JNIESTR TRUST'S
**SMT. INDIRA GANDHI COLLEGE OF ENGINEERING**
An Autonomous Institute with NAAC 'A' Grade
Approved by AICTE, Affiliated to the University of Mumbai

**DEPARTMENT OF MECHANICAL ENGINEERING**

# Department of Mechanical Engineering

## CURRICULUM AND SYLLABI

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|---|---|
| **EXIT DEGREE** | B.TECH (Mechanical Engg.) |
| **CURRICULUM STRUCTURE:** | For All Semester |
| **DETAILED SYLLABI:** | For SEM III, SEM IV |
| **BATCH:** | 2025-2029 |
| **WITH EFFECT FROM:** | AY 2026-27 |
| **VERSION:** | SIGCE-NEP-R25-Y2 |

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|---|---|
| Board of Studies Approval Date: | 19 May 2026 |
| Academic Council Approval Date: | 30 June 2026 |

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**Document Control**

**a. Document History**

| Ver. | Effective Date | Compiled By | Reviewed by | Description |
|---|---|---|---|---|
| 0.0 | 8 May 2026 | NEP Cell | AC | Initial Version and template and Curriculum Structure (Version SIGCE-NEP-R25-Y2 – III and IV Sem 2026-27) |
| 1.0 | 19 May 2026 | BoS | AC and GB | Detailed Syllabus (Version SIGCE-NEP-R25-Y2 – III and IV Sem 2026-27) |

**b. Document Approvals**

i) The latest version is: - **Version 2 (30.06.2026)**

ii) COMPILED by: - **NEP Cell and BOS**

iii) APPROVED by: -
a) **BOS** in its meeting held on 19.05.2026
b) **Academic Council in its meeting held on 30.06.2026**
c) **Governing Body**

**Dr. Sunil Chavan**
Member Secretary
Governing Body / CDC

# Table of Contents

# *Chapter 1*: Preamble

The Department of Mechanical Engineering is committed to providing quality technical education that prepares graduates to address the challenges of modern engineering practice, technological advancement, sustainable development, and global competitiveness. The curriculum for the Second Year B. Tech. Mechanical Engineering Programme has been designed in accordance with the provisions of the National Education Policy (NEP) 2020, the curriculum framework prescribed by the Directorate of Technical Education (DTE), Maharashtra, and the guidelines, regulations, and model curriculum recommendations of the All India Council for Technical Education (AICTE). The curriculum aims to develop competent, innovative, ethical, and socially responsible mechanical engineers capable of contributing effectively to industry, research, entrepreneurship, and society.

The curriculum adopts the fundamental principles of Outcome-Based Education (OBE), experiential learning, multidisciplinary education, flexibility in learning pathways, and skill-oriented education envisioned under NEP 2020. It emphasizes holistic development through a balanced integration of engineering sciences, core mechanical engineering courses, multidisciplinary learning, skill enhancement courses, open electives, vocational education, projects, internships, and value-added learning experiences. The framework promotes flexibility in course selection, interdisciplinary exposure, and lifelong learning opportunities through credit-based learning systems and academic mobility.

The curriculum structure has been carefully designed to ensure compliance with the NEP 2020 multidisciplinary engineering framework implemented by the Government of Maharashtra for autonomous engineering institutions. It incorporates Major (Core) courses, Minor courses, Open Electives, Ability Enhancement Courses, Value Education Courses, Vocational and Skill Enhancement Courses, Community Engagement activities, Internship/OJT, and Project-Based Learning components.

Special emphasis has been placed on strengthening practical competency through compulsory skill-based laboratories, industry-oriented courses, simulation-based learning, modern engineering software tools, and project-based education. In line with the recommendations of the Board of Studies and industry stakeholders, the curriculum integrates emerging technologies such as Industry 4.0, Artificial Intelligence applications in Mechanical Engineering, Digital Manufacturing, Robotics, Automation, Additive Manufacturing, Electric Vehicles, Sustainable Energy Systems, and Data Analytics. Application-oriented mathematics, computational methods, and engineering problem-solving have been incorporated to enhance analytical and design capabilities.

The curriculum promotes experiential and competency-based learning through laboratory courses, design challenges, mini-projects, internships, industrial training, and major projects. To strengthen employability and higher education preparedness, GATE-oriented learning, module-wise MCQ-based assessments, online certification courses, and industry-recognized skill development programs have been incorporated as integral components of the learning process.

In alignment with the vision of NEP 2020, the curriculum encourages multidisciplinary learning, innovation, entrepreneurship, critical thinking, research aptitude, ethical practices, environmental consciousness, and sustainable development. Sustainable Development Goals (SDGs), professional ethics, constitutional values, and societal responsibilities have been embedded within the curriculum to develop engineers who are technically proficient and socially responsible.

The Department firmly believes that this curriculum will provide students with a strong foundation in Mechanical Engineering while equipping them with the knowledge, skills, attitudes, and professional competencies required to excel in a rapidly evolving technological environment. The curriculum shall be reviewed periodically through feedback from academia, industry, alumni, employers, students, and other stakeholders to ensure continuous improvement and relevance to national and global requirements.

# *Chapter 2*
# Vision, Mission and Outcomes

## 2.1 Vision and Mission of SIGCE

### Vision

- To serve and have a transformative impact on society by constantly pursuing excellence in technical education, innovation, and entrepreneurship for human development with strong ethical values.

### Mission

- Serve and help transform society by graduating talented, broadly educated engineers, equipped with state-of-the-art technology resources for developing sustainable solutions.
- Academic excellence in Science, Engineering and Technology through dedication to duty, commitment to research, innovation in learning and faith in human values.
- Cultivate the spirit of entrepreneurship and the connection between academia and industry that fosters problem solving through collaboration
- Enable the students to develop into outstanding professionals with high ethical standards capable of creating, developing, and managing global engineering enterprises.

## 2.2 Vision and Mission of Mechanical Engineering

### Vision of the Department

- The Mechanical Engineering Department endeavors to be recognized for outstanding education leading to employable engineers to shoulder the responsibilities of transforming society with ethical values.

### Mission of the Department

- Create competent Mechanical Engineering graduates by providing excellent infrastructure and facilities.
- Develop industry ready multifaceted graduates by promoting Industry-Institute Relations.
- To provide the students with an academic environment of excellence, leadership, ethical guidelines and lifelong learning.
- To develop and motivate students to pursue higher studies.

## 2.3 Program Education Outcomes

1. To train students with practical skills, experimental practices, and problem-solving abilities related to core, applied, and emerging areas of Mechanical Engineering.
2. To prepare learners to use modern engineering tools, digital technologies, and interdisciplinary techniques effectively for solving real-life industrial and societal problems.

3. To train students to analyze real-life engineering problems through industrial visits, vocational training, internships, project work, and expert lectures covering practical aspects of Mechanical Engineering and allied multidisciplinary domains.

## 2.4 Program Outcomes

1. **PO1: Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop the solution of complex engineering problems.
2. **PO2: Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3. **PO3: Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
4. **PO4: Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
5. **PO5: Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
6. **PO6: The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
7. **PO7: Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
8. **PO8: Individual and Collaborative Team work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9. **PO9: Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
10. **PO10: Project Management and Finance**: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
11. **PO11: Life-Long Learning**: Recognize the need for and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

## 2.5 Program Specific Outcomes

1. The student will be able to apply the knowledge of Mathematics, Sciences and engineering fundamentals to formulate, analyse and provide solutions to the problems related to Mechanical engineering.
2. The students will be able to successfully apply the principles of design, analysis and implementation of mechanical systems/processes which have been learned as a part of the curriculum.

## 2.6 Knowledge and Attitude Profile (WK)

1. **WK1**: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
2. **WK2**: Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. engineering
3. **WK3**: A systematic, theory-based formulation of fundamentals required in the engineering discipline.
4. **WK4**: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
5. WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
6. **WK6**: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
7. **WK7**: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
8. **WK8**: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
9. **WK9**: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

# *Chapter 3*

# Curriculum Structure and Scheme

## 3.1 Nomenclature of the Course Categories

| Abbreviation | Course Category | Description |
|---|---|---|
| **BSES** | Basic Science and Engineering Sciences | Consist of Basic Science (BS) and Engineering Sciences (ES) which serves as foundation of Engineering |
| **PRC** | Program Related Courses | Consists of:<br>**Program Core** (the primary, in-depth subject of study which ensures foundational knowledge and expertise in a chosen discipline.<br>**Program Elective** (an optional course a student chooses that directly aligns with, supports, or deepens their specific field of study or major) |
| **MDM** | Multi-Disciplinary Minor | A structured, secondary area of study taken alongside a student's primary major to gain foundational knowledge in a different field. It fosters interdisciplinary expertise, employability, and holistic skill sets. |
| **OE** | Open Elective | Institute level course chosen from outside a student's main department or discipline |
| **SEC** | Skill Enhancement Courses | A specialized, practical training program designed to provide students with industry-relevant skills, value-based knowledge, and hands-on experience, aimed at increasing employability |
| **HSSM** | Humanities, Social Sciences, and Management | Academic disciplines focus on understanding human culture, behavior, society, and organizational leadership. They foster critical thinking, communication, and ethical perspectives. |
| **CC (LLC)** | Co-Curricular Courses (Liberal Learning Courses) | Structured educational experiences that take place outside the traditional classroom but are intentionally designed to complement, supplement, and enhance the academic curriculum |

## 3.2 Credit Distribution Structure

| Broad Category Code | Course Catg. Code | Semester→ / Course Type | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Sub-Total | Tot | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BSES | BS | Basic Science | 07 | 07 | 03 | 03 | | | | | 20 | 29 | 18.13 |
| | ES | Engineering Science | 06 | 03 | | | | | | | 09 | | |
| PRC (Program Related Courses) | PC | Program Core | | 03 | 11 | 11 | 08 | 08 | 04 | | 45 | 80 | 50 |
| | PE | Program Elective | | | | | 04 | 03 | 06 | | 13 | | |
| | RM | Research Methodology | | | | | | | 02 | | 02 | | |
| | CP | Community Engagement Project | | | | | | | 02 | | 02 | | |
| | PR | Project | | | | 01 | 01 | 02 | 02 | | 06 | | |
| | IN | Internship / OJT | | | | | | | | 12 | 12 | | |
| MDM + OE | MM | Multidisciplinary Minor | | | | | 03 | 03 | 04 | 04 | 14 | 22 | 13.75 |
| | OE | Open Elective | | | 02 | 02 | 02 | 02 | | | 08 | | |
| SEC (Skill Enhance-ment Courses) | VS | Voc. and Skill Enhancement | 02 | 04 | 02 | 03 | | 01 | | | 12 | 22 | 13.75 |
| | AE | Ability Enhancement | 02 | | 01 | | 01 | | | | 04 | | |
| | IK | Indian Knowledge System | | 02 | | | | | | | 02 | | |
| | VE | Value Education | 02 | 02 | | | | | | | 04 | | |
| HSSM | EM | Entrepreneurship / Mgmt. | | | 02 | 02 | | | | | 04 | 04 | 2.50 |
| CC (LLC) | CC | Co-Curricular | 02 | | 01 | | | | | | 03 | 03 | 1.87 |
| Total | | | 21 | 21 | 22 | 22 | 19 | 19 | 20 | 16 | 160 | 160 | 100 |

## 3.3 Components of Curriculum

| Curriculum Component | Curriculum Content % | Total number of contact hours | Total number of credits |
|---|---|---|---|
| Basic Science | 12.5 | 6,00 | 20 |
| Engineering Science | 5.63 | 270 | 09 |
| Program Core | 28.13 | 1,350 | 45 |
| Program Elective | 8.13 | 390 | 13 |
| Research Methodology | 1.25 | 60 | 02 |
| Community Engagement | 1.25 | 60 | 02 |
| Project | 3.75 | 180 | 06 |
| Internship / OJT | 7.5 | 360 | 12 |
| Multidisciplinary Minor | 8.75 | 420 | 14 |
| Open Elective | 5 | 240 | 08 |
| Voc. and Skill Enhancement | 6.25 | 360 | 12 |
| Ability Enhancement | 2.5 | 120 | 04 |
| Indian Knowledge System | 1.25 | 60 | 02 |
| Value Education | 2.5 | 120 | 04 |
| Entrepreneurship / Mgmt. | 2.5 | 120 | 04 |
| Co-Curricular | 1.88 | 90 | 03 |
| Any other (Please specify) | - | - | - |
| **Total** | **100** | **4800** | **160** |

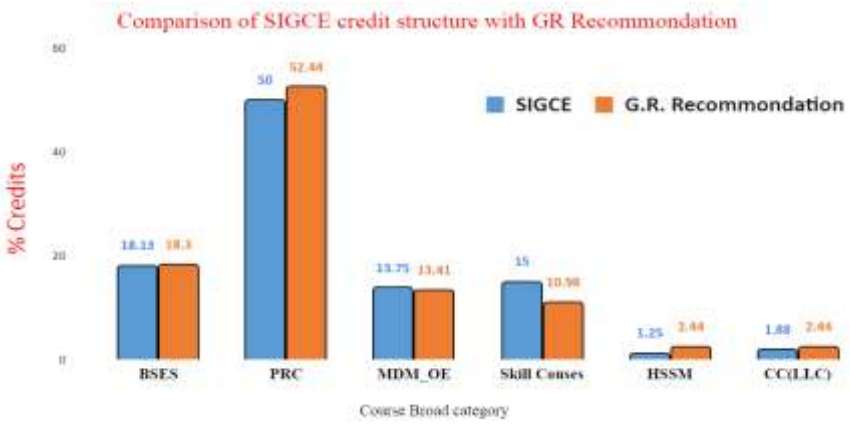
## 3.4 Course Codes – Letter Placement and Meaning

| COURSE CODES - LETTER PLACEMENT | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Department / Program Name | | Course Category Code | | Course Level * | Course Number** | |
| **AD** - AI and Data Science<br>**AS** - Applied Science & Humanities<br>**CA** - CSE-AIML<br>**CE** - Computer Engg.<br>**CI** - CSE-IOTCSBT<br>**EE** - Electrical Engg<br>**IG** - SIGCE (Institute Level)<br>**ME** - Mechanical Engg | | **AE** - Ability Enhancement<br>**BS** - Basics Sciences<br>**CC** - Cocurricular Course<br>**CP** - Community Engaged Project<br>**EM** - Entrepreneurship/Economics/ Management<br>**ES** - Engineering Sciences<br>**IK** - Indian Knowledge System<br>**IN** - Internship/On job Training<br>**MM** - Multi-Disciplinary Minor<br>**OE** - Open Elective<br>**PC** - Program Core<br>**PE** - Program Elective<br>**PR** - Project<br>**RM** - Research Methodology<br>**VE** – Value Education<br>**VS** - Vocational and skill enhancement course | | **0** - Pre-requisite<br>**1** - Foundation<br>**2** - Intermediate<br>**3** - Higher-level<br>**4** - Advanced | **0** | **1** |

