quotation marks appropriately referenced. Proper attention is to be paid not only to the technical contents but also to the organization of the report and clarity of the expression. Due care should be taken to avoid spelling and typing errors. The student should note that report-write-up forms the important component in the overall evaluation of the project
10. Hardware projects must include: the component layout, complete circuit with the component list containing the name of the component, numbers used, etc. and the main component data sheets as Appendix.
11. At the time of report submissions, the students must hand over a copy of these details to the project coordinator and see that they are entered in proper registers maintained in the department.
12. Software projects must include a virus free disc, containing the software developed by them along with the read me file. Read me file should contain the details of the variables used, salient features of the software and procedure of using them: compiling procedure, details of the computer hardware/software requirements to run the same, etc. If the developed software uses any public domain software downloaded from some site,then the address of the site along with the module name etc. must be included on a separate sheet. It must be properly acknowledged in the acknowledgments.
13. Sponsored Projects must also satisfy the above requirements along with statement of accounts, bills for the same dully attested by the concerned guides to process further, They must also produce NOC from the concerned guide before taking the internal viva examination.
14. The reports submitted to the department/guide(s) must be hard bounded, with a plastic covering.
15. Separator sheets, used if any, between chapters, should be of thin paper.

**COLOUR OF THE OUTER COVER/FRONT PAGE OF UG DISSERTATION / PROJECT REPORT - SKY BLUE**

# Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An autonomous institution, Aided by Govt. of Karnataka, Affiliated to VTU)
BDA Outer Ring Road, Near Jnana Bharathi Campus, Bengaluru - 560056

## Department of Mechanical Engineering

# *CERTIFICATE*

Certified that the Mini project work (Sixth Semester)entitled… .....is carried out by the following bonafide students of Mechanical Engineering in partial fulfillment for the award of Bachelor of Engineering, B. E (Mechanical) at **Dr. Ambedkar Institute of Technology, Bangalore,** during the academic year ..... .

| Sl. No | U S N (ascending order) | Name of Student |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the project report.

The project report has been approved satisfying the academic requirements prescribed for the said Degree.

| | | |
|---|---|---|
| **Guide** | **HOD** | **Principal** |

**External Viva:**

| Sl. No | Name of the examiner | Signature with date |
|---|---|---|
| 1 | | |
| 2 | | |

**ADMISSION YEAR** :2023-24 ACADEMIC YEAR: 2026-27

**SEMESTER : SIXTH**

| Course Title | **COMPUTER-AIDED DESIGN AND MANUFACTURING** | |
|---|---|---|
| Sub Code: **MEU601** | **No of Credits: 04**<br>**L-T-P 3:0:2 =04** | **No. of Lecture Hours/Week:03**<br>**No. of Practical hours/week :02** |
| **Exam Duration: 3 hrs.** | **CIE+SEE=50+50=100** | **Total No of Contact Hours: 39 + 13 lab Slots** |
| Category | **IPCC** | |
| Pre-requisites | **Manufacturing Processes** | |

**COURSE OBJECTIVES:**

1. Describe the importance of computers role of CAD/CAM in modern design and manufacturing
2. Comprehend and solve the basic mathematical elements of Computer Graphics.
3. Effective learning of NC & CNC technology and create simple CNC programs for machining operations.
4. To impart the use of CAD and CAM in the design and production preparation process.
5. Demonstrate the concept, configurations and features of Robotics along with its applications.

| Sl. No. | CONTENTS | Hrs |
|---|---|---|
| **UNIT-1** | **INTRODUCTION** | **08** |
| | Role of computers in design and manufacturing influence of computers in manufacturing environment. Product cycle in convention to computerized manufacturing environment. Introduction to CAD. Introduction to CAM. Advantages and disadvantages of CAD and CAM, Types of surface generation and its applications. Automation, Types of Automation, Benefits of Automation, Levels of Automation, Design for manufacture | |
| **UNIT-2** | **GEOMETRIC TRANSFORMATIONS IN COMPUTER GRAPHICS** | **08** |
| | Software configuration of a graphic system. Function of graphics package, Elements of Solid Modeling, wire frame and solid modeling, CAD/CAM integration. Desirable modeling facilities and transformation..<br>**SOLID MODELLING** – Boundary Representation Cubic splines and Bezier curves and its characteristics | |
| **UNIT-3** | **NC, CNC, DNC TECHNOLOGIES** | **08** |
| | NC, CNC, DNC, modes. NC element, advantages and limitations of NC, CNC. Functions of computer in DNC. CNC tooling: Turning tool geometry, milling tooling system, tool presetting. ATC, work holding.<br>Operational features of CNC machine; CNC Technology (Machine Spindle, Drives, Feedback devices etc.) | |
| **UNIT-4** | **CNC TURNING & MACHINING CENTERS** | **08** |

| | | |
|---|---|---|
| | Introduction to CNC, elements of CNC, CNC turning & machining centers, part programming fundamental steps involved in development of part programming for milling and turning.<br>Canned Cycles (Stock Removal, Threading, Grooving, Parting Off, Contour, Drilling, Face Milling, End Milling), Preparing the Process chart. | |
| **UNIT-5** | **INTRODUCTION TO ROBOTICS** | **08** |
| | Introduction, robot configuration, robot motion, programming of robots, end effectors work cell, control and interlock, sensor, robot applications. Kinematic Analysis – Direct and Inverse Kinematic analysis, numerical problems. | |

**LABORATORY WORK:**

| SL No. | CONTENTS | Hrs |
|---|---|---|
| **PART A** | ➢ Three typical simulations to be carried out using simulation packages like Master- CAM, or any equivalent software.<br>➢ Simulation of Turning, Drilling, Milling operations. | **10** |
| **PART B** | ➢ Executing NC part programming using software package like Spectra light or any equivalent software<br>➢ NC programming on milling operations, turning operations and drilling operations has to be written and executed. | **10** |
| **PART C** | **(ONLY FOR DEMO/VIVA VOCE)** | **06** |
| | ➢ Pneumatics and Hydraulics, Electro-Pneumatics: Three typical experiments on Basics of these topics to be conducted.<br>➢ FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components.<br>➢ Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects, 2 programs. | |

**REFERENCE BOOKS**


1. Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) by Mikell Groover, Pearson Education INC, Fifth Impression, 2008.
2. CAD/CAM by P N Rao, Tata McGraw Hill, Sixth Reprint, 2006.
3. CAD/CAM by Ibrahim Zied, Tata McGraw Hill, Fourth Reprint, 2008.
4. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P Groover, 4th Edition, 2015, Pearson Education INC.


**COURSE OUTCOMES:** On completion of the course, students will be able to:

**CO1:** Understand the possible applications of the CAD/CAM systems in structure analysis, optimize and virtual engineering.

**CO2:** Demonstrate the basic fundamentals that are used to create, manipulate and analyze Geometric models in a computer graphics.

**CO3:** Explain the basic concepts, features of NC, CNC, DNC machines.

**CO4:** Explain the features of machining centres and able to write part programmes for different operations and work parts.

**CO5:** Appraise the functions of robotic configurations, sensors, end effectors, Programming and able to analyze kinematic and dynamic motion of robot.

| **Assessment Details both (CIE and SEE)** |
|---|
| The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.<br><br>**CIE:** The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE.<br><br>Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks. |

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max Marks** | | **Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)** |
|---|---|---|---|---|
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **30** | | **12** |
| **Laboratory components** | **Lab components:** Rubrics for each lab component are added, then taken average | **10** | **20** | **08** |
| | **Lab CIE** | **10** | | |
| | **TOTAL** | **50** | | **20** |

| **CIE PATTERN** | | |
|---|---|---|
| **Sl. No.** | **Particulars** | **Max Marks** |
| Q 1 | Any one question from Part -A | 20 |
| Q 2 | Any one question from Part -B | 20 |
| Q 3 | Viva Voice | 10 |
| | | 50 (Scale down to 10) |

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO2** | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO3** | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO4** | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO5** | 3 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 1 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : SIXTH**

| | | |
|---|---|---|
| Course Title | **OPERATIONS RESEARCH** | |
| Sub.Code:**MET602** | No. of Credits:**04 = 4:0:0 (L-T-P)** | No. of Lecture Hours/Week**:04** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ Asmt +GA +SEE=40+5+5+50=100** | Total No.of Contact Hours:**52** |
| Category | **PEC** | |
| Pre-requisites | **Engineering Mathematics** | |

**COURSE OBJECTIVES:**

1. Impart knowledge of mathematics, basic and applied sciences.
2. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.
3. Learn effective engineering communication.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Develop awareness of the ethical, professional and environmental implications of work in a global and societal context.

| # | CONTENTS | Hrs. |
|---|---|---|
| **UNIT-1** | **INTRODUCTION & SOLUTION OF LINEAR PROGRAMMING PROBLEMS** | **10** |
| | Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method.<br>The simplex method-canonical and standard forms of an LP problem, slack, surplus and artificial variables (Numerical problems). | |
| **UNIT-2** | **TRANSPORTATION PROBLEM** | **10** |
| | Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem, maximization cases | |
| **UNIT-3** | **ASSIGNMENT PROBLEM & SEQUENCING** | **10** |
| | Assignment Problem-formulation balanced and unbalanced types, application to maximization cases and travelling salesman problem (Numericals).<br>Basic assumptions, sequencing using Johnson's algorithm, 'n' jobs 2 machines, 'n' jobs 3 machines, 'n' jobs 'm' machines without passing sequence, graphical solutions. .**:** | |
| **UNIT-4** | **PERT-CPM TECHNIQUES** | **12** |
| | Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects. | |
| **UNIT-5** | **GAME THEORY & REPLACEMENT** | **10** |
| | Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games.<br>Replacement items deteriorating with time, when money value remains same<br>Replacement of items which fail suddenly; Individual replacement policy, Group replacement policy. | |

**TEXT BOOKS:**


1. **Operations Research,** P K Gupta and D S Hira, Chand Publications, New Delhi - 2007
2. **Operations Research,** Taha H A, Pearson Education

**REFERENCE BOOKS:**


1. **Operations Research,** A P Verma, S K Kataria & Sons, 2008
2. **Operations Research,** Paneerselvan, PHI
3. **Operations Research,** A M Natarajan, P Balasubramani, Pearson Education, 2005
4. **Introduction to Operations Research,** Hiller and Liberman, McGraw Hill.


**COURSE OUTCOMES:** On completion of the course, student should be able to:

**CO1:** Define models for linear programming and convert the linear variable problems to a mathematical model and depict by graphical method.

**CO2:** Compute the minimum cost of transportation by NWCR, LCM and VAM method and then to find optimum solution by MODI method.

**CO3:** Find optimal assignment by Hungarian method.

**CO4:** Design a project network diagram and schedule the project activities and duration using PERT and CPM.

**CO5:** Illustrate the strategies of different players in a game and find the best strategy by graphical and dominance method.