**** Course Level :*** *Please refer NEP GR to determine the levels*

***** Course Number:*** *Sequence number of course in that Course Category offered by a specific department*

## 3.5 Comparison of SIGCE credit structure with the G.R recommendation



# 3.6 Semester wise allocation of credits

## Semester 3

| Course Code | Broad Catg. | Course Name | Course Choice | Teaching Scheme | | | | | | Credit Assigned | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | CR | | Lab | | SL | TE | L | T | P/ D | TC |
| | | | | L | T | P | D | | | | | | |
| MEBS231 | BS | Engineering Mathematics - III | Compulsory | 2 | 1 | - | - | 3 | **6** | 2 | 1 | - | **3** |
| MEPC231 | PC | Strength of Materials | Compulsory | 3 | - | 2 | - | 3 | **8** | 3 | - | 1 | **4** |
| MEPC232 | PC | Materials and Manufacturing Technology | Compulsory | 3 | - | 2 | - | 3 | **8** | 3 | - | 1 | **4** |
| MEPC233 | PC | Thermodynamics | Compulsory | 3 | - | - | - | 3 | **6** | 3 | - | - | **3** |
| IGOE23x | OE | Open Elective | Choice Based* | 2 | - | - | - | 2 | **4** | 2 | - | - | **2** |
| MEVS231 | VS | CAD Modelling and Working Drawing Lab | Compulsory | | | 2 | 2 | - | **4** | - | - | 2 | **2** |
| IGAE231 | AE | Comprehensive Soft Skills and Professional Development | Compulsory | - | - | 2 | | - | **2** | - | - | 1 | **1** |
| IGEM231 | EM | Entrepreneurship and Business Model Development | Compulsory | - | - | 2 | 2 | - | **4** | - | - | 2 | **2** |
| IGCC11x | CC | CO-CURRICULAR COURSES | Compulsory | - | - | 2 | - | - | **2** | - | - | 1 | **1** |
| TOTAL | | | | 13 | 1 | 12 | 4 | 14 | **44** | 13 | 1 | 8 | **22** |

## Semester 4

| Course Code | Broad Catg. | Course Name | Course Choice | Teaching Scheme | | | | | | Credit Assigned | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | CR | | Lab | | SL | TE | L | T | P/ D | TC |
| | | | | L | T | P | D | | | | | | |
| MEBS241 | BS | Finite Element Analysis | Compulsory | 2 | - | 2 | - | 2 | **6** | 2 | - | 1 | **3** |
| MEPC241 | PC | Fluid Mechanics | Compulsory | 3 | - | 2 | - | 3 | **8** | 3 | - | 1 | **4** |
| MEPC242 | PC | Kinematics & Controls | Compulsory | 3 | - | 2 | - | 3 | **8** | 3 | - | 1 | **4** |
| MEPC243 | PC | Mechanical Measurement and Control | Compulsory | 3 | - | - | - | 3 | **6** | 3 | - | - | **3** |
| IGOE24x | OE | Open Elective-2 | Choice Based* | 2 | - | - | - | 2 | **4** | 2 | - | - | **2** |
| IGEM241 | EM | Design Thinking | Compulsory | - | - | 2 | 2 | - | **4** | - | - | 2 | **2** |
| MEVS241 | VS | AI Tools | Compulsory | - | - | 2 | 2 | - | **4** | - | - | 2 | **2** |
| IGVS241 | VS | Engineering Fundamentals and Technical Skills | Compulsory | - | - | 2 | - | - | **2** | - | - | 1 | **1** |
| MEPR241 | PR | Mini Project 1 | Compulsory | - | - | 2 | - | - | **2** | - | - | 1 | **1** |
| TOTAL | | | | 13 | - | 14 | 4 | 13 | **44** | 13 | - | 9 | **22** |

## 3.7 Program Examination Scheme

### Semester 3

| Course Code | Category | Course Name | Course Choice | Evaluation Scheme ( Marks ) | | | | | | | | | | Evaluation Scheme ( % ) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | | | | | LAB | | | TH+ LAB GT | Theory | | | | | LAB | | |
| | | | | IA1 | IA2 | FA | ESE | Tot | ESE Hrs | CIE | ESE | Tot | | IA1 | IA2 | FA | ESE | Total | CIE | ESE | Total |
| MEBS231 | BS | Engineering Mathematics - III | Compulsory | 15 | 15 | 10 | 60 | **100** | 2.5 | 25 | - | 25 | **125** | 15 | 15 | 10 | 60 | **100** | - | - | **-** |
| MEPC231 | PC | Strength of Materials | Compulsory | 15 | 15 | 10 | 60 | **100** | 2.5 | 25 | 25 | 50 | **150** | 15 | 15 | 10 | 60 | **100** | 50 | 50 | **100** |
| MEPC232 | PC | Materials and Manufacturing Technology | Compulsory | 15 | 15 | 10 | 60 | **100** | 2.5 | 25 | 25 | 50 | **150** | 15 | 15 | 10 | 60 | **100** | 50 | 50 | **100** |
| MEPC233 | PC | Thermodynamics | Compulsory | 15 | 15 | 10 | 60 | **100** | 2.5 | - | - | - | **100** | 15 | 15 | 10 | 60 | **100** | 50 | 50 | **100** |
| IGOE23x | OE | Open Elective | Choice – Based | 15 | 15 | 10 | 60 | **100** | 2.5 | - | - | - | **100** | 15 | 15 | 10 | 60 | **100** | - | - | **-** |
| MEVS231 | VS | CAD Modelling and Working Drawing Lab | Compulsory | - | - | - | - | **-** | - | 50 | 25 | 75 | **75** | - | - | - | - | **-** | 50 | 50 | **100** |
| IGAE231 | AE | Comprehensive Soft Skills and Professional Development | Compulsory | - | - | - | - | **-** | - | 25 | - | 25 | **25** | - | - | - | - | **-** | 100 | - | **100** |
| IGEM231 | EM | Entrepreneurship and Business Model Development | Compulsory | - | - | - | - | **-** | - | 50 | - | 50 | **50** | - | - | - | - | **-** | 100 | - | **100** |
| IGCC11x | CC | CO-CURRICULAR COURSES | Choice – Based | - | - | - | - | **-** | - | 25 | - | 25 | **25** | - | - | - | - | **-** | 100 | - | **100** |
| **TOTAL** | | | | **75** | **75** | **50** | **300** | **500** | | **225** | **75** | **300** | **800** | | | | | | | | |

### Semester 4

| Course Code | Category | Course Name | Course Choice | Evaluation Scheme ( Marks ) | | | | | | | | | | Evaluation Scheme ( % ) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | | | | | LAB | | | TH+ LAB GT | Theory | | | | | LAB | | |
| | | | | IA1 | IA2 | FA | ESE | Tot | ESE Hrs | CIE | ESE | Tot | | IA1 | IA2 | FA | ESE | Total | CIE | ESE | Total |
| MEBS241 | BS | Finite Element Analysis | Compulsory | 15 | 15 | 10 | 60 | **100** | 2.5 | 25 | - | **25** | **125** | 15 | 15 | 10 | 60 | **100** | 100 | - | **100** |
| MEPC241 | PC | Fluid Mechanics | Compulsory | 15 | 15 | 10 | 60 | **100** | 2.5 | 25 | 25 | **50** | **150** | 15 | 15 | 10 | 60 | **100** | 50 | 50 | **100** |
| MEPC242 | PC | Kinematics & Controls | Compulsory | 15 | 15 | 10 | 60 | **100** | 2.5 | 25 | 25 | **50** | **150** | 15 | 15 | 10 | 60 | **100** | 50 | 50 | **100** |
| MEPC243 | PC | Mechanical Measurement and Control | Compulsory | 15 | 15 | 10 | 60 | **100** | 2.5 | - | - | **-** | **100** | 15 | 15 | 10 | 60 | **100** | - | - | **-** |
| IGOE24x | OE | Open Elective | Choice-Based | 15 | 15 | 10 | 60 | **100** | 2.5 | - | - | **-** | **100** | 15 | 15 | 10 | 60 | **100** | - | - | **-** |
| IGEM241 | EM | Design Thinking | Compulsory | - | - | - | - | **-** | - | 50 | - | **50** | **50** | - | - | - | - | **-** | 100 | - | **100** |
| MEVS241 | VS | AI Tools | Compulsory | - | - | - | - | **-** | - | 25 | 25 | **50** | **50** | - | - | - | - | **-** | 50 | 50 | **100** |
| IGVS241 | VS | Engineering Fundamentals and Technical Skills | Compulsory | - | - | - | - | **-** | - | 25 | - | **25** | **25** | - | - | - | - | **-** | 100 | - | **100** |
| MEPR241 | PR | Mini Project 1 | Compulsory | - | - | - | - | **-** | - | 25 | 25 | **50** | **50** | - | - | - | - | **-** | 50 | 50 | **100** |
| **Total** | | | | **75** | **75** | **50** | **300** | **500** | | **200** | **100** | **300** | **800** | | | | | | | | |

## 3.8 Framework for Assessment and Evaluation

At SIGCE, alignment with NEP 2020 and targeting Outcome based education, assessment instruments and methods go beyond traditional written examination.

Assessment instruments and methods and evaluation mechanism should be multi-dimensional and should measure leanings of students through various ways as all students may not demonstrate their learning if only limited instruments and methods are used. Faculty members are encouraged to use various combination of Instruments, Methods and Evaluation and just not rely on traditional tools.

Following section list some "suggested" Assessment instruments, methods and mechanism. However, teachers are encouraged to be creative in using different assessment instruments and methods to evaluate learners.

### Assessment Instruments

These are the tools and techniques used for assessment. Following is the indicative list of Assessment Instruments. However, teachers are encouraged to be creative in using different assessment instruments to evaluate learners

| SN | ASSESSMENT INSTRUMENTS | Description |
|---|---|---|
| 1 | Paper – Pen/Pencil | Students are assessed through written examinations, tests, assignments, numerical problems, or analytical exercises. It evaluates conceptual understanding, problem-solving ability, application of knowledge, and written communication skills |
| 2 | Quiz | Short, focused assessments conducted in oral, written, or digital mode to evaluate understanding of specific concepts and topics. Quizzes provide timely feedback and support continuous monitoring of student learning. |
| 3 | Case Studies | Students analyse real-world or simulated situations to identify problems, evaluate alternatives, and propose justified solutions. It assesses analytical thinking, decision-making, application of interdisciplinary knowledge, and professional judgement |
| 4 | Presentation | Students communicate technical, conceptual, or project-based content through structured oral and visual presentations. It evaluates subject understanding, communication skills, logical organisation, confidence, and ability to respond to questions. |
| 5 | Attendance | Student participation is assessed based on regularity, punctuality, and consistent engagement in scheduled academic activities. It reflects continuity in the learning process; however, its weightage should be governed by institutional academic regulations. |
| 6 | Portfolio / e-Portfolio | A systematic collection of student work demonstrating learning progress, achievements, competencies, and reflections over a |

| | | |
|---|---|---|
| | | defined period. It enables longitudinal assessment of knowledge, skills, creativity, and continuous improvement. |
| **7** | Teachers Observation | Faculty systematically observe student performance, participation, practical skills, teamwork, professional behaviour, and learning engagement. Assessment should be based on predefined criteria, checklists, rating scales, or rubrics to ensure objectivity. |
| **8** | e-Parikshak | A technology-enabled assessment instrument used for conducting, evaluating, and analysing student performance through digital platforms for programing (coding) subjects. |
| **9** | Mini Project | Students undertake a limited-scope project to apply theoretical knowledge to a defined engineering or interdisciplinary problem. It assesses problem identification, design thinking, technical implementation, teamwork, documentation, and presentation skills. |
| **10** | Major Project | Students undertake a comprehensive project involving problem formulation, design, development, experimentation, analysis, and validation. It assesses integration of disciplinary knowledge, innovation, project management, teamwork, ethics, and professional competence. |
| **11** | Field Project | Students engage with real-world environments, industries, communities, or field settings to investigate and address practical problems. It evaluates experiential learning, observation, data collection, contextual analysis, stakeholder interaction, and solution development. |
| **12** | Dissertation / Report | Students prepare a structured academic or technical document presenting objectives, methodology, analysis, findings, conclusions, and recommendations. It assesses depth of study, research ability, technical writing, critical analysis, and adherence to academic integrity. |
| **13** | Oral Examination | Students respond verbally to questions related to concepts, experiments, projects, design work, or practical applications. It evaluates depth of understanding, clarity of thought, technical articulation, reasoning ability, and ability to defend decisions. |
| **14** | Group Discussion | Students collaboratively discuss a given technical, social, ethical, or contemporary topic within a structured setting. It assesses communication, teamwork, listening skills, critical thinking, leadership, reasoning, and respect for diverse perspectives. |
| **15** | Role Play | Students enact assigned roles in simulated professional, technical, managerial, or societal situations to demonstrate applied |

| | | |
|---|---|---|
| | | understanding. It evaluates communication, decision-making, empathy, teamwork, ethical reasoning, and response to real-world scenarios. |

## Assessment Methods

Assessment Methods are methods which are used for execution and evaluation of the assessment.

| SN | ASSESSMENT METHODS / MODE | DESCRIPTION |
|---|---|---|
| 1 | Supervised In-Class Mode | Assessment is conducted physically during scheduled academic time under faculty or authorised supervision. |
| 2 | Open book Mode | Students are permitted to consult specified books, notes, standards, or approved resources during the assessment. Tasks should emphasise application, analysis, synthesis, and judgement rather than direct recall. |
| 3 | Closed-Book Mode | Students complete the assessment without access to external learning resources, except specifically permitted materials. This mode is generally used to assess retained understanding, procedural fluency, and independent application. |
| 4 | Online Assessment | Assessment is conducted through an approved digital platform under defined access, duration, submission, and authentication conditions. It may be synchronous or asynchronous and supervised or unsupervised. |
| 5 | Take home Test | Students complete an assessment outside scheduled classroom conditions within a specified submission period. Permitted resources, collaboration rules, originality requirements, and academic integrity expectations are clearly defined |
| 6 | In Class Assignment | Students complete a defined assignment during scheduled class time under specified conditions and with stated levels of faculty guidance. The mode enables immediate application of concepts and controlled completion of learning tasks. |
| 7 | Field Based Mode | Assessment is conducted in authentic environments such as industries, communities, laboratories, sites, or field locations. Students generate evidence through observation, investigation, data collection, interaction, or practical engagement. |

| | | |
|---|---|---|
| 8 | Peer Assessment | Students evaluate the work or performance of their peers using faculty-approved criteria, checklists, rating scales, or rubrics. Peer judgements may be used for formative feedback or controlled scoring, with appropriate faculty moderation to ensure fairness and consistency |
| 9 | Self-Assessment | Students evaluate their own learning, performance, or work against predefined criteria, expected outcomes, checklists, or rubrics. The process is used to identify strengths, gaps, learning needs, and improvement actions, with faculty validation where required. |

## Evaluation Mechanism

Evaluation mechanism define "How the performance of the learners is Judged, scored or interpreted"

| | EVALUATION MECHANISM | DESCRIPTION |
|---|---|---|
| 1 | Answer Key-Based Evaluation | Student responses are evaluated against predetermined correct answers or acceptable response options. It is most appropriate for objective based assessment instruments |
| 2 | Model Answer / Model Solution-Based Evaluation | Responses are compared with an approved model answer or solution indicating expected content, methodology, steps, and outcomes. Marks are awarded according to the extent and quality of demonstrated achievement |
| 3 | Rubric-Based Evaluation | Performance is judged against predefined criteria with clearly described levels of achievement. Scores or grades are assigned by matching demonstrated performance with descriptors for each criterion |
| 4 | Checklist-Based Evaluation | Performance is evaluated by recording the presence, absence, or completion of predefined behaviours, steps, features, or requirements. It is particularly suitable for practical tasks, procedures, and compliance-oriented performance. |
| 5 | Milestone-Based Evaluation | Performance is evaluated at predefined stages of a project, dissertation, design activity, or extended task. Each milestone is judged against specified deliverables, progress expectations, and achievement criteria. |

# *Chapter 4:*
# Indicative List of Courses

## 4.1 BSE Courses

| SN | LIST OF SUGGESTED OPEN ELECTIVES | COURSE CODE | Semester |
|---|---|---|---|
| 1 | Applied Mathematics-III | MEBS231 | III |
| 5 | FEA | MEBS241 | IV |

## 4.2 Humanities Courses

| SN | LIST OF SUGGESTED OPEN ELECTIVES | COURSE CODE | Semester |
|---|---|---|---|
| 1 | Entrepreneurship and Business Model development | IGEM231 | III |
| 2 | Design Thinking | IGHS241 | III |

## 4.3 Co-Curricular Courses

| SN | LIST OF SUGGESTED Co-curricular courses | COURSE CODE | Semester |
|---|---|---|---|
| 1 | Theater Drama | IGCC231 | III |
| 2 | Social Science and Community Services | IGCC232 | III |
| 3 | Analytical and Aptitude Skills | IGCC233 | III |

*Link for Co-curricular Course syllabus*

## 4.4 Open Elective

| SN | LIST OF SUGGESTED OPEN ELECTIVES | COURSE CODE | Semester |
|---|---|---|---|
| 1 | Financial Management | IGOE231 | III |
| 2 | Financial Literacy | IGOE232 | III |
| 3 | Fin Tech | IGOE233 | III |
| 4 | Disaster Management and Mitigation Measures | IGOE234 | III |
| 5 | Leadership Management | IGOE241 | IV |
| 6 | Waste Management | IGOE242 | IV |
| 7 | Principles and Practices of Management | IGOE243 | IV |
| 8 | Cyber and Digital safety | IGOE244 | IV |

Link for Open Elective Course *syllabus*

# *Chapter 5*
# Mapping and Justification

## 5.1 Indicative Mapping of Courses to PO

All the courses are mapped to PO by taking average of CO-PO mapping from individual courses. These values are just indicative, and individual faculty can change it based on the depth of coverage and pedagogical tools used which will be reflected in the lesson plans.
Mapping of 3 signifies “High Correlation”, Mapping of 2 signifies “Medium Correlation” and mapping of 1 signifies “Low Correlation”

### Semester III

| Course Code | Course Name | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEBS231 | Engineering Mathematics - III | 3 | 3 | 3 | - | - | - | - | - | - | - | - | 3 | 3 |
| MEPC231 | Strength of Materials | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 | 2 |
| MEPC232 | Materials and Manufacturing Technology | 3 | 3 | 2 | - | 2 | 2 | - | - | - | - | 2 | 2 | 3 |
| MEPC233 | Thermodynamics | 3 | 3 | - | - | 2 | 2 | - | - | - | - | - | 3 | 3 |
| MEVS231 | CAD Modelling and Working Drawing Lab | 2 | 2 | 3 | - | 3 | - | - | - | - | - | - | 3 | 3 |
| IGAE231 | Comprehensive Soft Skills and Professional Development | 2 | 2 | 3 | 2 | 2 | 2 | - | 2 | 3 | 3 | 2 | 3 | 2 |
| IGEM231 | Entrepreneurship and Business Model Development | 2 | 2 | 3 | - | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | - |

### Semester IV

| Course Code | Course Name | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEBS241 | Finite Element Analysis | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | 2 | 3 | 3 |
| MEPC241 | Fluid Mechanics | 3 | 3 | - | - | 2 | 2 | - | - | - | - | - | 3 | 3 |
| MEPC242 | Kinematics & Controls | 3 | 3 | 3 | - | 2 | - | - | - | - | - | - | 3 | 2 |
| MEPC243 | Mechanical Measurement and Control | 3 | 3 | 2 | - | 2 | - | - | - | - | - | - | 3 | 3 |
| IGEM241 | Design Thinking | 2 | 3 | 2 | 2 | 2 | - | - | 2 | 2 | - | - | 3 | 2 |
| MEVS241 | AI Tools | 3 | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 3 | 3 |
| IGVS241 | Engineering Fundamentals and Technical Skills | 2 | 2 | 2 | 2 | 2 | 2 | - | 2 | 3 | 3 | 2 | 2 | 2 |
| MEPR241 | Mini Project 1 | 3 | 3 | 2 | 2 | 2 | 3 | - | - | - | - | - | 2 | 2 |

## 5.2 Indicative Mapping of Courses to WK

### Semester III

| Course Code | Course Name | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|---|
| MEBS231 | Engineering Mathematics - III | | ✓ | ✓ | ✓ | | | | | |
| MEPC231 | Strength of Materials | | ✓ | ✓ | ✓ | | ✓ | | | |
| MEPC232 | Materials and Manufacturing Technology | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| MEPC233 | Thermodynamics | ✓ | ✓ | ✓ | ✓ | ✓ | | | | |
| MEVS231 | CAD Modelling and Working Drawing Lab | | | ✓ | ✓ | ✓ | ✓ | | | |
| IGAE231 | Comprehensive Soft Skills and Professional Development | ✓ | | | | | ✓ | ✓ | ✓ | |
| IGEM231 | Entrepreneurship and Business Model development | | ✓ | | ✓ | ✓ | ✓ | | | |

### Semester IV

| Course Code | Course Name | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|---|
| MEBS241 | Finite Element Analysis | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| MEPC241 | Fluid Mechanics | ✓ | ✓ | ✓ | ✓ | | ✓ | | | |
| MEPC242 | Kinematics & Controls | | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| MEPC243 | Mechanical Measurement and Control | ✓ | ✓ | ✓ | | ✓ | ✓ | | | |
| IGEM241 | Design Thinking | | ✓ | | | ✓ | | ✓ | ✓ | |
| IGVS241 | Engineering Fundamentals and Technical Skills | ✓ | ✓ | ✓ | | ✓ | ✓ | | | |
| MEVS242 | AI Tools | ✓ | | ✓ | ✓ | | ✓ | | | ✓ |
| MEPR241 | Mini Project 1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |

## 5.1 Mapping Justification

| Courses | Justification w.r.t WKs |
|---|---|
| **PCC-1: Elements of Mechanical Engineering** | **WK1:** Introduces scientific principles governing mechanical systems and energy conversion.<br>**WK2:** Involves engineering calculations and quantitative analysis.<br>**WK3:** Provides fundamental concepts of mechanics, materials and manufacturing. |
| **PCC-2: Strength of Materials** | **WK2:** Uses mathematical analysis for stress, strain, torsion and deflection calculations.<br>**WK3:** Develops theoretical foundations of solid mechanics.<br>**WK4:** Provides specialist knowledge in structural analysis and component strength evaluation.<br>**WK6:** Applies engineering practices for design and analysis of machine and structural elements. |
| **PCC-3: Materials and Manufacturing Technology** | **WK1:** Explains material behavior based on material science principles.<br>**WK3:** Develops fundamentals of engineering materials and manufacturing processes.<br>**WK4:** Provides specialist knowledge of casting, welding, machining, additive manufacturing and advanced materials.<br>**WK5:** Covers sustainable manufacturing, efficient material utilization and resource conservation.<br>**WK6:** Introduces industrial manufacturing technologies and engineering practices.<br>**WK8:** Exposes students to Industry 4.0, automation and emerging manufacturing technologies. |
| **PCC-4: Thermodynamics** | **WK1:** Applies laws of physics and thermal sciences to engineering systems. **WK2:** Uses mathematical modelling and thermodynamic relations for engineering analysis.<br>**WK3:** Develops fundamentals of energy interactions, heat and work transfer.<br>**WK4:** Provides specialist knowledge of thermodynamic systems, power cycles and steam processes.<br>**WK5:** Supports efficient energy utilization and sustainable thermal system operation. |
| **PCC-5: Fluid Mechanics** | **WK1:** Applies scientific principles governing fluid behavior and flow phenomena.<br>**WK2:** Uses mathematical equations and analytical methods for fluid flow analysis.<br>**WK3:** Develops theoretical foundations of fluid mechanics.<br>**WK4:** Provides specialist knowledge of pipe flow, boundary layers and hydraulic systems.<br>**WK6:** Introduces engineering technologies and practices used in fluid engineering applications. |
| **PCC-6: Kinematics & Controls** | **WK2:** Uses analytical and graphical techniques for motion analysis. |

| | |
|---|---|
| | **WK3:** Develops engineering fundamentals of mechanisms and machine motion.<br>**WK4:** Provides specialist knowledge of gears, cams, governors and gyroscopic systems.<br>**WK5:** Supports efficient machine design and motion transmission systems.<br>**WK6:** Applies engineering technologies used in machine design and control applications. |
| **PCC-7: Mechanical Measurement and Control** | **WK1:** Applies physical principles related to measurement of engineering parameters.<br>**WK2:** Uses mathematical modelling, transfer functions and response analysis.<br>**WK3:** Develops fundamentals of instrumentation and control engineering.<br>**WK5**: Applied in improving resource utilization, minimizing energy losses and supporting sustainable operation of engineering systems through effective measurement and control.<br>**WK6**: Introduces practical instrumentation technologies, calibration methods and digital control systems. |

# Chapter 6: Subject- Engineering Mathematics III(Sem III)

| Overview | | | |
|---|---|---|---|
| **Course Code:** | MEBS231 | Course Category: | Basic Sciences |
| **Sem:** | III | Syllabus & Version: | SIGCE-R25-Y2 |

## 6.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | | Team work/ Self learning | Total |
|---|---|---|---|---|---|---|
| | L | T | P | D | SL | |
| **Hours/Week** | 2 | 1 | - | - | 3 | 6 |
| **Hours/Sem** | 30 | 15 | - | - | 45 | 90 |
| **Credits** | 2 | 1 | - | - | - | 3 |

** L = Lectures; T= Tutorials; P = Practical; D = Demo; SL = Self Learning*

## 6.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| Theory | 40% | 60% | 100% | 2 |
| Tutorial & Term Work | 100% | 0% | 100% | 1 |

## 6.3 Course Objectives

| **Pre-requisite Course Codes, if any.** | Knowledge of Applied Mathematics I and II |
|---|---|

**Course Overview:**

This course provides a mathematical foundation for solving Mechanical Engineering problems using analytical and computational techniques. It covers transform methods, Fourier analysis, matrix theory, vector calculus, and numerical methods applied in areas such as heat transfer, vibrations, and fluid mechanics, with emphasis on problem-solving and engineering applications.

**Course Objective:**

1. To understand Laplace Transform techniques and their applications in solving engineering problems.
2. To apply Inverse Laplace Transform methods for solving differential equations and related problems.
3. To analyze periodic functions using Fourier Series and related mathematical tools.
4. To develop understanding of matrices, eigenvalues, eigenvectors, and matrix transformations.
5. To apply concepts of Vector Calculus in engineering fields such as fluid flow and force analysis.
6. To solve partial differential equations using analytical and numerical methods relevant to Mechanical Engineering applications.

## 6.4 Course Outcomes

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **MEBS231.1** | Use Laplace Transform methods for solving initial and boundary value problems. | Apply |
| **MEBS231.2** | Apply Inverse Laplace Transform technique to solve problems related to vibration analysis, fluid mechanics etc. | Apply |
| **MEBS231.3** | Analyze periodic functions using Fourier Series and apply them to Vibration and Heat Conduction Problems. | Analyze |
| **MEBS231.4** | Analyze matrices using eigenvalues, eigenvectors, diagonalization, and matrix transformations for vibration and stability analysis. | Analyze |
| **MEBS231.5** | Apply vector calculus concepts such as gradient, divergence, curl, and line integrals to analyze fluid flow, heat transfer, and force fields. | Apply |
| **MEBS231.6** | Solve partial differential equations using analytical and numerical methods for Mechanical Engineering problems. | Create |

## 6.5 Modules / Syllabus Content

### Theory Component

| Module | Unit | Topic | CO | BL | Reference | Hrs |
|---|---|---|---|---|---|---|
| 1 | **Title** | **Laplace Transform** | **CO1** | **BL** | **T, R** | **4** |
| | 1.1 | Definition of Laplace transform, Condition of Existence of Laplace transform. Laplace Transform (L) of standard functions like $e^{at}$, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n$, $n \geq 0$. | | | | |
| | 1.2 | Properties of Laplace Transform: Linearity, First Shifting Theorem, Change of Scale, Multiplication by t, Division by t | | | | |
| | 1.3 | Laplace Transform of derivatives and integrals (Properties without proof), Evaluation of real improper integrals by using Laplace Transformation | | | | |
| 2 | **Title** | **Inverse Laplace Transform** | **CO2** | **BL** | **T, R** | **4** |
| | 2.1 | Definition of Inverse Laplace Transform, Linearity property, Inverse Laplace Transform of standard functions, Inverse Laplace transform using derivatives. | | | | |
| | 2.2 | Partial fractions method to find Inverse Laplace transform | | | | |
| | 2.3 | Inverse Laplace transform using Convolution theorem (without proof) | | | | |
| | 2.4 | Application of ILT in Vibration Analysis and Heat Transfer | | | | |
| 3 | **Title** | **Fourier Series** | **CO3** | **BL** | **T, R** | **4** |
| | 3.1 | Definition of Fourier series and Parseval's Identity (without proof), Dirichlet's conditions, Fourier series of periodic functions with period 2π and 2l. | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 3.2 | Fourier series of even and odd functions | | | | |
| | 3.3 | Half range Fourier Sine and Cosine Series | | | | |
| 4 | **Title** | **Linear Algebra (Theory of Matrices)** | **CO4** | **BL** | **T, R** | **4** |
| | 4.1 | Characteristic Equation, Eigenvalues and Eigenvectors, and properties (without proof) | | | | |
| | 4.2 | Cayley-Hamilton Theorem (without proof), verification and reduction of higher degree polynomials | | | | |
| | 4.3 | Similarity of matrices, diagonalizable and non-diagonalizable matrices | | | | |
| | 4.4 | Application in Vibration Analysis, Truss and Mechanical system | | | | |
| 5 | **Title** | **Vector Calculus** | **CO5** | **BL** | **T, R** | **5** |
| | 5.1 | Vector Differentiation: Basics of Gradient, divergence and Curl (without proof) | | | | |
| | 5.2 | Properties of Vector field: Solenoidal and Irrotational (conservative) vector fields | | | | |
| | 5.3 | Vector Integral: Line and Surface Integrals, Green's theorem and Stoke's theorem (without proof) in a plane. | | | | |
| | 5.4 | Application of Vector Calculus in Fluid mechanics and Heat Transfer | | | | |
| 6 | **Title** | **Numerical methods for Partial Differential Equation** | **CO6** | **BL** | **T, R** | **5** |
| | 6.1 | Introduction of Partial Differential equations, method of separation of variables, Vibrations of string, Analytical method for one dimensional heat equations. (Only problems) | | | | |
| | 6.2 | Crank Nicholson method | | | | |
| | 6.3 | Bender Schmidt method | | | | |
| | 6.4 | Application in Mechanical Engineering focusing on approximating Fluid flow and Heat Transfer | | | | |
| Self Study | **SS.1** | Periodic functions, Heaviside's Unit Step function, Dirac Delta Function, Special functions (Error and Bessel) | | | | |
| | **SS.2** | Applications to solve initial and boundary value problems involving ordinary differential equations. | | | | |
| | **SS.3** | Orthogonal and orthonormal set of functions, Complex form of Fourier Series, Fourier Transforms | | | | |
| | **SS.4** | Derogatory and non-derogatory matrices, Functions of Square Matrix, Linear Transformations, Quadratic forms. | | | | |
| | **SS.5** | Gauss Divergence theorem and Application of Vector | | | | |
| | **SS.6** | Analytical method for one dimensional wave equations, Analytical methods of solving two and three dimensional problems. | | | | |