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 1 | 2 | 0 | 1 | 0 | 2 | 1 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 1 | 2 | 1 | 1 | 0 | 2 | 1 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 1 | 2 | 1 | 1 | 0 | 2 | 1 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 1 | 2 | 3 | 1 | 0 | 2 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 1 | 2 | 3 | 1 | 1 | 3 | 3 | 3 | 3 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : SIXTH**

| | | |
|---|---|---|
| Course Title | **MECHANICAL VIBRATIONS (PROFESSIONAL ELECTIVE COURSES – II)** | |
| Sub.Code:**MET603A** | No. of Credits:**03 = 3:0:0 (L-T-P)** | No. of Lecture Hours/Week**:03** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ Asmt +GA +SEE=40+5+5+50=100** | Total No.of Contact Hours:**40** |
| Category | **PEC** | |
| Pre-requisites | **Engineering Physics, TOM** | |

**COURSE OBJECTIVES:**

1. To study basic concepts of vibration analysis in mechanical systems, various technique to solve single degree freedom with and without damping. Estimate natural frequency of simple mechanical system using various numerical techniques.
2. To study the vibration parameters numerically for forced vibration and also acquaint with the principles of vibration measuring instruments.
3. To determine fundamental natural frequencies of two degree freedom systems without damping and semi definite systems
4. To estimate the natural frequency of multi DOF system using various numerical methods.
5. To study balancing of mechanical systems, and able to mathematically formulate real-world vibration problems in engineering.

| # | CONTENTS | Hrs |
|---|---|---|
| **UNIT-1** | **BASIC CONCEPTS OF VIBRATION:** Vibration and oscillation, causes and effects of vibrations, Vibration parameters – spring, mass, damper, Damper models, Motion – periodic, non-periodic, harmonic, non- harmonic, Degree of freedom, static equilibrium position, Vibration classification, Steps involved in vibration analysis. Definitions, Simple Harmonic Motion (S.H.M.), Work done by harmonic force, Beats and Numerical.<br>**FREE UNDAMPED SINGLE DEGREE OF FREEDOM VIBRATION SYSTEMS:** Longitudinal, transverse, torsional vibration system, Methods for formulation of differential equations by Newton, Energy and Rayleigh's Method, Different methods of determination of natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and problems. | **08** |
| **UNIT-2** | **FREE DAMPED SINGLE DEGREE OF FREEDOM VIBRATION SYSTEMS:** Types of damping**,** Analysis with viscous damping - Derivations for over damped, critically damped and under damped systems, Logarithmic decrement and numerical. | **08** |
| **UNIT-3** | **FORCED VIBRATIONS:** Introduction**,** Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, support excitation for relative and absolute amplitudes, force and motion transmissibility and numerical.<br>**Rotor Dynamics:** Critical speed of single rotor, undamped and damped vibrations and numerical.<br>**Vibration Measurement**: Principle of seismic instruments, vibrometer, and accelerometer - undamped, damped, Frequency measuring instruments. | **08** |

| | | |
|---|---|---|
| **UNIT-4** | **SYSTEMS WITH TWO DEGREES OF FREEDOM:** Principle modes and normal modes of vibrations, natural frequencies of systems (without damping) – Simple spring mass systems, torsional systems, combined rectilinear and angular systems, geared semi-defined systems, semi-definite systems, Dynamic vibration absorber and numerical. | **08** |
| **UNIT-5** | **NUMERICAL METHODS FOR MULTI DEGREE FREEDOM OF SYSTEMS**: **(A) Free Undamped Multi Degree Freedom System:** Introduction, Maxwell's reciprocal theorem, Influence coefficients, and numerical.<br>**(B) Multi Degree System Numerical Methods:-** (i) Rayleigh`s, (ii) Dunkerley's (iii) Holzer`s Numerical | **08** |

**TEXT BOOKS:**

1. **Mechanical Vibrations,** G. K.Grover, Nem Chand and Bros, 7th edition, 2003.
2. **Mechanical Vibrations,** S. S. Rao, Pearson Education Inc, 4th edition, 2003.
3. **Mechanical Vibrations,** V. P. Singh, Dhanpat Rai& Company, 3rd edition, 2006.

**REFERENCE BOOKS:**

1. **Theory of Vibration with Applications,** W. T. Thomson, M. D. Dahleh and C. Padmanabhan, Pearson Education Inc, 5th edition, 2008.
2. **Mechanical Vibrations:** S. Graham Kelly, Schaum's outline Series, Tata McGraw Hill, Special Indian Edition, 2007.
3. **Theory and Practice of Mechanical Vibrations:** J. S. Rao& K. Gupta, New Age International Publications, New Delhi, 2001.
4. **Vibration Fundamentals**, R. Keith Mobley, Newness, 1999.

**COURSE OUTCOMES:** After completion of the course, students will be able to:

**CO1:** Understand the different methods to determine the fundamental natural frequencies of SDOF without damping.
**CO2:** Solve the different parameters of single degree damped vibrations by the basic knowledge of damped vibration.
**CO3:** Able to find vibration parameters numerically for forced vibration and also explore modern vibration measuring instruments and rotor dynamics.
**CO4:** Determine fundamental natural frequencies of two degree freedom systems without damping and semi definite systems.
**CO5:** Find the influence of coefficient of spring mass system and apply the numerical methods to find the frequency of multi degree freedom system.

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 1 | 0 | 1 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 1 | 0 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 0 | 1 | 0 | 2 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| QUESTION PAPER PATTERN (SEE) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : SIXTH**

| | | |
|---|---|---|
| Course Title | **EXPERIMENTAL STRESS ANALYSIS (PROFESSIONAL ELECTIVE COURSES – II)** | |
| Sub.Code:**MET603B** | No. of Credits:**03 = 3:0:0 (L-T-P)** | No. of Lecture Hours/Week**:03** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ Asmt +GA +SEE=40+5+5+50=100** | Total No.of Contact Hours:**40** |
| Category | **PEC** | |
| Pre-requisites | **Engineering Physics, TOM** | |

**COURSE OBJECTIVES:**

1. Analyze stresses within the elastic range in 3D.
2. Compile strains and displacements.
3. Evaluate stress and strain relations for linear elastic materials.
4. Demonstrate the experimental methods for analysing stresses and strains in given specimen.
5. Develop photo-elastic, Moiré techniques, holography methods, force, torque and strain measurements for analysing stresses experimentally

| # | CONTENTS | Hrs |
|---|---|---|
| **UNIT-1** | **PHOTOELASTICITY :** Nature of light, Wave theory of light - optical interference, stress optic law – effect of stressed model in plane and circular polariscopes, Analysis of plane polariscope by Jones calculus, isoclinics & isochromatics, Fringe order determination, determination of fractional fringe order, photo-elastic model materials and Applications. | **08** |
| **UNIT-2** | **TWO DIMENSIONAL PHOTOELASTICITY:** Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photo-elastic model materials, materials for 2D photo-elasticity. | **08** |
| **UNIT-3** | **BRITTLE COATINGS :** Coatings stresses, crack patterns, refrigeration techniques, load relaxation techniques, crack detection methods, types of brittle coatings, resin and ceramic based brittle coatings, calibration of coating, advantages and brittle coating applications. | **08** |
| **UNIT-4** | **PHOTOELASTIC(BIREFRINGENT) COATINGS**<br>Theory of birefringence coating stresses, sources of error, effects of coating thickness: reinforcing effects, poission's, stress separation techniques: oblique incidence, strip coatings. Stress freezing technique, birefringent coating materials.<br>**MOIRE METHODS:** Moiré fringes produced by mechanical interference. Geometrical approach, out of plane displacement measurements, applications and advantages. | **08** |
| **UNIT-5** | **ELECTRICAL RESISTANCE STRAIN GAUGES**<br>Gauged factors & strain sensitivity in metallic alloys, gauge construction, characteristics of strain gauges, adhesives and mounting techniques, gauge sensitivity and gauge factor, performance characteristics, environmental effects, strain gauge circuits. Wheatstone's potentiometer bridges, constant current strain gauge circuits.<br>**STRAIN ANALYSIS METHODS:** Two element, three element rectangular and delta rosettes, stress-strain relations, correction for transverse strain effects.<br>**FORCE, TORQUE AND STRAIN MEASUREMENTS:** Mass balance measurement, Elastic element for force measurements, torque measurement. | **08** |

**TEXT BOOKS:**

1. "Experimental Stress Analysis", Dally and Riley, McGraw Hill.
2. "Experimental Stress Analysis". Sadhu Singh, Khanna publisher.
3. Experimental stress Analysis, Srinath L.S tataMcGraw Hill..

**REFERENCE BOOKS:**

1. "Photoelasticity Vol I and VolII,M.M.Frocht, John Wiley & sons.
2. "Strain Gauge Primer", Perry and Lissner,
3. "Photo Elastic Stress Analysis", Kuske, Albrecht & Robertson John Wiley &Sons.
4. "Motion Measurement and Stress Analysis", Dave and Adams.

**COURSE OUTCOMES:** After completion of the course, students will be able to:

**CO1:** Analyze stresses within the elastic range of materials.
**CO2:** Compile strains and displacements.
**CO3:** Evaluate stress and strain relations for linear elastic materials.
**CO4:** Describe the importance of experimental methods in analyzing stress and strain.
**CO5:** Describe photo elastic, Moiré technique, force, torque and strain measurements of experimental stress analysis Validate results with experiments.

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 1 | 0 | 1 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 1 | 0 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 0 | 1 | 0 | 2 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : SIXTH**

| | | |
|---|---|---|
| Course Title | **TURBO MACHINES (PROFESSIONAL ELECTIVE COURSES – II)** | |
| Sub.Code:**MET603C** | No. of Credits:**03 = 3:0:0 (L-T-P)** | No. of Lecture Hours/Week**:03** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ Asmt +GA +SEE=40+5+5+50=100** | Total No.of Contact Hours:**40** |
| Category | **PEC** | |
| Pre-requisites | **Basic Thermodynamics, Fluid Mechanics** | |

**COURSE OBJECTIVES:**

1. To outline the working principle of turbo machines with examples and classify turbomachines and describe the energy transfer mechanism of turbo machines.
2. To understand the thermodynamics of flow and apply dimensional analysis and similarity laws for conducting model tests.
3. To explain the functioning of radial flow and axial flow turbo machines such as centrifugal pumps, compressors, steam, gas and hydraulic turbines
4. To demonstrate the effect of important variables affecting the output of turbo machines.
5. To analyze a given problem, apply the fundamental knowledge to solve the problems.
6. To estimate and evaluate unknown parameters and predict the performance of turbo machines.

| # | CONTENTS | Hrs |
|---|---|---|
| **UNIT-1** | **Introduction to Turbo Machine**<br>**Introduction**: Definition of a turbo machine; parts of a turbo machine; comparison with positive displacement machine; classification of Turbomachines. **Thermodynamics of fluid flow:** Application of first and second law of thermodynamics to turbo machines; Efficiencies of turbo machines; Static and Stagnation states; Overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes; Reheat factor for expansion process; Simple numerical problems on stage efficiency and polytropic efficiency.<br>**Dimensional Analysis:** Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham theorem, dimensionless numbers, and similitude, types of similitude, dimensional analysis and similarity studies. Numerical problems | **8** |
| **UNIT-2** | **GENERAL ANALYSIS OF RADIAL AND AXIAL FLOW TURBOMACHINES**<br>**Energy transfer in a turbo machine -** Euler turbine equation; alternate form of Euler turbine equation (components of energy transfer); degree of reaction, utilization factor and relationship between them.<br>**General analysis of radial flow turbo machines (turbines and pumps) -** Effect of blade discharge angle on their performance; Theoretical head-capacity relationship; Numerical problems.<br>**General analysis of axial flow turbines** – utilization factor, degree of reaction, relationship between utilization factor and blade speed ratio; Maximum utilization factor and optimum blade speed ratio for impulse and reaction axial flow turbines; General analysis of axial flow compressors and pumps – general expression for energy transfer and degree of reaction; Numerical problems. | **8** |

| | | |
|---|---|---|
| **UNIT-3** | **STEAM TURBINES**<br>Introduction; Different efficiencies; Analysis of single stage impulse (De Laval) turbine; Impulse staging and need for compounding; Analysis of velocity compounded impulse (Curtis) turbine; Analysis of Impulse-reaction (Rateau) turbine; Reheat factor for multi stage turbine; Numerical problems. | **8** |
| **UNIT-4** | **HYDRAULIC TURBINES**<br>Introduction; Classification; Different heads and efficiencies; Pelton turbine-velocity triangles; Francis turbine-velocity triangles, runner shapes for different blade speeds; function of a draft tube, types of draft tube; Kaplan and Propeller turbines – velocity triangles and analysis; Related numerical problems; Specific speed and its significance; Unit quantities and their uses; Characteristic curves of hydraulic turbines; Numerical Problems. | **8** |
| **UNIT-5** | **CENTRIFUGAL PUMPS AND COMPRESSORS**<br>Centrifugal pumps –Introduction, Main parts of a centrifugal pump; Work done; Definitions of heads and efficiencies; minimum speed for starting; Multistage centrifugal pump; Specific speed; Priming; Characteristic curves; Cavitation; Thoma's cavitation factor; Maximum suction lift; Net positive suction head; Related numerical problems: Centrifugal compressors-Introduction; Work done; Overall pressure ratio developed; Pressure ratio in terms of , , ; Compressibility and pre-whirl; Diffuser design; Surging; Numerical problems. | **7** |

**TEXT BOOKS**

1. A Textbook of Turbo Machines, Dr M S Govindegowda and Dr A M Nagaraja, 8th Edition, M M Publishers, 2014
2. Turbo Machines, Dr. N. Krishnamurthy, Sunstar Publisher, 2nd Edition, 2015.
3. A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units), Dr. R.K. Bansal, Laxmi Publications (P) Limited, Revised 9th Edition, 2010.

**REFERENCE BOOKS**

1. An introduction to energy conversion, Vol. III – Turbomachinery, V. Kadambi and Manohar Prasad, 2nd Edition, New Age International Publishers (P) Limited, 2011.
2. Principles of turbomachinery, D. G. Shepherd, MacMillan Company, 1964.
3. Turbomachines, B.U. Pai, Wiley Precise Textbook Series, 2014.