## Tutorial

| SN | Topics to be covered | CO | Hrs |
|---|---|---|---|
| 1 | Problems based on different properties of Laplace Transforms | CO1 | 1 |
| 2 | Solving problem on Laplace Transform of derivatives and integrals | CO1 | 1 |

| | | | |
|---|---|---|---|
| 3 | Problems based on Inverse Laplace Transform using Partial Fractions and Convolution theorem | CO2 | 2 |
| 4 | Apply inverse Laplace transforms to solve problems in vibration analysis and Heat Transfer | CO2 | 1 |
| 5 | Determination of Fourier Expansion of periodic functions with period 2π and 2l | CO3 | 1 |
| 6 | To obtain Fourier Expansion of odd and even functions also half range sine and cosine series | CO3 | 1 |
| 7 | Numerical on Eigen Values and Eigen Vectors along with its properties | CO4 | 1 |
| 8 | Application of Cayley Hamilton theorem and Diagonalization | CO4 | 2 |
| 9 | Problems on Gradient, Curl and Divergent with application of Vector fields in Fluid Mechanics problems | CO5 | 1 |
| 10 | Problems on Line and Surface Integrals with application of Green's and Stokes theorem | CO5 | 1 |
| 11 | To Solve one dimensional Heat equation by analytical method and problems on Vibration of strings | CO6 | 1 |
| 12 | Numerical on Bender Schmidt method and Crank Nicholson method | CO6 | 2 |

## 6.6 Assessment Methodologies and Tools

### Theory Component

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | IA-1 | 1 | CAT | Paper- Pen, Pencil | Class Room Test | 15 | 15 | 1 Hrs |
| **2** | IA-2 | 1 | CAT | Paper- Pen, Pencil | Class Room Test | 15 | 15 | 1 Hrs |
| **3** | FA | 2 | CAT | #MCQ/Quiz | Online Assessment | 10 | 10 | 1 Hrs |
| **4** | ESE | 1 | ESE | Paper- Pen, Pencil | In Class-End Sem Exam | 60 | 60 | 2.5 Hrs |

**IA = Internal Assessment; FA = Formative Assessment;*

*IA-1 will be conducted after completion of 1-3 Modules; IA-2 will be conducted after completion of 4-6 modules*

*#MCQ/Quiz based on Modules & GATE based Question.*

### Term Work

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | Tutorial | 6 | CAT | Tutorial | Journal (Rubrics Based) | 60 (Converts to 10) | 40 | 1 Hrs |
| **2** | Mini Project | 1 | CAT | Mini Project Presentation | Rubrics based | 10 | 40 | 0.5 Hrs |
| **3** | Attendance | - | CAT | Attendance | Record and Rubrics | 5 | 20 | - |

## 6.7 Suggested CO-PO/PSO Correlation Matrix

*CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)*

| CO# | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MEBS231.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | 2 | - |
| **MEBS231.2** | 3 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 |
| **MEBS231.3** | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 | 2 |
| **MEBS231.4** | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 | 3 |
| **MEBS231.5** | 2 | 3 | - | - | - | - | - | - | - | - | - | 3 | 3 |
| **MEBS231.6** | 2 | 3 | - | - | - | - | - | - | - | - | - | 3 | 3 |

## 6.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| **1** | WK2 | Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. | The course extensively uses advanced mathematics, numerical analysis, matrix methods, Fourier Series, Laplace Transforms, Vector Calculus, and PDE solution techniques for detailed analysis and mathematical modeling of mechanical engineering systems. |
| **2** | WK3 | A systematic, theory-based formulation of fundamentals required in the engineering discipline. | Provides the mathematical foundations required for engineering disciplines through applications in vibration analysis, truss systems, fluid flow, heat transfer, and dynamic system modeling. |
| **3** | WK4 | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline. | Develops specialist analytical tools widely used in mechanical engineering practice, including transform techniques, eigenvalue problems, numerical methods, and vector field analysis for solving complex engineering problems. |

## 6.9 Resources

### Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | Engineering Mathematics-III (NEP) | 1st | G.V. Kumbhojkar | P. Jamnadas LLP | 2025 |
| **T2** | Engineering mathematics | 44th | Dr. B.S Grewal | Khanna | 2017 |
| **T3** | Text Book of Matrices | 6th | Shanti Narayan & P.K. Mittal | S. Chand Publication | 2010 |
| **T4** | Engineering Mathematics-IV | 1st | G.V. Kumbhojkar | P. Jamnadas LLP | 2014 |

### Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | Advance Engg. Mathematics | 4th | R.K. Jain & S.R.K Iyengar | Narosha | 2014 |

| | | | | | |
|---|---|---|---|---|---|
| **R2** | Advance Engg. Mathematics | 10th | Erwin Kreyszig | Wiley | 2011 |
| **R3** | Higher Engineering Mathematics | 2nd | B.V. Ramana | McGraw Hill | 2017 |
| **R4** | Laplace Transforms | Revised | Murray R. Spiegel | Schaum's Outline Series | 1965 |

## Online References

| SN | Title | Description |
|---|---|---|
| **O1** | NPTEL Engineering Mathematics Course | Complete course covering Laplace Transforms, Fourier Series, Linear Algebra, Vector Calculus, and Numerical Methods |
| **O2** | YouTube Fourier Series Lecture | Video lecture explaining Fourier Series concepts, periodic functions, and graphical interpretation |
| **O3** | MATLAB Software | Software tool used for mathematical computation, numerical analysis, matrix operations, and engineering problem-solving |
| **O4** | Research Paper on Fourier Series | Research paper discussing mathematical and graphical models of Fourier Series and its applications in electric current and oscillations |

# Chapter 7: Subject- Strength of Materials (Sem III)

| Overview | | | |
|---|---|---|---|
| **Course code:** | MEPC231 | Course Category: | Program Core Course |
| **Sem:** | III | Syllabus & Version: | SIGCE-R25-Y2 |

## 7.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | Team work/ Self learning | Total |
|---|---|---|---|---|---|
| | L | T | P | SL | |
| **Hours/Week** | 3 | - | 2 | 3 | 8 |
| **Hours/Sem** | 45 | - | 30 | 45 | 120 |
| **Credits** | 3 | - | 1 | - | 4 |

## 7.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | 40% | 60% | 100% | 3 |
| **Labs** | 50% | 50% | 100% | 1 |

## 7.3 Course Objectives

| | |
|---|---|
| **Pre-requisite Course Codes, if any.** | Engineering Mechanics, Engineering Mathematics, Basic Physics, concepts of equilibrium, centroid and moment of inertia. |

**Course Overview:**

This course introduces the fundamental concepts of stresses, strains, deformation and strength behavior of engineering materials under different loading conditions. The course covers analytical methods for beams, shafts, columns and pressure vessels with emphasis on engineering applications, structural safety and mechanical component design.

**Course Objective:**

1. To understand stresses, strains and elastic behavior of engineering materials.
2. To analyze members subjected to axial, torsional and bending loads.
3. To evaluate shear force and bending moment in beams under different loading conditions.
4. To determine bending stresses, shear stresses and stresses in thin pressure vessels.
5. To compute slope and deflection in beams using analytical methods.
6. To evaluate stability and buckling behavior of columns and structural members.

## 7.4 Course Outcomes

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **MEPC231.1** | Analyse stresses, strains and principal stresses in structural members. | Analyse |
| **MEPC231.2** | Evaluate torsional stresses and strain energy in shafts subjected to loading. | Apply |
| **MEPC231.3** | Construct shear force and bending moment diagrams for beams. | Apply |
| **MEPC231.4** | Determine bending stresses, shear stresses and stresses in thin shells. | Analyse |
| **MEPC231.5** | Calculate slope and deflection of beams using analytical methods. | Apply |
| **MEPC231.6** | Evaluate crippling loads and buckling behaviour of columns. | Evaluate |

## 7.5 Modules / Syllabus Content

### Theory Component

| Module | Unit | Topic | CO | Blooms Level | Reference | Hrs |
|---|---|---|---|---|---|---|
| 1 | **Title** | **Stress, Strain and Material Behavior** | **CO1** | **BL** | **T, R** | **7** |
| | 1.1 | Concept of stress and strain, deformation in solids, Hooke's law, elastic constants and relations | | | | |
| | 1.2 | Stress-strain diagrams for ductile and brittle materials, factor of safety, working stress | | | | |
| | 1.3 | Thermal stresses and strains, volumetric strain, Poisson's ratio | | | | |
| | 1.4 | Principal stresses and strains, Mohr's circle | | | | |
| | 1.5 | Introduction to material failure theories | | | | |
| 2 | **Title** | **Torsion and Strain Energy** | **CO2** | **BL** | **T, R** | **7** |
| | 2.1 | Polar moment of inertia, torsion equation | | | | |
| | 2.2 | Torsion of solid and hollow shafts | | | | |
| | 2.3 | Power transmission through shafts | | | | |
| | 2.4 | Composite shafts and shaft couplings | | | | |
| | 2.5 | Strain energy due to axial, bending and torsional loads, impact loading | | | | |
| 3 | **Title** | **Shear Force and Bending Moment** | **CO3** | **BL** | **T, R** | **6** |
| | 3.1 | Types of beams, supports and loading | | | | |
| | 3.2 | Shear force and bending moment concepts and sign conventions | | | | |
| | 3.3 | SFD and BMD for cantilever and simply supported beams | | | | |
| | 3.4 | Beams subjected to UDL, UVL and couples | | | | |
| 4 | **Title** | **Bending Stresses and Thin Shells** | **CO4** | **BL** | **T, R** | **6** |
| | 4.1 | Theory of simple bending and bending equation | | | | |
| | 4.2 | Bending stress distribution and section modulus | | | | |
| | 4.3 | Shear stress distribution in beams | | | | |
| | 4.4 | Thin cylindrical and spherical shells subjected to internal pressure | | | | |
| 5 | **Title** | **Slope and Deflection of Beams** | **CO5** | **BL** | **T, R** | **6** |
| | 5.1 | Double integration method | | | | |
| | 5.2 | Macaulay's method | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 5.3 | Moment area method | | | | |
| | 5.4 | Maxwell's reciprocal theorem and applications | | | | |
| 6 | **Title** | **Columns and Stability** | **CO6** | **BL** | **T, R** | **7** |
| | 6.1 | Short and long columns, slenderness ratio | | | | |
| | 6.2 | Euler's column theory and assumptions | | | | |
| | 6.3 | End conditions and crippling load calculations | | | | |
| | 6.4 | Rankine formula and eccentric loading | | | | |
| Self - Study | **SS.1** | Failure analysis of machine shafts | | | | |
| | **SS.2** | Design applications of hollow shafts | | | | |
| | **SS.3** | SFD/BMD software simulation | | | | |
| | **SS.4** | Pressure vessel applications in industries | | | | |
| | **SS.5** | Beam deflection analysis using MATLAB | | | | |
| | **SS.6** | Buckling analysis of columns in structures | | | | |

### Laboratory Component

| SN | Title of the experiment | Hrs |
|---|---|---|
| 1 | Tensile test on mild steel specimen using UTM | 2 |
| 2 | Compression test on ductile and brittle materials | 2 |
| 3 | Torsion test on circular shaft | 4 |
| 4 | Verification of bending equation using beam setup | 4 |
| 5 | Determination of modulus of elasticity of beam | 2 |
| 6 | Deflection test on simply supported beam | 2 |
| 7 | Determination of shear centre for channel section | 4 |
| 8 | Buckling test on columns with different end conditions | 2 |
| 9 | Spring stiffness test on helical spring | 2 |
| 10 | Shear force and bending moment analysis on beam apparatus | 2 |
| 11 | Impact test on Izod/Charpy testing machine | 2 |
| 12 | Strain measurement using strain gauges | 2 |

## 7.6 Assessment Methodologies and Tools

### Theory Component

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | IA 1 | 1 | CAT | Paper- Pen, Pencil | Classroom Test | 15 | 15 | 1 Hrs |
| **2** | IA 2 | 1 | CAT | Paper- Pen, Pencil | Classroom Test | 15 | 15 | 1 Hrs |
| **3** | TA/FA | 1/2 | CAT | NPTEL Course / #MCQ/Quiz | Online Assessment | 10 | 10 | 60 Min |
| **4** | ESE | 1 | ESE | Paper- Pen, Pencil | In Class-End Sem Exam | 60 | 60 | 2.5 Hrs |

**IA = Internal Assessment; FA = Formative Assessment;*

*IA-1 will be conducted after completion of 1-3 Modules; IA-2 will be conducted after completion of 4-6 modules*
*#MCQ/Quiz based on Modules & GATE based Question.*

### Lab Component

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | Exp 1 – Exp 12 | 12 | CAT | Practical | Journal (Rubrics Based) | 20 | 40 | 2 Hrs |
| **2** | Class Participation | | CAT | Attendance | Record and Rubrics | 5 | 10 | Continuous |
| **3** | ESE | 1 | ESE | Oral and Practical | Rubrics Based | 25 | 50 | 2 Hrs |

## 7.7 Suggested CO-PO/PSO Correlation Matrix

*CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)*

| CO # | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MEPC231.1** | 3 | 2 | – | – | – | – | – | – | – | – | – | 3 | – |
| **MEPC231.2** | 3 | 3 | – | – | – | – | – | – | – | – | – | 3 | – |
| **MEPC231.3** | 3 | 3 | – | – | – | – | – | – | – | – | – | 3 | 2 |
| **MEPC231.4** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 2 |
| **MEPC231.5** | 3 | 3 | – | – | – | – | – | – | – | – | – | 3 | 2 |
| **MEPC231.6** | 3 | 3 | – | – | – | – | – | – | – | – | – | 3 | 2 |

## 7.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| **1** | WK2 | Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. | Used in stress-strain calculations, beam analysis, torsion equations, numerical problem solving and engineering computations. |
| **2** | WK3 | A systematic, theory-based formulation of fundamentals required in the engineering discipline. | Provides core mechanical engineering fundamentals related to stress analysis, bending, shear force, strain energy and structural behavior. |
| **3** | WK4 | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline. | Applied in design and analysis of machine elements, structural members and mechanical systems subjected to static and dynamic loading. |
| **4** | WK6 | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline. | Applied in laboratory testing, stress analysis methods and practical engineering applications involving beams, shafts and columns. |

## 7.9 Resources

### Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | Strength of Materials | 6th Edition | R.K. Rajput | S. Chand | 2019 |
| **T2** | Mechanics of Materials | 9th Edition | Gere & Goodno | Cengage | 2020 |
| **T3** | Strength of Materials | 5th Edition | S.S. Bhavikatti | Vikas Publication | 2018 |
| **T4** | Mechanics of Structures | 27th Edition | S.B. Junnarkar | Charotar | 2017 |
| **T5** | Strength of Materials | 2nd Edition | R. Subramanian | Oxford | 2016 |

### Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | Mechanics of Materials | 7th Edition | Beer & Johnston | McGraw Hill | 2018 |
| **R2** | Strength of Materials | 3rd Edition | Ryder | Macmillan | 2015 |
| **R3** | Introduction to Solid Mechanics | 1st Edition | Shames | Pearson | 2016 |
| **R4** | Schaum's Strength of Materials | 6th Edition | William Nash | McGraw Hill | 2017 |
| **R5** | Mechanics of Materials | 3rd Edition | Ferdinand Singer | Harper Collins | 2014 |

### Online Resources

| SN | Title | Description |
|---|---|---|
| **O1** | NPTEL Strength of Materials | Complete SOM course covering stress, strain, torsion and bending concepts |
| **O2** | NPTEL Mechanics of Materials | Beam analysis, shear force, bending moment and stress analysis |
| **O3** | SWAYAM SOM Course | Video lectures and tutorials on mechanics and strength of materials |
| **O4** | NPTEL Solid Mechanics | Elasticity, strain energy and advanced stress analysis concepts |
| **O5** | MIT Open Course Ware Mechanics of Materials | Advanced concepts in mechanics of materials and structural behavior |

# *Chapter 8 : Subject- Material & Manufacturing Technology (Sem III)*

| Overview | | | |
|---|---|---|---|
| **Course code:** | MEPC232 | Course Category: | Program Core |
| **Sem:** | III | Syllabus & Version: | SIGCE_R25_Y2 |

## 8.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | Team work/ Self learning | Total |
|---|---|---|---|---|---|
| | L | T | P | SL | |
| **Hours/Week** | 3 | - | 2 | 3 | 8 |
| **Hours/Sem** | 45 | - | 30 | 45 | 120 |
| **Credits** | 3 | - | 1 | - | 4 |

## 8.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | 40% | 60% | 100% | 3 |
| **Labs** | 50% | 50% | 100% | 1 |

## 8.3 Course Objectives

| **Pre-requisite Course Codes, if any.** | Basic Manufacturing Processes, Engineering Mechanics |
|---|---|

**Course Overview:**

This course provides fundamental and advanced knowledge of engineering materials and modern manufacturing processes used in mechanical engineering industries. Students will understand material properties, selection techniques, conventional and advanced manufacturing methods, machining, joining, automation, additive manufacturing, and sustainable manufacturing practices for industrial applications.