**COURSE OUTCOMES:** After completion of the course, students will be able to:

CO1: Explain the fundamentals of energy transfer in turbo machines with the application of first and second laws of thermodynamics; Understand the dimensional analysis and model studies applied to turbomachines; and solve related numerical problems (RBTL 1, 2, 3)
CO2: Analyse the radial flow and axial flow turbines and solve related numerical problems (RBTL 1, 2, 3).
CO3: Classify and analyse the various types of steam turbines and solve related numerical problems (RBTL 1, 2, 3).
CO4: Classify and analyse the various types of hydraulic turbines and solve related numerical problems (RBTL 1, 2, 3).
CO5: Classify and analyse the various types of centrifugal pumps and compressors and solve related numerical problems (RBTL 1, 2, 3)

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 1 | 0 | 1 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 1 | 0 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 0 | 1 | 0 | 2 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| QUESTION PAPER PATTERN (SEE) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : SIXTH**

| | | |
|---|---|---|
| Course Title | **INTERNAL COMBUSTION ENGINES (PROFESSIONAL ELECTIVE COURSES – II)** | |
| Sub.Code:**MET603D** | No. of Credits:**03 = 3:0:0 (L-T-P)** | No. of Lecture Hours/Week**:03** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ Asmt +GA +SEE=40+5+5+50=100** | Total No.of Contact Hours:**40** |
| Category | **PEC** | |
| Pre-requisites | **Basic and Applied Thermodynamics** | |

**COURSE OBJECTIVES:**

1. To understand the basic principle of thermodynamic process
2. To understand the basic components and structure of IC engines (both SI and CI engines), process parameters.
3. Understanding the performance of the engine, combustion and exhaust parameters.

| # | CONTENTS | Hrs |
|---|---|---|
| **UNIT-1** | **REVIEW OF I.C. ENGINE CYCLES AND CARBURETION**<br>Review of thermodynamics cycles used in IC engines; Introduction to carburetion, airfuel mixture requirement at different loads and speeds, Automotive air-fuel mixture requirement, principle of carburetion, simple carburettor, calculation of air-fuel ratio, essential parts of a carburettor, compensating devices, additional systems in modern carburettors, types of carburettors, automobile carburettors, altitude compensation, Numerical problems on air-fuel mixture and carburetion. | **08** |
| **UNIT-2** | **MECHANICAL AND ELECTRONIC INJECTION SYSTEMS**<br>Introduction to mechanical injection system; Functional Requirements of an Injection System; Classification of Injection Systems; Fuel Feed Pump, Injection Pump - Jerk Type Pump, Distributor Type Pump; Injection Pump Governor, Mechanical Governor; Pneumatic Governor; Fuel Injector; Nozzle - Types of Nozzle; Spray Formation, Quantity of Fuel and the Size of Nozzle Orifice; Injection in SI Engine; Introduction to electronic injection system; Gasoline injection - Types of Injection Systems, Components of Injection System; Electronic Fuel Injection System - Merits and Demerits of EFI System; Multi-Point Fuel Injection (MPFI) System; Functional Divisions of MPFI System; Injection Timing; Group Gasoline Injection System; Electronic Diesel Injection System; Electronic Diesel Injection Control; Numerical problems on mechanical injection system. | **08** |
| **UNIT-3** | **COMBUSTION IN SPARK IGNITION AND COMPRESSION IGNITIION ENGINES**<br>Introduction; Homogeneous Mixture; Heterogeneous Mixture; Combustion in SparkIgnition Engines; Stages of Combustion in SI Engines; Flame Front Propagation; Factors Influencing the Flame Speed; Rate of Pressure Rise; Abnormal Combustion; The Phenomenon of Knock in SI Engines, Effect of Engine Variables on Knock; Combustion Chambers for SI Engines; Combustion in Compression-Ignition Engines; Stages of Combustion in CI Engines; Factors Affecting the Delay Period; The Phenomenon of Knock in CI Engines; Comparison of Knock in SI and CI Engines; Combustion Chambers for CI Engines. | **08** |

| | | |
|---|---|---|
| **UNIT-4** | **ENGINE ELECTRONICS AND SUPERCHARGING**<br>Introduction; Typical Engine Management Systems; Different types of Position Displacement and Speed, Pressure, Temperature, Intake air flow and Exhaust oxygen measurement sensors and transducers; Supercharging – Introduction; Types Of Superchargers – Centrifugal, Root's and Vane Type; Methods of Supercharging - Electric Motor Driven, Ram Effect, Under Piston, and Kadenacy System of Supercharging; Effects of Supercharging; Limitations to Supercharging; Thermodynamic Analysis of Supercharged Engine Cycle; Power Input for Mechanical Driven Supercharger; Gear Driven and Exhaust Driven Supercharging Arrangements; Turbocharging - Charge Cooling; Numerical problems on supercharged engines. | **08** |
| **UNIT-5** | **NON CONVENTIONAL ENGINES**<br>Introduction; Comprehensive study on working principle, thermodynamic analysis, design, types, advantages and disadvantages of the following types of engines - Common Rail Direct Injection Engine; Dual Fuel and Multi-Fuel Engines; Multi-fuel Engines; Gasoline Direct Injection Engine; Homogeneous Charge Compression Ignition (HCCI) Engine; Lean Burn Engine; Stirling Engine; Stratified Charge Engine; Variable Compression Ratio Engine; Wankel Engine; Hybrid electric vehicle (HEV), Introduction to Electric Vehicle Propulsion Systems, Motors and Controls for Electric Vehicles Applications, Storage technologies for EV, Battery pack and battery management system, Solar powered EVs. | **08** |

**TEXT BOOKS:**


1. Internal Combustion Engines, V. Ganesan, Tata Mc-Graw Hill Publications,4th Edition, 2012.
2. A Text Book of Internal Combustion Engines, R.K. Rajput, Laxmi Publishers, 2007.
3. Internal Combustion Engines, M. L. Mathur and R. P. Sharma, Dhanpat Rai Publications, 2014.


**REFERENCE BOOKS:**


1. Internal Combustion Engine Fundamentals, John B. Heywood, Mc-Graw Hill Education India Limited, 2011.
2. Engineering Fundamentals of the Internal Combustion Engines, WillardW Pulkrabek. Pearson Education, 2nd Edition, 2015.


**COURSE OUTCOMES:** After completion of the course, students will be able to:

CO1: Describe the carburetion and working principle of different type of carburettor. (RBTL: 1, 2, 3)
CO2: Explain the fuel injection systems in IC engines. (RBTL: 1, 2, 3)
CO3: Describe the combustion process and select suitable combustion chambers for IC engines. (RBTL: 1, 2, 3)
CO4: Understand the engine electronics and supercharging and solve problems on supercharged engines. (RBTL: 1, 2, 3)
CO5: Differentiate and select non-conventional engines in the context of modern developments. (RBTL: 1, 2, 3)
(RBTL: Revised Bloom's Taxonomy Levels; 1 – Remembering, 2 – Understanding, 3 – Applying, 4 - Analyzing, 5 - Evaluating, 6 - Creating)

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 1 | 0 | 1 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 1 | 0 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 0 | 1 | 0 | 2 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| QUESTION PAPER PATTERN (SEE) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR: 2023-24** **ACADEMIC YEAR: 2026-27**

**SEMESTER : SIXTH**

| Course Title | **MAJOR PROJECT PHASE I** | |
|---|---|---|
| **Sub Code: MEP605** | **No. of Credits: 2 = 0:0:4 (L-T-P)** | **No. of lecture hours/week : 02** |
| **Exam Duration: 03 Hrs.** | **Max. Marks : CIE=100** | |
| **Category** | **PROJECT** | |

**Course objectives:**

1. To provide an amicable atmosphere for students to plan
2. To test their learned theory knowledge in an actual working situation
3. To discover the value of work and relish rewards of accomplishment
4. To ensure a professional preparation to the liberal educational goals.

| **STAGES FOR PROJECT WORK** | |
|---|---|
| Step 1 | Formulation of the problem |
| Step 2 | Exhaustive literature survey |
| Step 3 | Methodology |
| Step 4 | Time estimation for completing the project |

The Project proposal shall be submitted within 3 weeks from the start of the semester in the prescribed standard format (04 copies) to the HOD, after the certification of the concerned guide and HOD.

Minimum number of students per batch: 02 Maximum number of students per batch: 04

CIE Evaluation: Two seminars shall be conducted at the end of 6 and 10 week of the semester.

**COURSE OUTCOMES:** On completion of the course, student should be able to:

**CO1:** Literature review on par with international journal standards

**CO2:** Literature gap determination and definition of the problem

**CO3:** Scientific Design / Numerical Analysis / Analytical model and interpret them

**CO4:** Apply tools / techniques for problem solving and prepare project work

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO3** | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO4** | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

## SCHEME OF EXAMINATION (CIE)

1. Departments shall constitute a Departmental Project Review Committee (internal guide + faculty) to review the project at the middle of the semester.
2. Internal guide alone shall evaluate the Project Phase I at the end of the semester for a maximum of 70 marks.
3. Project Review Committee shall evaluate the Project Phase I at the end of the semester for a maximum of 30 marks.

| SCHEME OF EVALUATION (CIE) | | | |
|---|---|---|---|
| **PARTICULARS** | **Guide (MAX MARKS)** | **Project Review Committee (MAX MARKS)** | **Total Marks** |
| Formulation of the problem | | **06** | |
| Relevance of the subject in the present context | | **04** | |
| Literature Survey | | **04** | |
| Problem formulation | | **06** | |
| Oral presentation | | **10** | |
| **TOTAL** | **70** | **30** | **100** |

## GUIDELINES FOR PREPARING PROJECT REPORT

1. Project reports should be typed neatly only on one side of the paper with 1.5 or double line spacing on an A4 size bond paper (210 x 297 mm).
2. **The margins should be:** Left – 1.25″, Right – 1″, Top and Bottom – 0.75″.
3. The total number of reports to be prepared are
   i) A copy to the department library
   ii) A copy to the concerned guide(s)
   iii) Two copies to the sponsoring agency
   iv) Candidate's copy.
4. Before taking the final printout, the approval of the **concerned guide(s) is mandatory** with suggested corrections, if any, to be incorporated.
5. For making copies dry tone Xerox is suggested. Every copy of the report must contain Inner title page (White) Outer title page with a plastic cover Certificate in the format enclosed both from the college and the organization where the project is carried out.
6. An **abstract (synopsis)** not exceeding 100 words, indicating salient features of the work. (NB: four copies of the abstract are to be submitted to the Department on the date of submission separately)
7. The organization of the report should be as follows
   i) Inner title page
   ii) Abstract or Synopsis
   iii) Acknowledgments
   iv) Table of Contents
   v) List of table & figures (optional)
   vi) Usually numbered in roman

vii) Chapters (to be numbered in Arabic) containing Introduction-, which usually specifies the scope of work and its importance and relation to previous work and the present developments, Main body of the report divided appropriately into chapters, sections and subsections.

viii) The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc.

ix) The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their headings must be left justified with section number and its heading in font size 16 and subsection and its heading in font size 14. The body or the text of the report should have font size 12.

x) The figures and tables must be numbered chapter wise for e.g.: Fig. 2.1 Block diagram of a serial binary adder, Table 3.1 Primitive flow table, etc.

xi) The last chapter should contain the summary of the work carried, contributions if any, their utility along with the scope for further work.

xii) **Reference OR Bibliography:** The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order in the following format.

**For textbooks –** A.V. Oppenheim and R.W. Schafer, Digital Signal Processing, Englewood, N.J., Prentice Hall, 3 Edition, 1975.

**For papers** – Devid, Insulation design to combat pollution problem, Proc of IEEE, PAS, Vol 71, Aug 1981, pp 1901-1907.

8. Only SI units are to be used in the report. Important equations must be numbered in decimal form for e.g.

$$V = IZ \quad \text{.....(3.2)}$$

All equation numbers should be right justified.

9. The project report should be brief and include descriptions of work carried out by others only to the minimum extent necessary. Verbatim reproduction of material available elsewhere should be strictly avoided. Where short excerpts from published work are desired to be included, they should be within quotation marks appropriately referenced. Proper attention is to be paid not only to the technical contents but also to the organization of the report and clarity of the expression. Due care should be taken to avoid spelling and typing errors. The student should note that report-write-up forms the important component in the overall evaluation of the project
10. Hardware projects must include: the component layout, complete circuit with the component list containing the name of the component, numbers used, etc. and the main component data sheets as Appendix.
11. At the time of report submissions, the students must hand over a copy of these details to the project coordinator and see that they are entered in proper registers maintained in the department.
12. Software projects must include a virus free disc, containing the software developed by them along with the read me file. Read me file should contain the details of the variables used, salient features of the software and procedure of using them: compiling procedure, details of the computer hardware/software requirements to run the same, etc. If the developed software uses any public domain software downloadedfrom some site, then the address of the site along with the module name etc. must be

included on a separate sheet. It must be properly acknowledged in the acknowledgments.