**Course Objective:**

1. Understand structure, properties, and behavior of engineering materials used in manufacturing industries.
2. Develop knowledge of ferrous, non-ferrous, composite, smart, and sustainable materials.
3. Understand conventional and advanced manufacturing processes used for product development.
4. Analyze machining, forming, joining, and additive manufacturing techniques.
5. Study automation, CNC, Industry 4.0, and modern manufacturing systems.
6. Apply material selection and manufacturing concepts for engineering applications and sustainable production.

## 8.4 Course Outcomes

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **MEPC231.1** | Analyse stresses, strains and principal stresses in structural members. | Understand |
| **MEPC231.2** | Evaluate torsional stresses and strain energy in shafts subjected to loading. | Analyze |
| **MEPC231.3** | Construct shear force and bending moment diagrams for beams. | Apply |
| **MEPC231.4** | Determine bending stresses, shear stresses and stresses in thin shells. | Understand |
| **MEPC231.5** | Calculate slope and deflection of beams using analytical methods. | Evaluate |
| **MEPC231.6** | Evaluate crippling loads and buckling behaviour of columns. | Analyze |

## 8.5 Modules / Syllabus Content

### Theory Component

| Module | Unit | Topic | CO | Blooms Level | Reference | Hrs |
|---|---|---|---|---|---|---|
| 1 | **Title** | **Engineering Materials Fundamentals** | **CO1** | **BL** | **T, R** | **6** |
| | 1.1 | Classification of engineering materials and applications | | | | |
| | 1.2 | Crystal structure, unit cell, crystal systems and imperfections | | | | |
| | 1.3 | Mechanical properties of materials and testing methods | | | | |
| | 1.4 | Fracture, fatigue and creep behavior of materials | | | | |
| | 1.5 | Engineering materials used in mechanical industries | | | | |
| 2 | **Title** | **Ferrous Materials and Heat Treatment** | **CO2** | **BL** | **T, R** | **7** |
| | 2.1 | Hot working, cold working and recrystallization | | | | |
| | 2.2 | Iron-Iron carbide equilibrium diagram | | | | |
| | 2.3 | Heat treatment processes: Annealing, normalizing, hardening and tempering | | | | |
| | 2.4 | Alloy steels, stainless steels and tool steels | | | | |
| | 2.5 | Surface hardening and corrosion prevention methods | | | | |
| 3 | **Title** | **Advanced Engineering Materials** | **CO3** | **BL** | **T, R** | **6** |
| | 3.1 | Composite materials and applications | | | | |
| | 3.2 | Engineering ceramics and polymers | | | | |
| | 3.3 | Smart materials and nano materials | | | | |
| | 3.4 | Biomaterials and sustainable materials | | | | |
| | 3.5 | Material selection for engineering applications | | | | |
| 4 | **Title** | **Casting and Forming Processes** | **CO4** | **BL** | **T, R** | **7** |
| | 4.1 | Pattern making, moulding sand and casting processes | | | | |
| | 4.2 | Special casting methods and casting defects | | | | |
| | 4.3 | Rolling, forging and extrusion processes | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 4.4 | Sheet metal operations and press working | | | | |
| | 4.5 | Powder metallurgy and polymer processing | | | | |
| 5 | **Title** | **Machining and Joining Processes** | **CO5** | **BL** | **T, R** | **7** |
| | 5.1 | Metal cutting theory and chip formation | | | | |
| | 5.2 | Lathe, drilling, milling and grinding machines | | | | |
| | 5.3 | Welding, brazing and soldering processes | | | | |
| | 5.4 | Welding defects, inspection and quality control | | | | |
| 6 | **Title** | **Modern Manufacturing Systems** | **CO6** | **BL** | **T, R** | **6** |
| | 6.1 | Non-traditional machining processes: EDM, ECM and USM | | | | |
| | 6.2 | CNC machines and CNC programming fundamentals | | | | |
| | 6.3 | Additive manufacturing and 3D printing | | | | |
| | 6.4 | Industry 4.0 and automation in manufacturing | | | | |
| | 6.5 | Sustainable and green manufacturing concepts | | | | |
| Self - Study | SS.1 | Crystal defects, dislocations and fracture mechanisms in engineering materials | | | | |
| | SS.2 | Heat treatment processes, TTT/CCT diagrams and alloy steels | | | | |
| | SS.3 | Smart materials, nano materials and composite materials applications | | | | |
| | SS.4 | Special casting methods, sheet metal operations and powder metallurgy | | | | |
| | SS.5 | Gear manufacturing, welding inspection and tool wear analysis | | | | |
| | SS.6 | CNC, additive manufacturing, Industry 4.0 and green manufacturing | | | | |

## Laboratory Component

| SN | Title of the experiment | CO | Hrs |
|---|---|---|---|
| 1 | Study of Binocular Metallurgical Microscope and identification of crystal structures | CO1 | 2 |
| 2 | Preparation of metallurgical specimen using abrasive belt grinder and polishing machine | CO1 | 2 |
| 3 | Jominy End Quench test for hardenability of steel | CO2 | 2 |
| 4 | Heat treatment of steel specimens using muffle furnace (Annealing, Normalizing and Hardening) | CO2 | 2 |
| 5 | Study of Iron-Iron Carbide equilibrium diagram and metallurgical specimen set | CO2 | 2 |
| 6 | Pattern making – One job using wood, wax or suitable material | CO4 | 2 |
| 7 | One composite job consisting of taper turning, shaping/milling & threading operations on lathe machine | CO5 | 6 |
| 8 | Demonstration of single point cutting tool grinding and tool geometry | CO5 | 2 |
| 9 | Welding experiment using Arc Welding/Gas Welding process(Demonstration) | CO5 | 2 |
| 10 | Demonstration of non-traditional machining processes (EDM/ECM/LBM) | CO6 | 2 |
| 11 | CNC Milling machine programming with profile milling using G-code and M-code | CO6 | 2 |
| 12 | Manual Data Input (MDI) operation on CNC lathe | CO6 | 4 |
| 13 | Industrial visit to manufacturing industry to observe machining, cutting of gears, conventional and non-conventional machining operations | CO6 | - |

## 8.6 Assessment Methodologies and Tools

### Theory Component

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | IA 1 | 1 | CAT | Paper- Pen, Pencil | Class Room Test | 15 | 15 | 1 Hrs |
| **2** | IA 2 | 1 | CAT | Paper- Pen, Pencil | Class Room Test | 15 | 15 | 1 Hrs |
| **3** | FA 1 – FA(6) | 6 | CAT | #MCQ/Quiz | Online Assessment | 10 | 10 | 0.5 Hrs |
| **4** | ESE | 1 | ESE | Paper- Pen, Pencil | In Class-End Sem Exam | 60 | 60 | 2.5 Hrs |

**IA = Internal Assessment; FA = Formative Assessment;*

*IA-1 will be conducted after completion of 1-3 Modules; IA-2 will be conducted after completion of 4-6 modules*

*#MCQ based on Modules & GATE based Question.*

### Lab Component

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | Exp 1 – Exp 12 | 12 | CAT | Practical | Journal (Rubrics Based) | 20 | 40 | 2 Hrs |
| **2** | Class Participation | | CAT | Attendance | Record and Rubrics | 5 | 10 | Continuous |
| **3** | ESE | | ESE | Oral and Practical | Rubrics Based | 25 | 60 | 2 Hrs |

## 8.7 Suggested CO-PO/PSO Correlation Matrix

*CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)*

| CO # | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MEPC232.1** | 3 | 2 | – | – | – | – | – | – | – | – | – | 2 | 2 |
| **MEPC232.2** | 3 | 3 | – | – | – | – | – | – | – | – | – | 3 | 2 |
| **MEPC232.3** | 3 | 3 | 2 | – | – | – | – | – | – | – | – | 3 | 3 |
| **MEPC232.4** | 3 | 2 | – | – | 2 | – | – | – | – | – | – | 2 | 3 |
| **MEPC232.5** | 3 | 3 | 2 | – | 2 | – | – | – | – | – | – | 2 | 3 |
| **MEPC232.6** | 3 | 3 | 2 | – | 2 | 2 | – | – | – | – | 2 | 2 | 3 |

## 8.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| 1 | WK1 | A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences. | The course covers material structure, bonding, mechanical behavior, heat treatment, and physical properties based on principles of physics, chemistry, and material science. |
| 2 | WK3 | A systematic, theory-based formulation of fundamentals required in the engineering discipline. | Fundamental concepts of engineering materials, manufacturing processes, machining, welding, and forming operations build the theoretical foundation of mechanical engineering. |
| 3 | WK4 | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline. | Advanced topics such as additive manufacturing, smart materials, CNC, FMS, and Industry 4.0 provide specialized knowledge relevant to modern manufacturing industries. |
| 4 | WK5 | Knowledge including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts that supports engineering design and operations. | Sustainable manufacturing, green materials, lean manufacturing, waste reduction, and efficient use of engineering resources are addressed in the course. |
| 5 | WK6 | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline. | Practical exposure to casting, welding, machining, heat treatment, additive manufacturing, and CNC systems develops understanding of industrial engineering practices. |
| 6 | WK8 | Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues. | Self-study topics and advanced modules on nano materials, smart manufacturing, Industry 4.0, and additive manufacturing encourage research orientation and innovative thinking. |

## 8.9 Resources

### Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| T1 | Materials Science and Engineering | 10th | William D. Callister Jr. | Wiley India | 2020 |
| T2 | Engineering Metallurgy | 6th | R.K. Rajput | S. Chand Publications | 2021 |
| T3 | Material Science and Metallurgy | 7th | O.P. Khanna | Dhanpat Rai | 2019 |
| T4 | Manufacturing Engineering and Technology | 8th | Serope Kalpakjian, Steven Schmid | Pearson Education | 2020 |
| T5 | Production Technology | Revised | P.C. Sharma | S. Chand Publications | 2019 |
| T6 | Manufacturing Processes | 3rd | H.N. Gupta | New Age International | 2018 |

### Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| R1 | Introduction to Physical Metallurgy | 2nd | Sidney H. Avner | McGraw Hill | 2017 |

| | | | | | |
|---|---|---|---|---|---|
| **R2** | Heat Treatment Principles and Techniques | 3rd | T.V. Rajan | PHI Learning | 2018 |
| **R3** | Materials Selection in Mechanical Design | 5th | M.F. Ashby | Elsevier | 2017 |
| **R4** | Manufacturing Processes for Engineering Materials | 6th | Serope Kalpakjian | Pearson Education | 2018 |
| **R5** | Welding Technology | 2nd | O.P. Khanna | Dhanpat Rai | 2019 |
| **R6** | Additive Manufacturing Technologies | 2nd | Ian Gibson | Springer | 2021 |

## Online Resources

| SN | Title | Description |
|---|---|---|
| **O1** | NPTEL Materials Science and Engineering | Fundamentals of engineering materials, crystal structures and material properties |
| **O2** | NPTEL Manufacturing Processes-I | Casting, metal forming and machining processes |
| **O3** | NPTEL Manufacturing Processes-II | Advanced manufacturing and machining techniques |
| **O4** | NPTEL Metal Casting and Welding Technology | Metal joining, casting operations and welding technology |
| **O5** | NPTEL Additive Manufacturing | Fundamentals of additive manufacturing and 3D printing |
| **O6** | NPTEL Industry 4.0 and Industrial Internet of Things | Smart manufacturing systems and Industry 4.0 concepts |
| **O7** | MIT OpenCourseWare – Materials Processing | Open educational resources related to material processing technologies |
| **O8** | Coursera – Manufacturing Process Specialization | Online learning modules on manufacturing systems and automation |

# Chapter 9 : *Subject- Thermodynamics (Sem III)*

| Overview | | | |
|---|---|---|---|
| **Course code:** | MEPC233 | Course Category: | Program Core |
| **Sem:** | III | Syllabus & Version: | SIGCE-R25-Y2 |

## 9.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | Team work/ Self learning | Total |
|---|---|---|---|---|---|
| | L | T | P | SL | |
| **Hours/Week** | 3 | - | - | 3 | 6 |
| **Hours/Sem** | 45 | - | - | 45 | 90 |
| **Credits** | 3 | - | - | - | 3 |

## 9.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | 40% | 60% | 100% | 3 |
| **Labs** | - | - | - | - |

## 9.3 Course Objectives

| | |
|---|---|
| **Pre-requisite Course Codes, if any.** | Thermodynamics system and types, Microscopic and Macroscopic approach, knowledge of Physics, gases, combustion, and properties of substances, understanding of work, power, pressure, and engineering systems. |

**Course Overview:**

This course introduces the fundamental principles of thermodynamics, including energy, heat, and work interactions. It covers energy analysis, thermodynamic properties, and the use of charts and diagrams for studying energy transfer processes. The course also explores vapour and gas power cycles, compressible fluid flow, and reactive systems with engineering applications.

**Course Objective:**

1. To understand the basic concepts of energy, heat, and work in thermodynamics.
2. To learn the fundamentals of energy quantification and the quality (grade) of energy.
3. To analyze the effect of energy transfer on the properties of substances using thermodynamic charts and diagrams.
4. To study the applications of thermodynamics in vapour power cycles and gas power cycles.
5. To understand the principles and behavior of compressible fluid flow.
6. To learn the fundamentals and applications of reactive thermodynamic systems.