13. Sponsored Projects must also satisfy the above requirements along with statement of accounts, bills for the same dully attested by the concerned guides to process further, They must also produce NOC from the concerned guide before taking the internal viva examination.
14. The reports submitted to the department/guide(s) must be hard bounded, with a plastic covering.
15. Separator sheets, used if any, between chapters, should be of thin paper

**COLOUR OF THE OUTER COVER/FRONT PAGE OF UG DISSERTATION / PROJECT REPORT - SKY BLUE**

# Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An autonomous institution, Aided by Govt. of Karnataka, Affiliated to VTU)
BDA Outer Ring Road, Near Jnana Bharathi Campus, Bengaluru - 560056


## Department of Mechanical Engineering

### CERTIFICATE

Certified that the project work - Phase I (Seventh Semester) entitled… ..... is carried out by the following bonafide students of Mechanical Engineering in partial fulfilment for the award of Bachelor of Engineering, B. E (Mechanical) at **Dr. Ambedkar Institute of Technology, Bangalore,** during the academic year ..... **.**

| Sl. No | U S N (ascending order) | Name of Student |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the project report.

The project report has been approved satisfying the academic requirements prescribed for the said Degree.

| | | |
|---|---|---|
| **Guide** | **Internal Examiner** | **HOD** |

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : SIXTH**

| Course Title | **Numerical Applications for Mechanical Engineering Lab** | |
|---|---|---|
| Sub Code: **MEL606** | No of Credits: **1 = 0:0:2 (L-T-P)** | No. of Practical Hours/Week**:02** |
| Exam Duration:**03** Hrs | **CIE+SEE =50+50** | Total No. of Contact Hrs. : 13 |
| Category | **PCCL** | |
| Pre-requisites | **Introduction To Python or introduction to C- programming** | |

| UNIT | CONTENT | Hrs. |
|---|---|---|
| **PART - A**<br><br>Introduction to MATLAB – As Programming Language | 1. Introduction to Simple Calculations with MATLAB<br>a) Data Types (Numeric, String) and their conversion<br>b) Scalar Quantities and Variables<br>c) Mathematical Functions<br>• Arithmetic Functions +,-,/,*<br>• Bitwise Operators, Relational Operators, Logical Operators<br>• Trigonometric and inverse trigonometric Functions<br>d) Vectors and Matrices<br>• Matrix Multiplication (scalar and Matrix Multiplications, division)<br>• Sum, Transpose, Diagonal and Inverse of a Matrix.<br>• LU decomposition, QR Factorization<br>2. Introduction to User Defined Functions, and Scripts<br>3. 2D and 3D plots (including contour plots)<br>4. Flow Control<br>a) Loops (For Loop, While Loop, Do while loop)<br>b) Conditional Statements if else<br>c) Switch statement<br>d) Vectorization<br>5. Polynomials<br>a) Inbuilt functions - root, polyfit, polyval, etc.<br>b) Root Finding by Bisection, Newton-Raphson Method, Secant Methods<br>6. Numerical Integration Methods<br>a) Trapezoidal Rule<br>b) Simpsons rules (1/ 3rd and 3/ 8th Rule )<br>7. Solving ODE using - Runge-Kutta Methods | **10** |
| **PART – B**<br><br>Application of MATLAB to Mechanical Engineering | 1. Engineering Mechanics<br>o Statics: Forces in Structures (Trusses, Friction etc)<br>o Dynamics<br>▪ Path of Projectile<br>▪ Moving Rigid bodies<br>2. Strength of Materials<br>o Plot Shear Force, Bending moment and Deflection diagrams for different beams<br>▪ Cantilever<br>▪ Simply supported beam<br>3. Fluid Mechanics<br>o Statics: Pascal Law<br>o Dynamics<br>▪ Applications of Bernoulli principle | **10** |

| | | |
|---|---|---|
| | ▪ Stream function and Potential functions<br>4. Kinematics and Kinetics of Four Bar Mechanism<br>5. Design of Machine Elements: Shaft subjected to combined torsion, bending and axial loads<br>6. Manufacturing: Generating a Merchant-circle diagram. | |

**References:**


1. An Engineer's Guide to MATLAB, Edward B. Magrab, MD Shapour Azarm, MD Balakumar Balachandran, MD James H. Duncan, MD Keith E. Herold Fischell, MD Gregory C. Walsh Leica
2. Essential MATLAB for Engineers and Scientists by Brian D. Hahn and Daniel T. Valentine
3. MATLAB an introduction with applications – Amos Gilat
4. Danilo. 6.094 Introduction to MATLAB, January IAP 2010. (Massachusetts Institute of Technology: MIT Open Courseware), http://ocw.mit.edu (Accessed 31 May, 2012). License: Creative Commons BY-NC-SA
5. Numerical Methods in MATLAB, Center for Interdisciplinary Research and Consulting,Department of Mathematics and Statistics University of Maryland, Baltimore County
6. MATLAB PROGRAMS for Textbook Kinematics, Dynamics, and Design of Machinery by K.J. Waldron and G. L. Kinzel
7. An Introduction to Programming and Numerical Methods in MATLAB by S.R. Otto and J.P. Denier
8. MATLAB Tutorial - Qian Wang Mechanical Engineering Penn State University


**COURSE OUTCOMES (COs):** On completion of this course you should be able to:
**CO1:** Apply algorithmic problem-solving skills
**CO2:** Create functions, scripts, programs which solve medium complex engineering tasks.
**CO3:** Develop solutions to mathematical models applied to practical Mechanical engineering problems.
**CO4:** Utilize MATLAB software to simulate practical problems

**Assessment**
**Scheme for Examination:**
Part A 15 Marks (05 Write-up + 10 Calculations)
Part B 25 Marks (05 Write-up + 20 Calculations)
Viva-voce 10 Marks
Total 50 Marks

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO3** | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO4** | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

**ADMISSION YEAR : 2023-24 ACADEMIC YEAR: 2026-27**
**SEMESTER : SIXTH**

| **COURSE TITLE : INTRODUCTION TO INTERNET OF THINGS** | | |
|---|---|---|
| **Sub Code: MET607A** | **No of Credits =01**<br>**L-T-P-SS::1:0:0:0** | **No. of lecture hours/week : 01** |
| **Exam Duration : 2 hours** | **CIE Marks: 50** | **SEE Marks : 50** |
| **Pre-requisites** | | |

**COURSE OBJECTIVES:** The students will be able to

- Understand the definition and significance of the Internet of Things
- Discuss the architecture, operation, and business benefits of an IoT solution
- Examine the potential business opportunities that IoT can uncover
- Explore the relationship between IoT, cloud computing, and big data
- Identify how IoT differs from traditional data collection systems

| UNIT | CONTENT | Hrs. |
|---|---|---|
| **UNIT 1** | Introduction to IoT: Sensing, Actuation, Basics of Networking: Basics of Networking: Communication Protocols: Sensor Networks: | **02** |
| **UNIT 2** | Machine-to-Machine Communications, Interoperability in IoT, Introduction to Arduino Programming: Integration of Sensors and Actuators with Arduino: Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi. | **02** |
| **UNIT 3** | Introduction to SDN, SDN for IoT: Data Handling and Analytics, Cloud Computing | **03** |
| **UNIT 4** | Fog Computing, Smart Cities and Smart Homes. | **03** |
| **UNIT 5** | Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring | **03** |

**REFERENCE BOOKS**


1. S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press.
2. S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.
3. Research Papers


**COURSE OUTCOMES (COS):** On completion of this course you should be able to:

1. Describe what IoT is and how it works today and Use real IoT protocols for communication
2. Recognize the factors that contributed to the emergence of IoT and Design and program IoT devices.
3. Secure the elements of an IoT device and Design an IoT device to work with a Cloud Computing infrastructure, Transfer IoT data to the cloud and in between cloud providers. Define the infrastructure for supporting IoT deployments
4. Identify how IoT differs from traditional data collection systems
5. Discuss the architecture, operation, and business benefits of an IoT solution

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 1 | 2 | | | | | | | | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 1 | | | | | | | 2 |
| **CO3** | 3 | 2 | 2 | | 1 | | | | | | | 1 |
| **CO4** | 3 | 2 | 2 | | 2 | 2 | 1 | 1 | 1 | | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

**SCHEME FOR EXAMINATIONS**

Pattern of question paper is MCQ (1 mark each).

CIE paper will be 25 objective type questions each of 1 mark

SEE paper will be 50 objective type questions each of 1 mark.

**ADMISSION YEAR**: 2023-24 ACADEMIC YEAR: 2026-27
**SEMESTER : SIXTH**

| Course Title | **COMPUTER AIDED DESIGN AND SIMULATION LAB** | |
|---|---|---|
| Sub Code: **MEL607B** | No. of Credits: **1 = 0:0:2 (L-T-P)** | No. of Practical Hours/Week**:01** |
| **Exam Duration:02 Hrs.** | **CIE+SEE =50+50** | Total No of Contact Hrs. 13 |
| Category | **AEC Lab** | |
| Pre-requisites | **Mechanics of Materials, Manufacturing Processes** | |

| **Course Learning Objectives:** | |
|---|---|
| **1** | To Create drawings and models using software |
| **2** | To Create solid models using sketching, extruding |
| **3** | Gaining a working knowledge of CAD solid modeling |
| **4** | Theoretical concepts of engineering graphics, including orthographic projection, auxiliary views and sectioning, |
| **5** | General dimensioning and tolerance, and geometric dimensioning and tolerance. |

| **UNIT No.** | **Syllabus** | **No. of hours** | **BTLs** |
|---|---|---|---|
| **1** | **SURFACE MODELING** | **04** | **L4** |
| | (i) Create semi-finished bottom casing of a smart Phone using surface tools.<br>(ii) Create semi-finished top casing of a mouse using surface tools. A mouse is a pointing device that functions by detecting two dimensional motion relative to its supporting surface. | | |
| **2** | **SIMULATION** | **04** | **L4** |
| | Static analysis of L shaped Cantilever Beam-<br>(i) Determine displacement due to elongation<br>(ii) Determine displacement and elongation due to bending<br>(iii) Modal analysis of L shaped cantilever Beam | | |
| **3** | **SHEET METAL DESIGN** | **04** | **L4** |
| | (i) Create a sheet metal body required for a SMPS (Switch Mode Power Supply) in a computer<br>(ii) Create a Sheet Metal Hopper Design | | |
| **4** | **WELDMENT** | **02** | **L4** |
| | (i) Create industrial steel frame using weldment<br>(ii) Create a piping structure using weldment | | |

| **Course Outcomes:** On completion of the course, student should be able to: | |
|---|---|
| **1** | Ability to create features complex faces and edges |
| **2** | Use Base Flange, Extruded Cut, Sketched Bend and Edit Material commands |
| **3** | Create weldment using software for industrial frames |
| **4** | Able to conduct static and dynamic analyses for mechanical components |

| **Course Out Comes** | **Level of CO** | **Program Outcomes** | | | | | | | | | | | | **Programme specific outcomes** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **CO1** | | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 0 |
| **CO2** | | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 0 |
| **CO3** | | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 0 |
| **CO4** | | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 0 |
| **CO5** | | 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 0 |

| **Text Books and Learning Sources** | |
|---|---|
| **1** | https://www.sdcpublications.com/Textbooks/Machining-Simulation-Using-SOLIDWORKS-CAM/ISBN/978-1-63057-570-0/ |
| **2** | https://www.sdcpublications.com/Textbooks/Hands-On-Introduction-SOLIDWORKS-2023/ISBN/978-1-63057-555-7/ |
| **3** | https://www.youtube.com/watch?v=lnJTfrqYfMU |

| **Sl. No.** | **Particulars** | **Max Marks** | **Break up Max. Marks** | |
|---|---|---|---|---|
| | | | **Write up** | **Modelling** |
| Q 1 | Any one from either from Unit 1 or Unit 2 | 25 | 5 | 20 |
| Q 2 | Any one from either from Unit 3 or Unit 4 | 15 | 5 | 10 |
| Q 3 | **Viva Voice** | 10 | - | - |
| **Total** | | **50** | | |

# Dr. Ambedkar Institute of Technology, Bengaluru-560056

**Outcome Based Education(OBE) and Choice Based Credit System**

**B.E. Name of the programme: Mechanical Engineering**

**Tentative Scheme of Teaching and Examination effective from the Academic Year 2026-27**

**VII - SEMESTER (Swappable VII and VIII SEMESTER)**

| Sl. No. | Course | Course Code | Course Title | Teaching Department (TD) and Question Paper Setting Board (PSB) | Teaching Hours/Week | | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical / Drawing | Self-Study | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | S | | | | | |
| 1 | IPCC | 22MEU701 | FINITE ELEMENT METHOD (+L) | ME | 3 | 0 | 2 | | 03 | 50 | 50 | 100 | 4 |
| 2 | IPCC | 22MEU702 | HEAT AND MASS TRANSFER (+L) | ME | 3 | 0 | 2 | | 03 | 50 | 50 | 100 | 4 |
| 3 | PCC | 22MET703 | CONTROL ENGINEERING | ME | 3 | 2 | 0 | | 03 | 50 | 50 | 100 | 4 |
| 4 | PEC | 22MET704x | PROFESSIONAL ELECTIVE COURSE | ME | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| 5 | OEC | 22MET705x | OPEN ELECTIVE COURSE | ME | 3 | 0 | 0 | | 01 | 50 | 50 | 100 | 3 |
| 6 | PROJ | 22MEP706 | MAJOR PROJECT PHASE - II | ME | 0 | 0 | 12 | | 03 | 100 | 100 | 200 | 6 |
| | | | | | | | | | | 400 | 300 | 700 | 24 |

**PCC**: Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC:** Professional Elective Course, **OEC** : Open Elective Course.**PR:** Project Work , **L:** Lecture, **T**: Tutorial, **P**: Practical, **S**= Self-Study, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD**-Teaching Department, **PSB**: Paper Setting department, **PROJ** : Project work

**Professional Elective Course 22MET704x**

| | | | |
|---|---|---|---|
| **22MET704A** | Computer Integrated Manufacturing and Automation | **22MET704C** | Refrigeration and Air Conditioning for a Sustainable Future |
| **22MET704B** | Rapid Prototyping | **22MET704D** | Smart Materials |
| **22MET704E** | Tribology and Bearing Design | | |

**Open Elective Course 22MET705x**

| | | | |
|---|---|---|---|
| **22MET705A** | Operation Research | **22MET705C** | Robotics |
| **22MET705B** | Computer Integrated Manufacturing and Automation | **22MET705D** | Smart Materials |

**Note: VII and VIII semesters of IV years of the program**

**(1)** Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships / industry internship safter the VI semester**.**

**(2)** Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters are completed during the beginning of the IV year or the later part of IV years of the program.

**Professional Elective Courses (PEC):** A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of Engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is10.However, this condition shall Not be applicable to cases where the admission to the program is less than 10.

**Open Elective Courses:**

Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator / Advisor / Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

**PROJECT WORK(21AEP75):**

The objective of the Project work is

**(i)** To encourage independent learning and the innovative attitude of the students.

**(ii)** To develop interactive attitude, communication skills, organization, time management, and presentation skills.

**(iii)** To impart flexibility and adaptability.

**(iv)** To inspire team working.

**(v)** To expand intellectual capacity, credibility, judgment and intuition.

**(vi)** To adhere to punctuality, setting and meeting deadlines. To install responsibilities to one self and others.

**(vii)** To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

**CIE procedure for Project Work:**

**(1) Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

**(2) Interdisciplinary:** Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external Guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

**SEE procedure for Project Work:** SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

# Dr. Ambedkar Institute of Technology, Bengaluru-560056

**Outcome Based Education(OBE) and Choice Based Credit System**

**B.E. Name of the programme: Mechanical Engineering**

**Tentative Scheme of Teaching and Examination effective from the Academic Year 2026-27**

**VIII - SEMESTER (Swappable VII and VIII SEMESTER)**

| Sl. No. | Course | Course Code | Course Title | Teaching Department (TD) and Question Paper Setting Board (PSB) | Teaching Hours / Week | | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical / Drawing | Self-Study | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | S | | | | | |
| 1 | PEC | 22MET801x | Professional Elective (Online Courses) | Online | 3 | 0 | 0 | | - | - | - | - | 3 |
| 2 | OEC | 22MET802x | Open Elective(Online Courses) | Online | 3 | 0 | 0 | | - | - | - | - | 3 |
| 3 | INT | 22MEI803 | Internship(Industry/Research) (14-20Weeks) | | 0 | 0 | 12 | | 03 | 100 | 100 | 200 | 10 |
| | | | | | | | | | | 200 | 200 | 400 | 16 |

**L:** Lecture, **T**: Tutorial, **P**: Practical **S** = Self-Study, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD**-Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work, **INT**: Industry Internship / Research Internship / Rural Internship.

| Professional Elective Course(Online courses) 22XXT801x | | | |
|---|---|---|---|
| 22XXT801A | | 22XXT801C | |
| 22XXT801B | | 22XXT801D | |

| Open Elective Courses (Online Courses) 22XXT802x | | | |
|---|---|---|---|
| 22XXT802A | | 22XXT802C | |
| 22XXT802B | | 22XXT802D | |

**Note: VII and VIII semesters of IV years of the program**

**(1)** Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships / industry internship safter the VI semester**.**

**(2)** Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters are completed during the beginning of the IV year or the later part of IV years of the program.

**Elucidation:**

At the beginning of IV years of the program i.e., after VI semester, VII semester class work and VIII semester **Research Internship /Industrial Internship/Rural Internship** shall be permitted to be operated simultaneously by the University so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester class work and a similar percentage of others shall attend to Research Internship or Industrial Internship or Rural Internship.

Research/Industrial /Rural Internship shall be carried out at an Industry, NGO, MSME, Innovation center, Incubation center, Start-up, center of Excellence (CoE), Study Centre established in the parent institute and/or at reputed research organizations/institutes.

The mandatory Research internship /Industry internship / Rural Internship is for 14 to 20 Weeks. The internship shall be considered as a head of passing and shall be considered for the award of a Degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent University examination after satisfying the internship requirements.

**Research internship:** A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

**Industry internship :** Is an extended period of work experience undertaken by students to supplement their Degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

**Rural Internship:** Rural development internship is an initiative of Unnat Bharat Abhiyan Cell, RGIT in association with AICTE to involve students of all departments studying in different academic years for exploring various opportunities in techno-social fields, to connect and work with Rural India for their upliftment.

The faculty coordinator or mentor has to monitor the student's internship progress and interact with them to guide for the successful completion of the internship. The students are permitted to carry out the internship anywhere in India or abroad. University shall not be arranging any expenses incurred in respect to the internship.

- With the consent of the internal guide and Principal of the Institution, students shall be allowed to carry out the internship at their hometown (**within or outside the state or abroad**), provided favorable facilities are available for the internship and the student remains regularly in contact with the internal guide. **University / Institute shall not bear any cost involved in carrying out the internship by students.** However, students can receive any financial assistance extended by the organization.

**ADMISSION YEAR : 2023-24 ACADEMIC YEAR: 2026-27**
**SEMESTER : SEVENTH**

| Course Title | **FINITE ELEMENT METHODS & ANALYSIS** | |
|---|---|---|
| Sub.Code:**22MEU701** | No. of Credits:**04 = 2:2:2 (L-T-P)** | **No. of Lecture Hours/Week:02 No. of Tutorial Hours/Week:02 No. of Practical hours/week :02** |
| Exam Duration: **03** Hrs. | **Max. Marks : CIE+ SEE=40+5+5+50=100** | **Total No of Contact Hours: 52 + 13 lab Slots** |
| Category | **IPCC** | |
| Pre-requisites | **Engineering Mathematics, MOM, DOM** | |

**COURSE OBJECTIVES:**

1. To learn basic principles of finite element analysis procedure and understand design problems in systematic manner
2. To impart structures analysis for stress, strain & dynamic loading knowledge and gain particle experience in 2D drafting
3. To enable formulation of the dimensional structure, mechanical and thermal problems into FEA and able to apply in real life applications.
4. To comprehend the basic concepts and enhance capabilities for solving 2 complex Problems.
5. To introduce the concepts of elastic and static analysis problems and understand various software used to solve the practical problems

| # | CONTENTS | Hrs. |
|---|---|---|
| **UNIT-1** | **INTRODUCTION** | **8L+2P** |
| | Equilibrium equations in elasticity subjected to body force, traction forces, and stress-strain relations for plane stress and plane strains. General description of Finite Element Method, Application and limitations. Types of elements, Node numbering, Half band width, Definitions of FEA and FDM.<br>**BASIC PROCEDURE**: Euler - Langrange equation for bar, beam (cantilever / simply supported fixed), principle of minimum potential energy, Raleigh's Ritz method. Direct approach for stiffness matrix formulation of bar element. Galerkin's method boundary conditions and general comments. | |
| **UNIT-2** | **INTERPOLATION MODELS** | **8L+2P** |
| | Interpolation polynomials- Linear, quadratic and cubic. Simplex complex and multiplex elements.2D PASCAL's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix.<br>**SOLUTION OF 1-DIMENSIONAL BARS:** Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique. Applications. | |
| **UNIT-3** | **HIGHER ORDER ELEMENTS** | **8L+2P** |
| | Lagrange's interpolation, Higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Iso-parametric, Sub parametric and Super parametric elements. | |
| **UNIT-4** | **TRUSSES & BEAMS** | **8L+2P** |

| | | |
|---|---|---|
| | 2D truss Elements Stiffness matrix of Truss element. Examples illustrating how to obtain various internal force diagrams for different types of structural member like trusses Numerical problems. Governing Differentia Equation for beam | |

| | | |
|---|---|---|
| | bending Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads. | |
| **UNIT-5** | **STEADY STATE HEAT TRANSFER** | **8L+2P** |
| | One Dimensional Heat Conduction – Governing Equation – Boundary Condition. Temperature Gradient & B matrix functional approach to Heat Conduction – Element Conductivity Matrix. Assembly & Boundary Conditions, Heat Flux Boundary Conditions, Forced and Natural Boundary Conditions – Numerical problems. Simple Problems. | |

| # | **Computer Aided Modelling and Analysis (CAMA) LABORATORY** | **Hrs.** |
|---|---|---|
| | | **24** |
| | 1. Analysis of 1D structural members and verification of the same through manual calculation.<br>2. Bars of constant cross section area, tapered cross section area and stepped bar<br>3. Trusses – (Minimum 2 exercises)<br>4. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc. (Minimum 6 exercises)<br>5. Includes Theoretical problems and Introduction to meshing<br>6. 2D Stress analysis of a rectangular plate subjected different loads<br>7. Determining of stress concentration factor for rectangular plate with circular cut out and square cutout<br>8. Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions(Minimum 4 exercises)<br>9. Dynamic Analysis<br>a. Fixed – fixed beam for natural frequency determination<br>b. Bar subjected to forcing function<br>c. Fixed – fixed beam subjected to forcing function | |

**TEXT BOOKS:**


1 Finite Elements in Engineering, T.R.Chandrupatla, A.D Belegunde, 3rd Ed PHI.

2. Finite Element Method in Engineering, S.S. Rao, 4th Edition, Elsevier, 2006.


**REFERENCE BOOKS:**


1. "Finite Element Methods for Engineers" U.S. Dixit, Cengage Learning, 2009.
2. Concepts and applications of Finite Element Analysis, R.D. Cook D.S Maltus, M.E Plesha, R.J.Witt, Wiley 4th Ed, 2009
3. Finite Element Methods, Daryl. L. Logon, Thomson Learning 3rd edition, 2001.
4. Finite Element Method, J.N. Reddy, McGraw -Hill International Edition.