## 9.4 Course Outcomes

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO** | **CO Details** | **Bloom's level** |
| **MEPC233.1** | Apply the laws of thermodynamics to analyze various engineering systems. | Apply |
| **MEPC233.2** | Calculate heat and work interactions in thermodynamic processes. | Apply |
| **MEPC233.3** | Use thermodynamic relations and functions to solve practical engineering problems. | Apply |
| **MEPC233.4** | Analyze thermodynamic processes using steam tables and Mollier charts. | Analyze |
| **MEPC233.5** | Evaluate the performance and efficiencies of heat engines and power cycles. | Evaluate |
| **MEPC233.6** | Apply the principles of compressible fluid flow in engineering applications. | Analyze |

## 9.5 Modules / Syllabus Content

### Theory Component

| Module | Unit | Topic | CO | Blooms Level | Reference | Hrs |
|---|---|---|---|---|---|---|
| 1 | **Title** | **Introduction and First Law of Thermodynamics** | **CO1** | **BL** | **T, R** | **06** |
| | 1.1 | Introduction And Basic Concepts: Thermodynamic State, Path, Process and Cycle, Point and Path Functions, Quasi-Static Process and Equilibrium | | | | |
| | 1.2 | Characteristic Gas Equation, Heat and Work, Concept of Pdv Work. First Law: Statement And Equation, Cyclic Process | | | | |
| | 1.3 | Joule Experiment, PMM-I, Application to Non-Flow Systems. | | | | |
| | 1.4 | First Law for Flow Systems: Flow Process and Flow Energy, Steady Flow Process | | | | |
| | 1.5 | Energy Balance, Applications to Nozzle, Turbine, Compressor, Pump, Boiler, Condenser, Heat Exchanger and Throttling Device, Steady Flow Work | | | | |
| 2 | **Title** | **Second Law of Thermodynamics & Entropy** | **CO2** | **BL** | **T, R** | **08** |
| | 2.1 | Limitations Of First Law, Thermal Reservoir, Heat Engine, Heat Pump and Refrigerator | | | | |
| | 2.2 | Statement Of Second Law, Reversible and Irreversible Process, Causes of Irreversibility, PMM-II | | | | |
| | 2.3 | Carnot Cycle and Carnot Theorem | | | | |
| | 2.4 | Entropy: Clausius Theorem, Entropy as A Property, Clausius Inequality | | | | |
| | 2.5 | Increase Of Entropy Principle, T-Ds Relations | | | | |
| 3 | **Title** | **Availability & Thermodynamic Relations** | **CO3** | **BL** | **T, R** | **04** |
| | 3.1 | High-Grade And Low-Grade Energy, Available and Unavailable Energy, Dead State, Useful Work, Irreversibility | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 3.2 | Availability Of Closed System and Steady Flow Process | | | | |
| | 3.3 | Helmholtz And Gibbs Function | | | | |
| | 3.4 | Thermodynamic Relations: Maxwell Relations, Clausius–Clapeyron Equation, Joule–Thomson Coefficient | | | | |
| 4 | **Title** | **Steam & Vapour Power Cycles** | **CO4** | **BL** | **T, R** | **07** |
| | 4.1 | Advantages And Applications of Steam, Phase Change of Water, Saturation Pressure and Temperature, Terminology Associated with Steam, Types of Steam | | | | |
| | 4.2 | Property Diagrams T-V, P-V, P-T, T-S And H-S, Critical and Triple Point | | | | |
| | 4.3 | Calculations Using Steam Table and Mollier Chart | | | | |
| | 4.4 | Principal Components of Simple Steam Power Plant | | | | |
| | 4.5 | Carnot Cycle and Limitations | | | | |
| | 4.6 | Rankine Cycle, Mean Temperature of Heat Addition | | | | |
| 5 | **Title** | **Gas Power Cycles** | **CO5** | **BL** | **T, R** | **06** |
| | 5.1 | Nomenclature Of Reciprocating Engine, Mean Effective Pressure, Assumptions for Air Standard Cycle | | | | |
| | 5.2 | Otto Cycle, Diesel Cycle | | | | |
| | 5.3 | Comparison Of Otto and Diesel Cycle for Same Compression Ratio | | | | |
| | 5.4 | Brayton Cycle, Sterling Cycle | | | | |
| | 5.5 | Ericsson Cycle | | | | |
| 6 | **Title** | **Compressible Fluid Flow & Reactive Systems** | **CO6** | **BL** | **T, R** | **08** |
| | 6.1 | Propagation Of Sound Waves Through Compressible Fluids, Sonic Velocity and Mach Number, Stagnation Properties | | | | |
| | 6.2 | Application Of Continuity, Momentum and Energy Equations for Steady State Flow Through Nozzle | | | | |
| | 6.3 | Isentropic Flow Through Ducts of Varying Area, Effect of Back Pressure on Nozzle Performance | | | | |
| | 6.4 | Reactive Systems: Combustion, Theoretical and Actual Combustion | | | | |
| | 6.5 | Enthalpy Of Formation, Enthalpy of Combustion, Adiabatic Flame Temperature | | | | |
| | SS.1 | Applications of Thermodynamics in Electric Vehicles | | | | |

| | | |
|---|---|---|
| Self - Study | **SS.2** | Energy Audit of Domestic Systems |
| | **SS.3** | Entropy Generation and Irreversibility |
| | **SS.4** | Boiler Efficiency Improvement Techniques |
| | **SS.5** | Performance Comparison of Petrol and Diesel Engines |
| | **SS.6** | CFD Basics for Compressible Flow |

## 9.6 Assessment Methodologies and Tools

| # | Assessment | How Many | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | IA 1 | 1 | CAT | Paper –Pen, Pencil | Class Room Test | 15 | 15 | 1 Hr |
| **2** | IA 2 | 1 | CAT | Paper –Pen, Pencil | Class Room Test | 15 | 15 | 1 Hr |
| **3** | TA | 2 | CAT | #MCQ/Quiz | Rubric Based | 10 | 10 | 0.5 Hrs |
| **4** | ESE | 1 | ESE | Paper –Pen, Pencil | In Class-End Sem Exam | 60 | 60 | 2.5 Hrs |

**IA = Internal Assessment; **FA** = Formative Assessment;*
*IA 1 will be conducted after completion of 3 Modules; IA 2 will be conducted after completion of next 3 modules*
**Assessment Instruments → **What** Tools and instruments are used for the assessment.*
**Assessment Methods → **How** Are assessments evaluated and/or executed.*
**Refer section 3.8*

## 9.7 Suggested CO-PO/PSO Correlation Matrix

*CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MEPC233.01** | 3 | 3 | – | – | – | – | – | – | – | – | – | 3 | 2 |
| **MEPC233.02** | 3 | 3 | – | – | – | – | – | – | – | – | – | 3 | 2 |
| **MEPC233.03** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 2 |
| **MEPC233.04** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 3 |
| **MEPC233.05** | 3 | 3 | – | – | 2 | 2 | – | – | – | – | – | 3 | 3 |
| **MEPC233.06** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 3 |

## 9.8 Course to Knowledge and Attitude Profile (WK) Mapping

| Sr. No | WK | WK Statement | Justification of Mapping |
|---|---|---|---|
| **1** | WK1 | A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences. | Applied in understanding laws of thermodynamics, heat transfer principles, properties of pure substances and energy interactions. |
| **2** | WK2 | Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. | Used in thermodynamic calculations involving energy equations, entropy analysis, thermodynamic cycles and gas laws. |
| **3** | WK3 | A systematic, theory-based formulation of fundamentals required in the engineering discipline. | Applied in analysis of thermodynamic systems, processes, heat engines, refrigeration cycles and power plant applications. |
| **4** | WK4 | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline. | Utilized in solving practical engineering problems related to IC engines, steam power systems, compressors and thermal devices. |
| **5** | WK5 | Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area. | Applied in design and performance evaluation of thermal systems, boilers, turbines, condensers and refrigeration equipment. |

## 9.9 Resources

### Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | Thermodynamics | 6th | P. K. Nag | TMH | 2017 |
| **T2** | Thermodynamics | 4th | Onkar Singh | New Age International | 2015 |
| **T3** | Thermodynamics | 1st | C. P. Arora | TMH | 2001 |
| **T4** | Thermodynamics: An Engineering Approach | 9th | Yunus A. Cengel and Michael A. Boles | TMH | 2019 |
| **T5** | Basic Engineering Thermodynamics | 5th | Rayner Joel | Longman Publishers | 1996 |

## Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | Basic Engineering Thermodynamics | 5th | Rayner Joel | Longman Publishers | 1996 |
| **R2** | Engineering Thermodynamics | 2th | P. Chattopadhyay | Oxford University Press India | 2016 |
| **R3** | Engineering Thermodynamics Through Examples | — | Y. V. C. Rao | Universities Press (India) Pvt. Ltd. | 2005 |
| **R4** | Fundamentals of Thermodynamics | 8th | Moran & Shapiro | Wiley | 2012 |
| **R5** | Fundamentals of Classical Thermodynamics | 9th | G. H. Van Wylen & R. E. Sonntag | John Wiley & Sons | 2016 |

## Online Resources

| SN | Title | Description |
|---|---|---|
| **O1** | https://www.physics.ox.ac.uk/system/files/file_attachments/basic_thermo.pdf | Basic of Thermodynamics. |
| **O2** | http://digimat.in/nptel/courses/video/112105123/L03.html | Different Kind of Energy and First Low - I |
| **O3** | https://nptel.ac.in/courses/101104063 | Fundamentals of Thermodynamics. |
| **O4** | https://home.iitk.ac.in/~gtm/thermodynamics/ui/Course%20Objective.html | Fundamentals of Classical Thermodynamics |
| **O5** | https://nptel.ac.in/courses/101104063 | Fundamentals of Thermodynamics. |
| **O6** | https://www.youtube.com/watch?v=YHJtM_CTA60 | Thermodynamics Concept |

# *Chapter 10: Subject- CAD Modelling & Working Drawing (Sem III)*

| Overview | | | |
|---|---|---|---|
| **Course code:** | MEVS231 | Course Category: | Vocational & Skill Enhancement |
| **Sem:** | III | Syllabus & Version: | SIGCE-R25-Y2 |

## 10.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | Team work/ Self learning | Total |
|---|---|---|---|---|---|
| | L | T | P | SL | |
| **Hours/Week** | - | - | 4 | - | 4 |
| **Hours/Sem** | - | - | 60 | - | 60 |
| **Credits** | - | - | 2 | - | 2 |

## 10.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | - | - | - | - |
| **Labs** | 50% | 50% | 100% | 2 |

## 10.3 Course Objectives

| **Pre-requisite Course Codes, if any.** | Engineering Graphics, Computer Fundamentals, AutoCAD |
|---|---|
| **Course Overview:**<br>This laboratory course focuses on computer aided drafting, parametric solid modelling, assembly modelling and preparation of industrial working drawings using AutoCAD and SolidWorks software. The course provides practical exposure to engineering drawing standards, dimensioning practices, assembly detailing and 3D product visualization. Students will also develop industry-oriented CAD documentation skills for manufacturing and design applications. | |
| **Course Objective:**<br>1. To develop proficiency in 2D drafting using AutoCAD.<br>2. To create parametric 3D solid models using SolidWorks.<br>3. To generate assembly models and detailed working drawings.<br>4. To apply GD&T standards in engineering drawings.<br>5. To develop engineering documentation and visualization skills.<br>6. To create industrial CAD models for manufacturing applications. | |

## 10.4 Lab Outcomes

| Course Outcomes (LO): At the End of the course students will be able to | | |
|---|---|---|
| **LO #** | **LO Detail** | **Bloom's level** |
| **MEVS231.1** | Create 2D engineering drawings using AutoCAD commands and standards. | Apply |
| **MEVS231.2** | Develop parametric 3D solid models using SolidWorks features. | Apply |
| **MEVS231.3** | Generate assembly models with appropriate mates and constraints. | Analyze |
| **MEVS231.4** | Prepare detailed working drawings with dimensions, tolerances and GD&T symbols. | Analyze |
| **MEVS231.5** | Apply surface modelling and sheet metal tools for industrial applications. | Apply |
| **MEVS231.6** | Design and document engineering components and assemblies for manufacturing applications. | Create |

## 10.5 Modules / Syllabus Content

### LAB Component

| Module | Unit | Topic | LO | Blooms Level | Reference | Hrs |
|---|---|---|---|---|---|---|
| 1 | **Title** | **Introduction to AutoCAD and Drafting Tools** | **LO1** | **BL** | **T,R** | **10** |
| | 1.1 | Introduction to CAD interface and coordinate systems | | | | |
| | 1.2 | Drawing commands, modify commands and layers | | | | |
| | 1.3 | Dimensioning, text and hatching tools | | | | |
| | 1.4 | Preparation of 2D machine component drawings | | | | |
| | 1.5 | Drawing commands, modify commands and layers | | | | |
| 2 | **Title** | **Solid Modelling using SolidWorks** | **LO2** | **BL** | **T,R** | **8** |
| | 2.1 | Sketch creation and geometric constraints | | | | |
| | 2.2 | Extrude, revolve and sweep features | | | | |
| | 2.3 | Loft, fillet, chamfer and pattern features | | | | |
| | 2.4 | Parametric modelling and design intent | | | | |
| 3 | **Title** | **Assembly Modelling and Motion Analysis** | **LO3** | **BL** | **T,R** | **8** |
| | 3.1 | Bottom-up and top-down assembly methods | | | | |
| | 3.2 | Mates and assembly constraints | | | | |
| | 3.3 | Exploded views and bill of materials | | | | |
| | 3.4 | Basic motion study and interference checking | | | | |
| 4 | **Title** | **Working Drawing and GD&T** | **LO4** | **BL** | **T,R** | **10** |
| | 4.1 | Orthographic projections and sectional views | | | | |
| | 4.2 | Limits, fits and tolerances | | | | |
| | 4.3 | Geometric Dimensioning and Tolerancing (GD&T) symbols | | | | |
| | 4.4 | Preparation of detailed manufacturing drawings | | | | |
| 5 | **Title** | **Surface and Sheet Metal Modelling** | **LO5** | **BL** | **T,R** | **8** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 5.1 | Surface modelling tools and applications | | | | |
| | 5.2 | Freeform and advanced surface operations | | | | |
| | 5.3 | Sheet metal features and bend allowance | | | | |
| | 5.4 | Flattening and fabrication drawings | | | | |
| 6 | **Title** | **Industrial CAD Project** | **LO6** | **BL** | **T,R** | **8** |
| | 6.1 | Product modelling and assembly development | | | | |
| | 6.2 | Working drawing documentation | | | | |
| | 6.3 | Design validation and visualization | | | | |
| | 6.4 | Mini project presentation and report | | | | |
| Self - Study | **SS1** | Study of industrial CAD standards and templates | | | | |
| | **SS2** | Advanced SolidWorks modelling techniques | | | | |
| | **SS3** | Assembly motion simulation and animation | | | | |
| | **SS4** | Industrial GD&T applications and case studies | | | | |
| | **SS5** | Surface modelling applications in automotive industries | | | | |
| | **SS6** | Product design and CAD documentation for manufacturing | | | | |

## Laboratory Component

| SN | Title of the experiment | CO | Hrs |
|---|---|---|---|
| 1 | Study of AutoCAD interface, coordinate systems and drawing setup | LO1 | 4 |
| 2 | Creation of basic 2D geometry using drawing and modify commands in AutoCAD | LO1 | 4 |
| 3 | Preparation of detailed 2D machine component drawing with dimensions and layers | LO1 | 4 |
| 4 | Development of parametric sketches using SolidWorks sketch tools and constraints | LO2 | 2 |
| 5 | Creation of 3D solid models using extrude, revolve and sweep features | LO2 | 6 |
| 6 | Advanced feature modelling using loft, fillet, chamfer, shell and pattern operations | LO2 | 6 |
| 7 | Assembly modelling using mates and constraints in SolidWorks | LO3 | 6 |
| 8 | Generation of exploded assembly views and bill of materials | LO3 | 4 |
| 9 | Preparation of orthographic views and sectional working drawings from 3D models | LO4 | 2 |
| 10 | Application of limits, fits, tolerances and GD&T symbols in working drawings | LO4 | 4 |
| 11 | Surface modelling and freeform surface creation using SolidWorks | LO5 | 2 |
| 12 | Sheet metal component modelling and flattening operations | LO5 | 4 |
| 13 | Industrial product modelling and detailed CAD documentation mini project | LO6 | 8 |
| 14 | Design presentation, report preparation and CAD model validation | LO6 | 4 |

## 10.6 Assessment Methods

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | Exp 1 – Exp 10 | 10 | CAT | Practical | Journal (Rubrics Based) | 45 | 45 | 4 Hrs |
| **2** | Lab Participation | | CAT | Attendance | Record and Rubrics | 5 | 5 | Continuous |
| **3** | ESE | | ESE | Oral and Practical | Rubrics Based | 25 | 50 | 2 Hrs |

## 10.7 Suggested LO-PO Correlation Matrix

*LO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)*

| CO # | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MEVS231.01** | 2 | – | 2 | – | 3 | – | – | – | - | – | – | 3 | 2 |
| **MEVS231.02** | 2 | 2 | 3 | – | 3 | – | – | – | – | – | – | 3 | 2 |
| **MEVS231.03** | 2 | 2 | 3 | – | 3 | – | – | – | – | – | – | 3 | 3 |
| **MEVS231.04** | 2 | 2 | 3 | – | 3 | – | – | – | - | – | – | 3 | 2 |
| **MEVS231.05** | 2 | 2 | 3 | – | 3 | – | – | – | – | – | – | 2 | 3 |
| **MEVS231.06** | 2 | 2 | 3 | – | 3 | – | – | – | - | – | – | 3 | 3 |

## 10.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| **1** | WK3 | A systematic, theory-based formulation of fundamentals required in the engineering discipline. | Provides mechanical engineering fundamentals related to engineering drawing standards, sectional views, assembly drawings and product modelling techniques. |
| **2** | WK4 | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline. | Applied in advanced 3D modelling, assembly design, working drawing preparation and CAD-based product development practices used in industries. |
| **3** | WK5 | Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that | Applied in developing optimized product models and manufacturing drawings with consideration for material utilization, manufacturability, cost effectiveness and sustainable engineering practices. |

| | | | |
|---|---|---|---|
| | | supports engineering design and operations in a practice area. | |
| **4** | WK6 | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline. | Applied through industrial CAD software tools, drafting standards, product modelling workflows and engineering documentation techniques. |

# 10.9 Resources

## Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | Engineering Drawing and CAD Applications | 2nd | P.S. Gill | Kataria | 2019 |
| **T2** | Mastering SolidWorks | 1st | Ibrahim Zeid | McGraw Hill | 2018 |
| **T3** | AutoCAD for Engineers | 1st | Sham Tickoo | CADCIM Technologies | 2021 |
| **T4** | Engineering Graphics with CAD | 3rd | James Bethune | Pearson | 2020 |

## Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | CAD/CAM Principles and Applications | 4th | P.N. Rao | McGraw Hill | 2020 |
| **R2** | SolidWorks for Engineers and Designers | 15th | Prof. Sham Tickoo | Dreamtech | 2022 |
| **R3** | Geometric Dimensioning and Tolerancing | 8th | Alex Krulikowski | Delmar | 2019 |
| **R4** | Product Design and Development | 7th | Ulrich & Eppinger | McGraw Hill | 2021 |

## Online Resources

| SN | Title | Description |
|---|---|---|
| **O1** | NPTEL CAD/CAM Course | Fundamentals of CAD/CAM systems, geometric modelling and manufacturing integration |
| **O2** | NPTEL Engineering Drawing and Graphics | Engineering graphics, projection methods and CAD drafting techniques |
| **O3** | SolidWorks Learning Portal | Official SolidWorks tutorials, certifications and modelling exercises |
| **O4** | Autodesk AutoCAD Learning Resources | AutoCAD tutorials, drafting standards and professional CAD learning resources |
| **O5** | MIT OpenCourseWare CAD Design | Open educational resources for CAD design and engineering applications |

# *Chapter 11:* Subject- Comprehensive Soft Skills & Professional Development (Sem III)

| Overview | | | |
|---|---|---|---|
| **Course code:** | IGAE231 | **Course Category:** | Ability Enhancement |
| **Sem:** | III | **Syllabus & Version:** | SIGCE-NEP-R25-Y2 |

## 11.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | | Team work/ Self learning | Total |
|---|---|---|---|---|---|---|
| | L | T | P | D | SL | |
| **Hours/Week** | - | - | 2 | | - | **2** |
| **Hours/Sem** | - | - | 30 | | - | **30** |
| **Credits** | - | - | 1 | | - | **1** |

** L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning*

## 11.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | - | - | **-** | **-** |
| **Lab/ Demo/Activity** | 100% | - | **100%** | **1** |

## 11.3 Course Objectives

| | |
|---|---|
| **Pre-requisite Course / Knowledge** | Knowledge of Principles of Communication and Ethics (PCE) |
| **Course Overview:**<br>This course is designed to develop students' communication, interpersonal, presentation, and professional skills required for academic and career success. It focuses on personality development, verbal and written communication, group discussions, resume writing, interview preparation, workplace etiquette, aptitude training, and career planning. The course helps students build confidence, teamwork, leadership qualities, and professional readiness for modern corporate and engineering environments. | |
| **Course Objectives:**<br>1. To develop effective verbal, non-verbal, written, and digital communication skills among students. | |

2. To enhance personality development, self-confidence, interpersonal skills, and professional behaviour.
3. To train students in group discussions, teamwork, leadership, and collaborative problem-solving techniques.
4. To prepare students for professional recruitment processes through resume writing, interview preparation, and mock interview practice.
5. To build awareness of workplace etiquette, corporate communication, time management, and professional ethics in modern work environments.
6. To strengthen aptitude, reasoning, career planning, and personal branding skills for improving employability and career growth.

## 11.4 Course Outcomes

| **Course Outcomes (CO): At the End of the course students will be able to** | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **IGAE231.1** | Demonstrate effective verbal and non-verbal communication using the 7Cs and self-awareness tools to enhance personality and confidence. | Apply (L3) |
| **IGAE231.2** | Develop professional written communication including formal emails and LinkedIn profiles while practicing digital etiquette. | Create(L6) |
| **IGAE231.3** | Participate actively and confidently in group discussions by applying group behaviour techniques and teamwork skills. | Apply (L3) |
| **IGAE231.4** | Create structured and ATS-compliant resumes and prepare for interviews using the STAR method and professional etiquette. | Create(L6) |
| **IGAE231.5** | Exhibit professional behaviour at the workplace through appropriate time management, ethical conduct, and corporate communication. | Apply(L3) |
| **IGAE231.6** | Solve aptitude problems and outline a career plan using test strategies and personal branding tools. | Analyze (L4) |

## 11.5 Modules / Syllabus Content

### Demonstration Component

| **Module** | **Unit** | **Topic** | **CO** | **Blooms Level** | **Reference** | **Hrs.** |
|---|---|---|---|---|---|---|
| **1** | **Title** | Fundamentals of Communication & Personality | **CO1** | **L3** | **T1, R1** | **5** |
| | 1.1 | Importance of Soft Skills in Engineering & Career, Verbal & Non-verbal Communication, 7Cs of Effective Communication | | | | |
| | 1.2 | Body Language, Facial Expressions & Grooming Etiquette | | | | |
| | 1.3 | Self-awareness, Personality Types & SWOT Analysis, Activities: Icebreakers, Self-introduction Video & Confidence-building Exercises | | | | |
| | 1.4 | **Activity**: Conduct self-introduction video recording to evaluate verbal and non-verbal communication skills including body language and confidence. | | | | |
| | 1.5 | **Activity**: Perform SWOT analysis and personality type assessment to understand self-awareness and personality development | | | | |
| **2** | **Title** | **Verbal, Written & Digital Communication Skills** | **CO2** | **L6** | **T2, R2** | **5** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 2.1 | Public Speaking, JAM & Storytelling Techniques, Professional Email Writing: Structure, Tone & Etiquette | | | | |
| | 2.2 | Grammar Improvement & Vocabulary Enhancement | | | | |
| | 2.3 | LinkedIn Profile Creation, Digital Behavior & Personal Branding, Activities: Draft Emails, LinkedIn Review & Mock JAM Rounds | | | | |
| | 2.4 | **Activity**: Draft and submit professional emails based on given workplace scenarios focusing on tone, structure, and etiquette | | | | |
| | 2.5 | **Activity**: Create and optimize LinkedIn profile to practice digital branding and professional online presence | | | | |
| **3** | Title | **Group Discussion & Team Dynamics** | **CO3** | **L3** | **T3, R3** | **4** |
| | 3.1 | Introduction to Group Discussion & Types of GDs, GD Techniques: Entry, Lead, Counter & Conclude | | | | |
| | 3.2 | Group Behavior, Leadership Roles & Team Dynamics, Teamwork, Cooperation & Collaborative Problem-solving, Activities: Mock GDs, Peer Feedback & Role Rotation | | | | |
| | 3.3 | **Activity**: Conduct mock group discussions with assigned topics focusing on entry, lead, counter, and conclusion techniques | | | | |
| | 3.4 | **Activity**: Perform role rotation activity in team tasks to understand leadership, cooperation, and teamwork dynamics | | | | |
| **4** | Title | **Resume Building & Interview Readiness** | **CO4** | **L6** | **T4, R4** | **4** |
| | 4.1 | Resume Format, Keywords & Achievement Writing, ATS-friendly Resume Preparation for Engineers | | | | |
| | 4.2 | HR & Technical Interview Questions, STAR Method, Interview Etiquette & Virtual Interview Activities: Resume Clinic, Mock Interviews & Peer Reviews | | | | |
| | 4.3 | **Activity**: Prepare ATS-friendly resume using proper keywords, achievements, and structured formatting. | | | | |
| | 4.4 | **Activity**: Conduct mock interview sessions using STAR method with peer evaluation and feedback | | | | |
| **5** | Title | **Workplace & Corporate Etiquette** | **CO5** | **L3** | **T5, R5** | **4** |
| | 5.1 | Work Ethics & Professionalism, Time Management Tools: Pomodoro & Eisenhower Matrix | | | | |
| | 5.2 | Email, Meeting & Call Etiquette, Work-from-home/Hybrid Professionalism & Accountability, Activities: Etiquette Checklist, Planner Setup & Roleplay | | | | |
| | 5.3 | **Activity**: Perform workplace roleplay activities focusing on email, meetings, and communication etiquette scenarios. | | | | |
| | 5.4 | **Activity**: Create personal time management planner using Pomodoro and Eisenhower matrix techniques | | | | |
| **6** | Title | **Aptitude Test Strategies & Career Planning** | **CO6** | **L4** | **T6, R6** | **4** |
| | 6.1 | Overview of Quantitative, Reasoning & Verbal Aptitude, Aptitude Test Strategies & Speed Improvement Techniques | | | | |
| | 6.2 | Previous Year Placement Aptitude Questions (TCS, Infosys, etc.), Career Goal Setting, Personal Branding & Self-pitch, Activities: Mini Aptitude Quiz, Pitch Presentation & Career Map Submission | | | | |
| | 6.3 | **Activity**: Attempt mini aptitude tests covering quantitative, reasoning, and verbal sections with timed evaluation | | | | |
| | 6.4 | **Activity**: Prepare and present personal career roadmap and self-pitch presentation for placement readiness | | | | |

## 11.6 Assessment Methodologies and Tools

### Lab Component

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **1** | Activity | 12 | CAT | Activity | Rubrics Based | 20 | 80 | 2 Hrs. |
| **2** | Attendance | - | CAT | Teachers Observation | Record | 5 | 20 | - |

*CAT Activity will be part of Term Work*

## 11.7 Suggested CO-PO/PSO Correlation Matrix

***CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)***

| CO # | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **IGAE231.1** | 2 | | - | - | - | 2 | - | 2 | 3 | 3 | - | - | - |
| **IGAE231.2** | 2 | 2 | - | - | 2 | - | - | - | - | 3 | - | 2 | - |
| **IGAE231.3** | - | - | 3 | 2 | - | 2 | - | 2 | - | - | 2 | - | - |
| **IGAE231.4** | 2 | - | - | | 2 | - | - | - | 3 | 3 | - | 3 | 2 |
| **IGAE231.5** | - | 2 | - | - | 2 | 3 | - | 3 | 3 | - | 2 | - | - |
| **IGAE231.6** | 2 | 3 | 2 | - | 2 | 2 | - | 2 | 2 | 3 | 2 | 3 | 2 |

## 11.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| 1 | **WK1** | A systematic, theory-based understanding of the natural sciences applicable to engineering fundamentals. | Students develop foundational understanding of communication principles, personality development, and professional behavior that is essential for engineering environments. |
| 2 | **WK6** | Knowledge of engineering practice includes technologies, processes, and standards in practical situations. | Workplace etiquette, virtual meeting behavior, email etiquette, and hybrid work professionalism expose students to modern corporate practices. |
| 3 | **WK7** | Comprehension of the role of engineering in society and identified issues in engineering practice. | Group discussions, leadership exercises, and teamwork activities develop collaboration, ethical awareness, and social interaction skills. |
| 4 | **WK8** | Engagement with selected knowledge in the research literature of the discipline. | Students explore placement trends, aptitude patterns, and professional communication strategies through self-learning and practical assignments. |

## 11.9 Resources

### Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | *Soft Skills: Know Yourself and Know the World* | 3rd | Dr. K. Alex | S. Chand Publishing | 2019 |
| **T2** | *Personality Development and Soft Skills* | 2nd | Barun K. Mitra | Oxford University Press | 2016 |
| **T3** | *Business Communication and Personality Development* | 1st | Biswajit Das & Ipseeta Satpathy | Excel Books | 2009 |
| **T4** | *Interview and Group Discussion* | 1st | T. Sudha | Tata McGraw Hill | 2010 |
| **T5** | *English and Soft Skills* | 1st | S.P. Dhanavel | Orient BlackSwan | 2010 |
| **T6** | *Campus to Corporate: Your Roadmap to Employability* | 1st | Gangadhar Joshi | Cengage Learning India | 2021 |

## Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | *Business Communication* | 2nd | Meenakshi Raman & Prakash Singh | Oxford University Press | 2012 |
| **R2** | *The 7 Cs of Communication: A Skills Workbook* | 1st | Lucas Burns | Independently Published | 2020 |
| **R3** | *Body Language: How to Read Others' Thoughts by Their Gestures* | Revised | Allan Pease | Manjul Publishing | 2017 |
| **R4** | *Group Discussion and Interview Skills* | 1st | Priyadarshi Patnaik & Barun K. Mitra | Cambridge University Press India | 2011 |
| **R5** | *Workplace Etiquette: A Guide to Career Success* | 1st | Barbara Pachter | Career Press | 2014 |
| **R6** | *Quantitative Aptitude for Competitive Examinations* | 2024 | R.S. Aggarwal | S. Chand Publishing | 2024 |