**COURSE OUTCOMES: on completion of the course, student should be able to:**

**CO1:** Understand the fundamental concepts of FEM and develop an ability to generate the governing FE equations for systems governed by partial differential Equations.
**CO2:** Understand the concept of interpolation function and analysis of Bar elements and using software able to do 3D/2D part Modelling
**CO3:** To imbibe the concept of shape functions of higher order elements of the models with different meshing techniques, mesh size and quality check.
**CO4:** Understand to analyze the structural applications of trusses and beams subjected to different loading conditions and assign the required boundary condition, loading condition, types of loading and solve
**CO5:** Obtain the ability to understand heat conduction, heat flux and apply the boundary conditions with analysis to solve numerical problems and to validate results with theoretical and experimental values.

| **Assessment Details both (CIE and SEE)** |
|---|
| The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.<br><br>**CIE:** The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE.<br><br>Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks. |

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max Marks** | **Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)** | |
|---|---|---|---|---|
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **30** | **12** | |
| **Laboratory components** | **Lab components:** Rubrics for each lab component are added, then taken average | **10** | **20** | **08** |
| | **Lab CIE** | **10** | | |
| | **TOTAL** | **50** | **20** | |

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 0 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 0 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 0 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 0 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 0 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR : 2023-24 ACADEMIC YEAR: 2026-27**
**SEMESTER : SEVENTH**

| | | |
|---|---|---|
| Course Title | **HEAT TRANSFER** | |
| Sub Code: **22MEU702** | **No of Credits: 04**<br>**L-T-P 2:2:2 =04** | **No. of Lecture Hours/Week:02**<br>**No. of Tutorial Hours/Week:02**<br>**No. of Practical hours/week :02** |
| **Exam Duration: 3 hrs.** | **CIE+SEE=50+50=100** | **Total No of Contact Hours: 52 + 13 lab Slots** |
| Category | **IPCC** | |
| Pre-requisites | **Engineering Mathematics, Engineering Thermodynamics and Fluid Mechanics** | |

| **Course Learning Objectives:** | |
|---|---|
| **1** | To outline the basic concepts of conduction, convection and radiation heat transfer and illustrate the application of various boundary conditions giving heat transfer examples. |
| **2** | To understand the unsteady heat conduction and convection heat transfer and apply the knowledge to solve real time problems. |
| **3** | To demonstrate the use of graphical charts for solving analytical problems. |
| **4** | To design heat exchangers based on the input variables such as inlet temperature of hot and cold fluids. |
| **5** | To calculate various heat transfer parameters and predict the rate of heat transfer and heat transfer coefficients. |
| **6** | To evaluate the conductivity, heat transfer coefficients, emissivity and other performance parameters of equipment like heat exchangers and refrigerators through laboratory experiments. |

| **UNIT No.** | **Syllabus** | **No. of hours** | **RBTLs** |
|---|---|---|---|
| **1** | **BASIC CONCEPTS AND CONDUCTION HEAT TRANSFER** | **9L+4P** | **L1, L2, L3** |
| | Introduction - Modes of heat transfer, Basic laws, Combined heat transfer mechanism, Resistance concept, Boundary conditions of 1$^{st}$, 2$^{nd}$ and 3$^{rd}$ kind; Thermal contact resistance; Overall heat transfer coefficient; Illustrations of applying the boundary conditions to heat transfer problems; Derivation of general equation of heat conduction in Cartesian coordinates; Special cases; Discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation);Steady state heat conduction in simple and composite slabs, cylinders and spheres (uniform thermal conductivity and without heat generation); Related numerical problems; Introduction to variable thermal conductivity and heat generation; Concept and derivation of critical thickness of insulation in cylinders and spheres; Related numerical problems | | |
| **2** | **EXTENDED SURFACES AND UNSTEADY STATE HEAT CONDUCTION TRANSFER** | **9L+4P** | **L1, L2, L3** |
| | Introduction to extended surfaces; Derivation of heat transfer and temperature distribution in fins (uniform cross-section without heat generation); Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources; Fin efficiency and effectiveness; Related numerical problems. | | |

| | | | |
|---|---|---|---|
| | Unsteady state heat conduction - Introduction; Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere; Use of transient temperature charts for transient conduction in semi-infinite solids; Related numerical problems. | | |
| **3** | **CONVECTION HEAT TRANSFER** | **9L+4P** | **L1, L2, L3** |
| | Introduction – Boundary layer concept in external and internal flow; Forced Convection - Dimensional analysis for forced convection; Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers; Use of correlations for flow over simple geometries (flat plate, cylinder and sphere); Use of correlations for flow inside a duct; Numerical problems; Free or natural convection - Dimensional analysis for free convection; Physical significance of Grashof number; Use of correlations of free convection over flat plates (vertical, horizontal and inclined), cylinders (vertical and horizontal) and spheres; Related numerical problems;<br>Introduction to boiling: pool boiling, Bubble Growth Mechanisms, Nucleate Pool Boiling, Critical Heat Flux in Nucleate Pool Boiling, Pool Film Boiling, Critical Heat Flux, Heat Transfer beyond the Critical Point, filmwise and dropwise Condensation Related numerical problems | | |
| **4** | **HEAT EXCHANGERS** | **9L+4P** | **L1, L2, L3** |
| | Introduction; Classification of heat exchangers; Compact, Shell-and-tube and Plate heat exchangers; Overall heat transfer coefficient and fouling factor; Parallel and counter flow heat exchangers; Use of LMTD; Heat transfer with phase change; Multi pass and cross-flow heat exchangers; Effectiveness-NTU method; Limiting cases; Related numerical problems; Compact heat exchangers – Introduction, types, advantages. | | |
| **5** | **RADIATION HEAT TRANSFER** | **9L+4P** | **L1, L2, L3** |
| | Introduction; Fundamental principles - Gray, White, Opaque, Transparent and Black bodies, Spectral emissive power, Wien's displacement law, Planck's laws, Hemispherical Emissive Power, Stefan-Boltzmann law for the total emissive power of a black body, Emissivity and Kirchhoff's Laws; Black bodies separated by a non-absorbing medium; Shape factor; Electrical analogy; Two black surfaces connected by non-conducting and re-radiating walls; Evaluation of shape factor; Radiation heat transfer between gray bodies; Radiosity and Irradiation; Radiation network for gray surfaces exchanging energy; Radiation shields; Related numerical problems | | |

**LABORATORY WORK:**

| Exp No. | LIST OF EXPRIMENTS | No. of hours | RBTLs |
|---|---|---|---|
| | **PART - A** | | |
| **1** | **MINOR EXPERIMENTS**<br>1. Composite wall - Determination of overall heat transfer coefficient of a composite wall.<br>2. Metal rod - Determination of thermal conductivity of a metal rod.<br>3. Fin – Determination of efficiency and effectiveness of a fin free convection mode.<br>4. Emissivity - Determination of emissivity of a given grey surface. | **10** | **L4** |
| | **PART - B** | | |
| **2** | **MAJOR EXPERIMENTS**<br>1. Vertical pipe - Determination of heat transfer coefficient in free convection mode.<br>2. Pipe flow - Determination of heat transfer coefficient in forced convection mode for hot air flowing through a circular pipe.<br>3. Stefan Boltzmann constant - Verification of Stefan Boltzmann Constant.<br>4. Fin - Determination of efficiency and effectiveness of a fin in forced convection mode.<br>5. Shell and Tube heat exchanger - Determination of Log Mean Temperature Difference (LMTD) and Effectiveness in (i) Parallel Flow mode and (ii) Counter Flow mode<br>6. Vapour Compression Refrigerator (VCR) – Determination of COP. | **16** | **L4** |

| **Course Outcomes:** | |
|---|---|
| **1** | *Understand* the basic modes of heat transfer and critical thickness of insulation. (RBTL: 1, 2, 3) |
| **2** | *Understand* the application of extended surfaces in heat conduction and unsteady conduction heat transfer through solids. (RBTL: 1, 2, 3) |
| **3** | *Interpret* and *analyse* the convection heat transfer and phenomenon of boiling and condensation (RBTL: 1, 2, 3) |
| **4** | *Analyse* and *design* the heat exchanger for the maximum effectiveness and efficiency. (RBTL: 1, 2, 3) |
| **5** | *Understand* the principles thermal radiation heat transfer and *develop* expressions for net radiation between various types of bodies. (RBTL: 1, 2, 3) |
| **6** | *Conduct* experiments on basic modes of heat transfer and performance tests on heat exchanger and vapour compression refrigerator. |

**Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes**.

| Course Out Comes (CO) | Level of CO | Program Outcomes (PO) | | | | | | | | | | | | Programme Specific Outcomes (PSO) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| CO1 | L1, 2, 3 | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| CO2 | L1, 2, 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| CO3 | L1, 2, 3 | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| CO4 | L1, 2, 3 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| CO5 | L1, 2, 3 | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| CO6 | L4 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |

| **Text Books.** | |
|---|---|
| **1** | **Heat and Mass Transfer,** P.K. Nag, 3rd Edition, Tata McGraw-Hill Publications, 2011. |
| **2** | A Text Book of Heat and Mass Transfer (SI Units) – R. K. Rajput, S. Chand & Company Limited, Revised Edition 2018. |

| **Data Hand Books and Charts** | |
|---|---|
| **1** | **Heat and Mass Transfer Data Hand Book,** C.P. Kothandaraman, S. Subramanyan, New Age International Publishers, 8th Edition, 2014. |
| **2** | Thermodynamics Data Handbook – B.T. Nijaguna and B.S. Samaga, Sudha Publications, 2016. |

| **Reference Text Books.** | |
|---|---|
| **1** | **Heat and Mass Transfer: Fundamentals and Applications**, Cengel,Y.A., and Ghajar, A.J., 5th Edition, McGraw-Hill Publications (SIE), 2015. |
| **2** | **Principles of Heat and Mass Transfer**, Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, and Adrienne S. Lavine, 7th Edition, Wiley Student Edition, 2013. |

| **Web Links.** | |
|---|---|
| **1** | Students are encouraged to visit http:// www.nptel.ac.in (http:// www.swayam.gov.in) and register for the following MOOCs:<br>(i) Fundamentals of Convective Heat Transfer (12 Week Course; July-Oct)<br>(ii) Heat Exchangers: Fundamentals and Design Analysis (12 Week Course; July-Oct)<br>(iii) Conduction and Convection: Fundamentals and Applications (12 Week Course; July-Oct)<br>(iv) Fundamentals of Conduction and Radiation (12 Week Course; July-Oct) |

| Assessment Details both (CIE and SEE) |
|---|
| The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.<br><br>**CIE:** The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE.<br><br>Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks. |

| **CONTINUOUS INTERNAL EVALUATION (CIE)** | | **Max Marks** | | **Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)** |
|---|---|---|---|---|
| **Theory** | **Weightage of CIE1 and CIE2 Tests or CIE3** | **30** | | **12** |
| **Laboratory components** | **Lab components:** Rubrics for each lab component are added, then taken average | **10** | **20** | **08** |
| | **Lab CIE** | **10** | | |
| **TOTAL** | | **50** | | **20** |

| **CIE PATTERN** | | |
|---|---|---|
| **Sl. No.** | **Particulars** | **Max Marks** |
| Q 1 | Any one question from Part -A | 15 |
| Q 2 | Any one question from Part -B | 25 |
| Q 3 | Viva Voice | 10 |
| | | 50 (Scale down to 10) |

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 0 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 0 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 0 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 0 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 0 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR : 2023-24 ACADEMIC YEAR: 2026-27**
**SEMESTER : SEVENTH**

| Course Title | **CONTROL ENGINEERING** | |
|---|---|---|
| **Sub Code: 22MET703** | **No. of Credits: 4 = 4:0:0 (L-T-P)** | **No. of lecture hours/week : 04** |
| **Exam Duration: 03 Hrs.** | **Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100** | **Total No. of Contact Hours:52** |
| **Category** | **PCC** | |
| **Pre-requisites** | **Basic Engineering Mathematics, Engineering Mechanics** | |

**COURSE OBJECTIVES:**

1. Mathematical modeling of the mechanical systems using differential equations.
2. Deduction of Transfer functions using block Diagrams and signal flow graphs
3. Emphasize on transient characteristics and response of the systems and Routh-Hurwitz stability criteria
4. Analysis of frequency response characteristics of control systems.
5. Construction of root locus plots and to ascertain the stability of the control systems

.

| # | CONTENTS | Hrs |
|---|---|---|
| **UNIT-1** | **MECHANICAL CONTROL SYSTEMS** | **10** |
| | Introduction to the Concept of automatic controls, open loop and closed loop control systems, representation of feedback systems, requirements of an ideal control system.<br>Temperature control, speed control and flight controls. Mathematical models**:** Transfer function models, models of mechanical systems (translational and rotational). | |
| **UNIT-2** | **BLOCK DIAGRAMS AND SIGNAL FLOW GRAPHS** | **08** |
| | Transfer Functions definition, blocks representation of systems, reduction of block diagrams, Mason's gain formula: signal flow graphs. Feed forward systems with examples, Positive Feedback systems. | |
| **UNIT-3** | **TRANSIENT AND STEADY STATE RESPONSE ANALYSIS** | **10** |
| | Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's-Hurwitz criterion; Types of controllers-proportional, integral proportional integral, proportional integral differential controllers. Compensation in control systems, lead-lag compensator. | |
| **UNIT-4** | **ROOT LOCUS PLOTS** | **12** |
| | Definition, general rules for constructing and analysis of closed loop and open loop systems using root locus plots. Effects of addition of poles and zeroes on stability of the systems. Introduction to MATLAB Programming for stability analysis of Root locus plots. | |
| **UNIT-5** | **FREQUENCY RESPONSE ANALYSIS** | **12** |
| | Asymptotic Approximations: Bode Magnitude and Phase angle plots.Stability, Gain Margin & Phase Margin via Bode plot. Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin. Introduction to MATLAB Programming for stability<br>analysis of bode plots. | |

## TEXT BOOKS:


1. Modern Control Engineering, Ogata, 5th Edition , 2010, Prentice Hall of India, New Delhi.ISBN: 10: 0-13-615673-8, 13: 978-0-13-615673-4
2. Automatic Control Systems, Kuo, 3rd Edition, 2009, Prentice Hall of India, New Delhi, ISBN: 0-13-054973-8
3. Control Systems Engineering, 5th Edition, Norman S Nise, Wiley India - 2009


## REFERENCE BOOKS:


1. Modern Control Systems, Richard.C.Dorf and Robert. H. Bishop, Addison Wesley,1999
2. System dynamics & control, Eronini-Umez,Thomson Asia pte Ltd. Singapore, 2002.
3. Feedback Control System, Schaum's series. 2001.
4. Automatic Control Systems, B C Kuo, F Golnaraghi, John Wiley & Sons, 2003.
5. Control Engineering: MATLAB Exercises Authors: Keviczky, L., Bars, R., Hetthessy, J., Banyasz, C.


**COURSE OUTCOMES: On completion of the course, student should be able to:**

**CO1:** Describe fundamentals of control elements and mathematical modeling
**CO2:** To understand the block diagram and signal flow graphs.
**CO3:** Analyze steady state and transient response of first and second order systems.
**CO4:** Evaluate the system stability through Bode and Nyquist plots.
**CO5:** Construction and stability analysis using root locus plots.

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/ POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 0 | 0 | 1 | 0 | 3 |
| **CO2** | 3 | 3 | 2 | 1 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 2 |
| **CO3** | 3 | 3 | 2 | 1 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR : 2023-24 ACADEMIC YEAR: 2026-27**
**SEMESTER : SEVENTH**

| Course Title | **COMPUTER INTEGRATED MANUFACTURING AND AUTOMATION** | |
|---|---|---|
| **Sub Code: 22MET704A** | **No. of Credits: 3 = 3:0:0 (L-T-P)** | **No. of lecture hours/week : 03** |
| **Exam Duration: 03 Hrs.** | **Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100** | **Total No. of Contact Hours:39** |
| **Category** | **PEC** | |
| **Pre-requisites** | **Manufacturing Process and CAD/CAM** | |

**Course Objectives:**

1. To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
2. To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.
3. To expose students to computer aided process planning, material requirement planning, capacity planning etc.
4. To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0 leading to Smart Factory.

| UNIT | CONTENT | Hrs. |
|---|---|---|
| **UNIT 1** | **Introduction to CIM and Automation:** Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Mathematical models and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-in process, Numerical problems and automation strategies. | **08** |
| **UNIT 2** | **Automated Production Lines and Assembly Systems:** Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with Storage buffer, fundamentals of automated assembly systems, numerical problems. | **08** |
| **UNIT 3** | **Flexible Manufacturing Systems:** Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture.<br>**Line Balancing:** Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method. | **08** |

| | | |
|---|---|---|
| **UNIT 4** | **Computerized Manufacture Planning and Control System:** Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPC System, computer integrated production management system, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control.<br>**Automated Assembly Systems:** Design for automated assembly systems, types of automated assembly system, Parts feeding devices-elements of parts delivery system-hopper, part feeder, Selectors, feedback, escapement and placement.<br>**Automated Guided Vehicle System**: Introduction, types, Vehicle guidance and routing, System management. | **08** |
| **UNIT 5** | **Additive Manufacturing Systems:** Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies, Additive manufacturing processes: Photo polymerization, material jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct energy deposition techniques, applications of AM. Recent trends in manufacturing, Hybrid manufacturing.<br>**Future of Automated Factory:** Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance,<br>industrial automation, supply chain optimization, supply-chain & logistics,cyber-physical manufacturing systems. | **07** |

## TEXT BOOKS:


1. Automation, Production system & Computer Integrated manufacturing, M. P. Groover" 4th Edition, 2015, Pearson Learning.
2. Principles of Computer Integrated Manufacturing, S. Kant Vajpayee, Prentice Hall India.
3. CAD/CAM/CIM, Dr P Radhakrishnan, 3rd edition, New Age International Publishers, New Delhi.


## REFERENCE BOOKS


1. "CAD/CAM" by Ibrahim Zeid, Tata McGraw Hill.
2. "Principles of Computer Integrated Manufacturing", S.Kant Vajpayee, 1999, Prentice Hall of India, New Delhi.
3. "Work Systems and the Methods, Measurement and Management of Work", Groover M. P, Pearson/Prentice Hall, Upper Saddle River, NJ, 2007.
4. "Computer Automation in Manufacturing", Boucher, T. O., Chapman & Hall, London, UK, 1996.
5. "Introduction to Robotics: Mechanics and Control", Craig, J. J., 2nd Ed., Addison-Wesley Publishing Company, Readong, MA, 1989.
6. Internet of Things (IoT): Digitize or Die: Transform your organization. Embrace the digital evolution. Rise above the competition, by Nicolas Windpassinger, Amazon.
7. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)
8. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Ed. (2015), Ian Gibson, David W. Rosen, Brent Stucker
9. "Understanding Additive Manufacturing", Andreas Gebhardt, Hanser Publishers, 2011
10. Industry 4.0: The Industrial Internet of Things, A press, 2017, by Alasdair Gilchrist.

**COURSE OUTCOMES (COS):** On completion of this course you should be able to:

**CO1:** Able to define Automation, CIM, CAD, CAM and explain the differences between these concepts.

**CO2:** Explain the basics of automated manufacturing industries through mathematical models and analyse different types of automated flow lines.

**CO3:** Analyse the FMS, GT, AS/RS and automated flow lines to reduce down time and enhance productivity.

**CO4:** Design and development of various types of Computerized Manufacture Planning and Control System, materials handling systems, CAPP, MRP, capacity planning, shop floor control and CAQC.

**CO5:** Visualize and appreciate the modern trends in Manufacturing like additive manufacturing, Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing.

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO2** | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 3 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 1 | 1 |
| **CO4** | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 2 |
| **CO5** | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 2 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

**ADMISSION YEAR : 2023-24 ACADEMIC YEAR: 2026-27**
**SEMESTER : SEVENTH**

| Course Title | **RAPID PROTOTYPING** | |
|---|---|---|
| **Sub Code: 22MET704B** | **No. of Credits: 3 = 3:0:0 (L-T-P)** | **No. of lecture hours/week : 03** |
| **Exam Duration: 03 Hrs.** | **Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100** | **Total No. of Contact Hours:39** |
| **Category** | **PEC** | |
| **Pre-requisites** | **Manufacturing Process** | |

**COURSE OBJECTIVES:**

1. Describe the manufacturing techniques of rapid prototyping process.
2. Successfully apply the following techniques in rapid prototyping process.
3. Analyze the different Rapid tooling methods.
4. Evaluate optimization in Rapid Manufacturing process.
5.

| # | CONTENTS | Hrs. |
|---|---|---|
| **UNIT-1** | **INTRODUCTION** | **07** |
| | Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry and classification of RP systems,general steps in producing components using RP technology.<br>**STEREO LITHOGRAPHY SYSTEMS:** Principle, Process parameter, Process details, Data preparation, data files and machine details, Application. | |
| **UNIT-2** | **SELECTIVE LASER SINTERING (SLS) PROCESS** | **08** |
| | Type of machine, Principle of operation, process parameters, Data preparation forSLS, Applications.<br>**FUSION DEPOSITION MODELLING**: Principle, Process parameter, Path generation, Applications. | |
| **UNIT-3** | **SOLID GROUND CURING** | **08** |
| | Principle of operation, Machine details, Applications. **Laminated Object manufacturing**: Principle of operation, LOM materials Process details, application.<br>**CONCEPTS MODELERS:** Principle, Thermal jet printer, Sander's model market, 3-D printing. GenisysXs printer HP system 5, object Quadra systems, comparisons of different RP technologies. | |
| **UNIT-4** | **RAPID TOOLING** | **08** |
| | Indirect Rapid tooling, Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, Cast Kirksite, 3Q Keltool, etc.<br>Direct Rapid Tooling Direct. AIM. RAPID TOOLING**:** Quick Cast process, Copper polyamide, Rapid Tool, DMLS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. Hard tooling. | |

| UNIT-5 | SOFTWARE FOR RAPID PROTOTYPING | 08 |
|---|---|---|
| | STL files, Overview of Solid view, Magics, Imics, Magic communicator, etc. Internet based software, Collaboration too factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, Influence of build orientation. | |

## TEXT BOOKS:


1. Stereo Lithography and other RP & M Technologies, Paul F. Jacobs: SME, NY 1996
2. Rapid Manufacturing, Flham D.T &Dinjoy S.S Verlog London 2001


## REFERENCE BOOKS:


1. Rapid Prototyping, Terry Wohler's Report 2000" Wohler's Association 2000
2. Rapid Prototyping Materials, Gurumurthi, IISc Bangalore.
3. Rapid Automated, Lament wood. Indus press New York


**COURSE OUTCOMES**: On completion of the course, student should be able to:

**CO1**: Describe the fundamentals of rapid prototyping technology and classification of RP techniques to prepare prototypes for a different product.

**CO2:** Study RP techniques such as SLA, SLS, FDM, SGC, and LOM based on their applicability, materials used and advantages.

**CO3:** Specifically designed concept modelers can adopt to create various models quickly and inexpensively.

**CO4:** Apply rapid tooling technique for the different specified product easily.

**CO5:** Create RP models using different software tools. Analyze advanced RP techniques for their suitability and merits.

| MAPPING OF COs WITH POs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO2** | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| **CO4** | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| QUESTION PAPER PATTERN (SEE) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

ADMISSION YEAR :2023-24 ACADEMIC YEAR: 2026-27

SEMESTER : SEVENTH

| Course Title | **REFRIGERATION AND AIR CONDITIONING FOR A SUSTAINABLE FUTURE** | |
|---|---|---|
| **Sub Code: 22MET704C** | **No. of Credits: 3 = 3:0:0 (L-T-P)** | **No. of lecture hours/week : 03** |
| **Exam Duration: 03 Hrs.** | **Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100** | **Total No. of Contact Hours:39** |
| **Category** | **PEC** | |
| **Pre-requisites** | **Basic and Applied Thermodynamics** | |

**Course Objectives**

1. Understand the components and operation of HVAC systems, and apply methods to calculate cooling loads.
2. Evaluate factors affecting Indoor Environmental Quality (IEQ) and propose strategies to enhance occupant comfort.
3. Explore sustainable cooling technologies, including passive and active systems, and assess their applications.
4. Analyze HVAC requirements for specialized applications such as smart buildings, data centers, and healthcare facilities.
5. Assess energy efficiency, carbon footprint, and understand the significance of certifications in sustainable HVAC practices.
6.

| # | CONTENTS | Hrs. |
|---|---|---|
| **UNIT-1** | **Fundamentals of HVAC Systems and Cooling Load Calculations** | **08** |
| | **Types of HVAC systems:** Centralized vs decentralized systems. Split ACs, Variable Refrigerant Flow (VRF) systems, packaged units: construction and working. Air Handling Unit (AHU): Components (filters, coils, fans, humidifiers), working principles. Filtration: Types of filters (mechanical, electrostatic, HEPA), filter ratings (MERV). Duct basics: Types of ducts, duct materials, static pressure losses and duct insulation.<br><br>Cooling Load Temperature Difference (CLTD), Cooling Load Factor (CLF), and Solar Cooling Load Factor (SCL) to calculate the heat gains from external and internal sources. solar radiation, internal heat generation, ventilation, and infiltration to determine the required cooling capacity for different building types. (Simple problems on CLTD method). | |
| **UNIT-2** | **Indoor Environmental Quality (IEQ)** | **08** |
| | Indoor Environmental Quality (IEQ): Components – Indoor Air Quality (IAQ), thermal comfort, lighting, acoustics. Thermal comfort: Factors influencing human comfort. Indoor Air Quality parameters: CO2 levels, particulate matter & VOCs.<br><br>Health impacts of poor IEQ and ventilation strategies to improve it. Ventilation: Concepts, natural vs mechanical ventilation, hybrid ventilation systems. | |

| | | |
|---|---|---|
| | | |
| **UNIT-3** | **Sustainable Cooling Technologies** | **08** |
| | Passive cooling techniques: Building orientation, shading, thermal mass, ventilation and green roofs. Evaporative cooling: Direct, indirect and 2-stage indirect-direct evaporative coolers, working principle and applications. Performance parameters of evaporative cooling systems, Wet bulb efficiency and Dew point efficiency.<br><br>Desiccant cooling systems: Principle of moisture removal, types of desiccants, integration with HVAC. Thermoelectric cooling: Peltier effect and seebeck effect basics, applications and limitations. Magneto-caloric cooling: working principle and recent developments. Hybrid cooling systems: Combining evaporative and Vapor compression cycles, benefits. | |
| **UNIT-4** | **Special Cooling Applications** | **08** |
| | Residential and Commercial Smart Building HVAC: Building Management Systems (BMS), Demand-controlled ventilation, Occupancy and Zone Control, Benefits and Challenges. Data center cooling: Heat loads, cooling requirements, cooling system types (CRAC, CRAH units, liquid cooling). Hot aisle/cold aisle containment.<br><br>Clean room HVAC: Classification of clean rooms (ISO classes), air cleanliness standards. Air filtration and pressurization strategies to avoid contamination. Hospital HVAC systems: Zoning, positive and negative pressure rooms, air filtration (HEPA), fresh air requirements. Other important applications | |
| **UNIT-5** | **Energy Efficiency, Carbon Footprint, Standards and Certifications** | **07** |
| | Energy performance metrics for HVAC systems: Coefficient of Performance (COP), Energy Efficiency Ratio (EER), Seasonal Energy Efficiency Ratio (SEER). Methods to improve energy efficiency: Variable speed drives, economizers, thermal storage, building automation systems. Carbon footprint calculation methodology for HVAC systems: Embodied energy, operational energy.<br><br>Overview of Certifications: LEED, GRIHA for green buildings, India Cooling Action Plan (ICAP).<br>Roles and responsibilities of: HVAC engineer, energy auditor, green building consultant. Importance of lifelong learning in sustainable cooling. | |

**Suggested Learning Resources:**

**Textbooks:**


1. *Refrigeration and Air Conditioning* by R.S. Khurmi, J.K. Gupta, S. Chand & Co., Revised Edition (2019).
2. *Refrigeration and Air Conditioning* by C.P. Arora, McGraw Hill Education, 3rd Edition (2013).
3. *Heating, Ventilation and Air Conditioning Analysis and Design* by McQuiston, Parker, Spitler, Wiley, 6th Edition.
4. *Fundamentals of HVAC Systems* by Robert McDowall, Fairmont Press, 1st Edition (2011).
5. *Sustainable Building HVAC Systems* by Lisa G. Cummings, Wiley, 1st Edition (2014).


**Reference Books:**


1. *ASHRAE Handbook – Fundamentals*, ASHRAE, (2021).

2. *Principles of Heating, Ventilation, and Air Conditioning in Buildings* by John W. Mitchell, James E. Braun, Wiley, 2nd Edition (1999).
3. *Refrigeration and Air Conditioning Technology* by Bill Whitman, Bill Johnson, John Tomczyk, Cengage Learning, 7th Edition.
4. *Sustainable HVAC Systems* by Lal Jayamaha, Butterworth-Heinemann, 1st Edition (2011).
5. *Data Center Handbook* by Hwaiyu Geng, Wiley, 1st Edition (2015).
6. *Green Building and Sustainable Design* by Sam Kubba, Butterworth-Heinemann, 1st Edition (2010).

**COURSE OUTCOMES: On completion of the course, student should be able to:**

**CO1:** Identify HVAC system components and calculate cooling loads using standard methods.

**CO2:** Assess and improve Indoor Environmental Quality (IEQ) parameters in various indoor environments.

**CO3:** Evaluate and implement sustainable cooling technologies in HVAC systems.

**CO4:** Design HVAC systems tailored to the specific needs of specialized applications.

**CO5:** Evaluate HVAC system energy efficiency and understand the roles of certifications in sustainability.

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%.
The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50).
The minimum passing mark for the SEE is 35% of the maximum marks (18 marks out of 50).
A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

| **Continuous Internal Evaluation (CIE) (Marks)** | | | | |
|---|---|---|---|---|
| **CIE 1** | **CIE 2** | **Assignment** | **Activity** | **Total** |
| **20** | **20** | **05** | **05** | **50** |

**Semester End Examination (SEE):**

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| MODULE | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs /POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 1 | 1 | 2 | 1 | 3 |
| **CO3** | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 1 | 1 | 1 | 1 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 3 |
| **CO5** | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 1 | 1 | 2 | 1 | 3 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |
| **Level 3- Highly Mapped, Level 2-Moderately Mapped, Level 1-Low Mapped, Level 0- Not Mapped** | | | | | | | | | | | | |

ADMISSION YEAR :2023-24 ACADEMIC YEAR: 2026-27

SEMESTER : SEVENTH

| Course Title | **SMART MATERIALS** | |
|---|---|---|
| **Sub Code: 22MET704D** | **No. of Credits: 3 = 3:0:0 (L-T-P)** | **No. of lecture hours/week : 03** |
| **Exam Duration: 03 Hrs.** | **Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100** | **Total No. of Contact Hours:39** |
| **Category** | **PEC** | |
| **Pre-requisites** | **Material Science** | |

**COURSE OBJECTIVES:**

1. The aim of this course is to integrate research results with curriculum development for the benefit of the students in physics, materials science and engineering civil and structural engineering, mechanical and aerospace engineering, industrial and systems engineering, as well as electrical and electronic engineering.
2. The fundamentals of smart materials, device and electronics, in particular those related to the development of smart structures and products.
3. The skills, knowledge and motivation in the design, analysis and manufacturing of smart structures and products.

| # | CONTENTS | Hrs. |
|---|---|---|
| **UNIT-1** | **INTRODUCTION TO SMART MATERIALS** | **07** |
| | Characteristics of composites and ceramic materials, Smart materials and their types, dynamics and controls, concepts, Electro-magnetic materials and shape memory alloys-processing and characteristics. | |
| **UNIT-2** | **SMART STRUCTURES** | **08** |
| | Types of smart Structures, potential feasibility of smart structures, key elements of smart structures, applications of smart structures. Piezoelectric materials, properties, piezoelectric constitutive relations, poling and coercive field, field strain relation. Hysteresis, creep and strain rate effects, inchworm linear motor. | |
| **UNIT-3** | **SENSING AND ACTUATION** | **08** |
| | Principles of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors and their applications, signal processing, principals and characterization of sensors. | |
| **UNIT-4** | **SHAPE MEMORY ALLOY** | **08** |
| | Experimental Phenomenology, Shape Memory Effect, phase transformation, super elasticity, Tanaka's constitutive model, SME testing of SMA wires, vibration control through SMA, Testing of super elasticity, Applications Of SMA.<br>**ER AND MR FLUIDS:** Mechanisms and properties, fluid composition and behavior, The Bingham plastic and related models, pre-yield response. Post-yield flow applications in clutches, dampers and others. | |
| **UNIT-5** | **VIBRATION ABSORBERS and MEMS** | **08** |

| | | |
|---|---|---|
| | **VIBRATION ABSORBERS: S**eries and parallel damped vibrations (overview), active vibration absorbers, fiber optics, physical phenomena, characteristics, sensors, fiber optics in crack detection, applications, biomimetics.<br>**MEMS:** Mechanical properties of MEMS materials, scaling of mechanical systems, fundamentals of theory, the intrinsic characteristics of MEMS, miniaturization, microelectronics integration. | |

TEXT BOOKS:

1. **'Analysis and Design',** A. V. Srinivasan, 'Smart Structures –Cambridge University Press, New York, 2001, (ISBN : 0521650267)
2. **'Smart Materials and Structures',** M V Gandhi and B S Thompson Chapmen & Hall, London, 1992 (ISBN : 0412370107)

REFERENCE BOOKS:

1. **'Smart Materials and Structures',** Banks HT, RC Smith, Y Wang, Massow S A, Paris 1996
2. **G P Gibss'Adaptive Structures',** Clark R L, W R Saunolers, Jhon Wiles and Sons, New York, 1998
3. **An introduction for scientists and Engineers',**EsicUdd, Optic Sensors :Jhon Wiley & Sons, New York, 1991 (ISBN : 0471830070).

**COURSE OUTCOMES:** On completion of this COURSE, students should be able to:
**CO1:** Understand the physical principles underlying the behaviour of smart materials;
**CO2:** Analyze the properties of smart structures, Piezo electric materials with the applications and select suitable procedure for fabrication.
**CO3:** Understand the engineering principles in smart sensor, actuator and technologies
**CO4:** Explain the principle concepts of ER & MR Fluids and shape memory alloys with principles of working.
**CO5:** Describe the methods of controlling vibration using smart systems and fabrication methods of MEMS. Explain the principle concepts of Biomimetic, Fibre optics and actuation with principles of working.

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO** | **PO1** | **PO1** | **PO1** |
| **CO1** | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| **CO2** | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |

ADMISSION YEAR :2023-24 ACADEMIC YEAR: 2026-27

SEMESTER : SEVENTH

| Course Title | **TRIBOLOGY AND BEARING DESIGN** | |
|---|---|---|
| **Sub Code: 22MET704E** | **No. of Credits: 3 = 3:0:0 (L-T-P)** | **No. of lecture hours/week : 03** |
| **Exam Duration: 03 Hrs.** | **Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100** | **Total No. of Contact Hours:39** |
| **Category** | **PEC** | |
| **Pre-requisites** | **Fluid Mechanics, TOM** | |

**COURSE OBJECTIVES:**

1. This subject introduces different types of composite materials to the students
2. Students are introduced to different properties of composite materials
3. Students get to know the different applications of these materials

| UNIT | CONTENTS | Hrs. |
|---|---|---|
| **UNIT-1** | **Introduction to Tribology**: Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems. | **07** |
| **UNIT-2** | **Hydrodynamic Lubrication**: Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynold‟s equation in two dimensions with assumptions. Introduction to idealized slide bearing with fixed shoe andPivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems<br>**Journal Bearings:** Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommerfeld number and its significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems. | **08** |
| **UNIT-3** | **Hydrostatic Bearings**: Hydrostatic thrust bearings , hydrostatic circular pad, annular pad, rectangular pad bearings, types of flow restrictors, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems, and hydrostatic journal bearings.<br>**EHL Contacts**: Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution. | **08** |
| **UNIT-4** | **Antifriction bearings**: Advantages, selection, nominal life, static and dynamic load earing capacity, probability of survival, equivalent load, cubic mean load, bearing Mountings.<br>**Porous Bearings:** Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages. | 08 |

| | | |
|---|---|---|
| **UNIT-5** | **Magnetic Bearings:** Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings. | 08 |

**TEXT BOOKS:**


1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001
2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press Company, 2000.


## REFERENCE BOOKS


1. Dudley D.Fulier “Theory and practice of Lubrication for Engineers", New York Company.1998
2. Moore "Principles and applications of Tribology", Pergamon press, 1975.
3. Oscar Pinkus, BenoSternlicht, “Theory of hydrodynamic lubrication”, McGraw-Hill, 1961.
4. G W Stachowiak, A W Batchelor ,“Engineering Tribology”, Elsevier publication 1993.
5. Hydrostatic and hybrid bearings, Butterworth 1983.
6. F. M. Stansfield, Hydrostatic bearings for machine tools and similar applications, Machinery Publishing, 1970.


## COURSE OUTCOMES (CO):

| **MAPPING OF COs WITH POs** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 2 | 2 | 0 | 0 | 3 | 3 | 2 | 0 | 0 | 0 | 2 |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 0 | 0 | 0 | 2 |
| **CO3** | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 0 | 0 | 0 | 2 |
| **CO4** | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 0 | 0 | 0 | 2 |
| **CO5** | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 0 | 0 | 0 | 2 |
| **Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 | | | | | | | | | | | | |

| **QUESTION PAPER PATTERN (SEE)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Q. No. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
| UNIT | 1 | | 2 | | 3 | | 4 | | 5 | |
| 1. Two full questions (each of 20 Marks) are to be set from each unit. | | | | | | | | | | |
| 2. Student shall answer five full questions selecting one full question from each unit. | | | | | | | | | | |