## Online Resources

| SN | Title | Description |
|---|---|---|
| **O1** | https://www.coursera.org/courses?query=communication%20skills | Offers professional courses on communication skills, public speaking, teamwork, and workplace communication from leading universities. |
| **O2** | https://www.linkedin.com/learning | Provides industry-oriented learning modules on professional communication, LinkedIn profile building, leadership, interview preparation, and career development. |
| **O3** | https://www.toastmasters.org | A global platform for improving public speaking, confidence, leadership, and presentation skills through practical activities. |
| **O4** | https://learning.tcsionhub.in/career-edge | Free employability enhancement program covering communication skills, resume writing, interview preparation, aptitude, and workplace etiquette. |
| **O5** | https://www.geeksforgeeks.org/aptitude-gq | Provides quantitative aptitude, logical reasoning, verbal ability practice questions, and placement preparation resources. |

| | | |
|---|---|---|
| **O6** | https://www.yoodli.ai | AI-powered platform for practicing speeches, interviews, group discussions, and improving communication confidence with feedback. |

# Chapter 12: *Subject- Entrepreneurship and Business Model Development (Sem III)*

| Overview | | | |
|---|---|---|---|
| **Course code:** | IGEM231 | **Course Category:** | Entrepreneurship /Eco / Mgmt. |
| **Sem:** | III | **Syllabus & Version:** | SIGCE-NEP-R25-Y2 |

## 12.1 Teaching & Learning Scheme

| Components | Classroom Instruction | | Lab instructions | | Teamwork/ Self learning | Total |
|---|---|---|---|---|---|---|
| | L | T | P | D | SL | |
| **Hours/Week** | - | - | 2 | 2 | - | **4** |
| **Hours/Sem** | - | - | 30 | 30 | - | **60** |
| **Credits** | - | - | 2 | | - | **2** |

** L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning*

## 12.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | - | - | **-** | **-** |
| **Labs** | 100% | - | **100%** | **2** |

## 12.3 Course Objectives

| | |
|---|---|
| **Pre-requisite Course / Knowledge** | Basic design thinking principles |
| **Course Overview:**<br>A course on Business Model Development typically teaches how to design, analyze, and refine the way a company creates, delivers, and captures value. | |
| **Course Objective:**<br>1. To introduce a learner to entrepreneurship and its role in economic development .<br>2. To familiarize a learner with the start-up ecosystem and government initiatives in India.<br>3. To explain the process of starting a business.<br>4. To familiarize a learner with the building blocks of a business.<br>5. To teach a learner to plan their own business with the help of Business model canvas.<br>6. To teach a learner to have a financial plan for a business model. | |

## 12.4 Course Outcomes

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **IGEM231.1** | Discuss the role of entrepreneurship in the economic development of a nation and describe the process of starting a business. | Understand(L2) |
| **IGEM231.2** | Describe start-up ecosystem in Indian and global context. | Understand(L2) |
| **IGEM231.3** | Identify different types of business models. | Understand(L2) |
| **IGEM231.4** | Identify customer segments, channels and customer relationship components for a particular business. | Apply(L3) |
| **IGEM231.5** | Identify key activities, key partners and key resources for a particular business. | Apply(L3) |
| **IGEM231.6** | Develop a financial plan for a business with the help of cost structure and revenue model. | Create(L6) |

## 12.5 Modules / Syllabus Content

### Theory Component

| Module | Unit | Topic | CO | Blooms Level | Reference | Hrs |
|---|---|---|---|---|---|---|
| 1 | **Title** | **Introduction Entrepreneurship** | **CO1** | **L2** | **T1,T2,R1,R2** | **4** |
| | 1.1 | Introduction, definition of entrepreneurship | | | | |
| | 1.2 | The role of entrepreneurship in economic development | | | | |
| | 1.3 | Women entrepreneurs, Corporate entrepreneurship | | | | |
| | 1.4 | Entrepreneurial mindset, feasibility planning's (four stage growth model, feasibility plan) | | | | |
| 2 | **Title** | Entrepreneurship Development | **CO2** | **L2** | **T1, T2,R1,R2** | **4** |
| | 2.1 | Types of business ownership: Proprietorship, success factor for entrepreneurs | | | | |
| | 2.2 | Public and Private Companies, | | | | |
| | 2.3 | Micro, Small and Medium Enterprises (MSME): Definition Role of MSMEs in economic development | | | | |
| | 2.4 | Synopsis for learning and stating how MSME works | | | | |
| 3 | **Title** | **Start-up financing** | **CO3** | **L2** | **T1,T2,R1,R2** | **5** |
| | 3.1 | Cost and revenue models, | | | | |
| | 3.2 | Sources of start-up findings: Angel investors, Venture capitalists, Crowd funding, | | | | |
| | 3.3 | Government schemes for start-up funding<br>Self-learning Topics: Successful business pitching | | | | |
| | 3.4 | Franchising, structuring of acquisition | | | | |
| 4 | **Title** | **Intellectual Property Rights (IPR)** | **CO4** | **L3** | **T1,T2,R1,R2** | **4** |
| | 4.1 | Intellectual Property Rights (IPR): Types of IPR: Patents, trademarks and copyrights | | | | |
| | 4.2 | Patent search and analysis, Strategies for IPR protection | | | | |
| | 4.3 | Ethics in technology and innovation | | | | |
| | 4.4 | Patents, type, disclosure process | | | | |
| 5 | **Title** | **Business Model Development** | **CO5** | **L3** | **T1,T2,R1,R2** | **5** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 5.1 | Business Model Development:<br>Types of business models, Value proposition | | | | |
| | 5.2 | Customer segments, Customer relationships | | | | |
| | 5.3 | Channels, Key partners, Key activities | | | | |
| | 5.4 | Key resources, Prototyping and MVP | | | | |
| | 5.5 | Perspective of marketing research, market research in pre-startup phase | | | | |
| **6** | **Title** | **Digital Business Management** | **CO6** | **L6** | **T1, T2,R1,R2** | **4** |
| | 6.1 | Digital Business Management:<br>Digital business models (Subscription, Fermium etc.) | | | | |
| | 6.2 | Digital marketing: Search Engine Optimization (SEO) | | | | |
| | 6.3 | Search Engine Marketing (SEM), social media and influencer marketing, | | | | |
| | 6.4 | Disruption and innovation in digital business | | | | |

## Laboratory Component (Suggested List of Experiments)

| SN | Title of the experiment | CO | Hrs |
|---|---|---|---|
| **1** | Problem identification (pain point, market survey) | CO1 | **2** |
| **2** | Design a digital solution for the problem (ideation techniques) | CO1 | **2** |
| **3** | Preparing a business model canvas value proposition, key patterns, key resources, key activities | CO2 | **2** |
| **4** | Preparing a business model canvas: customer segment, customer relationship and channels | CO2 | **2** |
| **5** | Preparing a business model canvas: cost and revenue structure | CO3 | **2** |
| **6** | Prototype development: low fidelity | CO3 | **2** |
| **7** | Prototype development: customer feedback | CO4 | **2** |
| **8** | Prototype development: HIGH Fidelity | CO4 | **2** |
| **9** | Feasibility plan Of an idea | CO5 | **2** |
| **10** | Franchisee plan of your company | CO6 | **2** |

## Assignments (Suggested list of Assignments)

| SN | Title of Assignments | CO |
|---|---|---|
| **1** | Presentation on case study of a failed business model | CO1 |
| **2** | presentation on case study of a woman entrepreneur | CO2 |
| **3** | Case study Angel investor and venture capitalist | CO3 |
| **4** | Case study of trademarks and copyright | CO4 |
| **5** | Business model prototyping | CO5 |
| **6** | Innovation in digital business | CO6 |

# 12.6 Assessment Methodologies and Tools

## Lab Component

| | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | Exp 1 – Exp 10 | 10 | CAT | Practical-Experiment | Journal (Rubrics Based) | 25 | 50 | 2Hrs |
| **2** | Assignments | 6 | CAT | Written | Assignment (Rubrics Based) | 10 | 20 | - |
| **3** | Report | 1 | CAT | Presentation | Rubrics based | 10 | 20 | - |
| **4** | Attendance | 1 | CAT | Attendance | Record Based | 5 | 10 | - |

*Note:*

1 *CAT Activity will be part of Term Work.*

2 *The final certification and acceptance of Term Work (TW) shall be granted only if the student has demonstrated satisfactory performance in laboratory work and has secured the minimum passing marks in the Term Work.*

3 *Learners will perform minimum 10 experiment at least 1 experiment from each module.*

***4*** *Each practical will be assessed considering* ***50% work of lab +20% Assignment+20% Report +10% attendances.***

# 12.7 Suggested CO-PO/PSO Correlation Matrix

***CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)***

| CO # | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **IGEM231.1** | 2 | 2 | - | - | - | 3 | 2 | - | 2 | 2 | 2 | - | 3 | - |
| **IGEM231.2** | 2 | 2 | - | - | - | 3 | - | - | 2 | 2 | 2 | - | 3 | - |
| **IGEM231.3** | 2 | 2 | 3 | - | - | 2 | - | - | - | 2 | 2 | 2 | 3 | - |
| **IGEM231.4** | - | 2 | 3 | - | - | 2 | - | 2 | 3 | 2 | 2 | 2 | 3 | - |
| **IGEM231.5** | 2 | 2 | 3 | - | - | 2 | - | 3 | 2 | 3 | 2 | 2 | 3 | - |
| **IGEM231.6** | 3 | 3 | 3 | - | 2 | 2 | - | 2 | 2 | 3 | 2 | 2 | 3 | - |

# 12.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| **1** | WK2 | Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modeling applicable to the discipline. engineering | The subject involves financial planning, cost structure analysis, and revenue modeling, which require strong analytical and quantitative decision-making skills. |

| | | | |
|---|---|---|---|
| **2** | WK4 | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline. | Focuses on business model development, startup ecosystems, and strategic frameworks, requiring domain-specific knowledge of business and entrepreneurship. |
| **3** | WK5 | Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area. | Emphasizes efficient use of resources, cost optimization, and long-term sustainability in business planning and value creation. |
| **4** | WK7 | Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development. | Highlights the impact of entrepreneurship and startups on economic development, employment generation, and societal growth. |

# 12.9 Resources

## Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | Entrepreneurship – David A | 1st | Kirby | McGraw Hill | 2002 |
| **T2** | Harvard Business Review: Entrepreneurs Handbook | 2nd | HBR Press | HBR Press | 2018 |

## Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | Entrepreneurship: New venture creation – David Holt, Prentice Hall of India Pvt. Ltd. | 2nd | David Holt | Prentice Hall of India Pvt. Ltd. | 2005 |
| **R2** | E-Business & E-Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education | 3rd | Implementation | Pearson Education | 2018 |
| **R3** | Business model generation; Alexander ostlewalder and YVES Pigneur | 1st | Strategyzer | Pearson Education | 2010 |

## Online Resources

| SN | Title | Description |
|---|---|---|
| **01** | Innovation, Business Models and Entrepreneurship by Prof. Rajat Agrawal, Prof. Vinay Sharma | The purpose of Innovation, Business Models, and Entrepreneurship is to help readers understand how innovation, business models, and entrepreneurship work together to create and grow successful businesses. |
| **02** | https://onlinecourses.nptel.ac.in/noc21_mg63/preview | - |

# Chapter 13: *Subject- Finite Element Analysis (Sem IV)*

| Overview | | | |
|---|---|---|---|
| **Course Code:** | MEBS241 | Course Category: | Basic Sciences |
| **Sem:** | IV | Syllabus & Version: | SIGCE-R25-Y2 |

## 13.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | | Team work/ Self learning | Total |
|---|---|---|---|---|---|---|
| | L | T | P | D | SL | |
| **Hours/Week** | 2 | - | 2 | - | 2 | 6 |
| **Hours/Sem** | 30 | - | 30 | - | 30 | 90 |
| **Credits** | 2 | - | 1 | - | - | 3 |

** L = Lectures; T= Tutorials; P = Practical; D = Demo; SL = Self Learning*

## 13.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | 40% | 60% | 100% | 2 |
| **Tutorial & Term Work** | 100% | 0% | 100% | 1 |

## 13.3 Course Objectives

| | |
|---|---|
| **Pre-requisite Course Codes, if any.** | Engineering Mechanics, Strength of Materials, Engineering Mathematics, Basics of Differential Equations and Matrix Algebra & Computer Aided Engineering Fundamentals |

**Course Overview:**

Finite Element Analysis is an advanced numerical analysis course that introduces students to computational techniques used for solving complex engineering problems involving structures, thermal systems, vibrations, and engineering design applications. The course emphasizes finite element modelling, matrix methods, interpolation functions, boundary conditions, and solution procedures for one-dimensional and two-dimensional engineering problems. The syllabus also incorporates engineering software exposure, modern industrial applications, and sustainable engineering considerations.

**Course Objective:**

1. To understand the fundamentals and formulation procedures of Finite Element Analysis.
2. To develop mathematical and engineering modelling skills for solving engineering problems.
3. To apply finite element techniques for structural, thermal, and vibration analysis.
4. To formulate stiffness matrices and solve engineering systems using numerical methods.

5. To develop the ability to use modern engineering software tools for finite element modelling and analysis.
6. To inculcate problem-solving, analytical thinking, and engineering decision-making skills for real-world applications.

## 13.4 Course Outcomes

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **MEBS241.1** | Explain the fundamentals, terminology, and engineering applications of Finite Element Analysis. | Understand |
| **MEBS241.2** | Apply matrix algebra and numerical techniques used in finite element formulations. | Apply |
| **MEBS241.3** | Formulate and solve one-dimensional finite element problems for engineering systems. | Apply |
| **MEBS241.4** | Analyze thermal and vibration problems using finite element methods. | Analyze |
| **MEBS241.5** | Develop finite element models for two-dimensional engineering applications. | Create |
| **MEBS241.6** | Use modern FEA software tools for engineering simulations and interpretation of results. | Apply |

## 13.5 Modules / Syllabus Content

### Theory Component

| Module | Unit | Topic | CO | BL | Reference | Hrs |
|---|---|---|---|---|---|---|
| 1 | **Title** | **Introduction to Finite Element Analysis** | **CO1** | **BL** | **T, R** | **4** |
| | 1.1 | Historical development of FEM, basic concepts, continuum, discretization, nodes, elements, degrees of freedom, engineering applications of FEM | | | | |
| | 1.2 | Engineering approximations, finite element procedures, solution methodology, advantages and limitations of FEM | | | | |
| | 1.3 | Stress-strain relations, equilibrium equations, compatibility conditions, boundary conditions and engineering modelling concepts | | | | |
| 2 | **Title** | **Matrix Methods and Numerical Techniques** | **CO2** | **BL** | **T, R** | **5** |
| | 2.1 | Matrix algebra, matrix operations, inverse of matrices, determinants and system of linear equations | | | | |
| | 2.2 | Gaussian elimination method, Gauss-Seidel method, eigenvalues and eigenvectors | | | | |
| | 2.3 | Coordinate systems, local and global coordinates, transformation matrices | | | | |
| 3 | **Title** | **One Dimensional Finite Elements** | **CO3** | **BL** | **T, R** | **4** |
| | 3.1 | Shape functions, interpolation functions, element properties, stiffness matrix formulation for spring and bar elements | | | | |
| | 3.2 | Beam and truss elements, assembly procedures, load vectors and boundary condition implementation | | | | |
| | 3.3 | Stress and displacement calculations, engineering interpretation of numerical results | | | | |
| 4 | **Title** | **Thermal and Dynamic Analysis** | **CO4** | **BL** | **T, R** | **5** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 4.1 | One-dimensional steady state heat transfer problems using finite element formulation | | | | |
| | 4.2 | Thermal conductivity matrix, convection boundary conditions and temperature distribution | | | | |
| | 4.3 | Introduction to dynamic analysis, vibration problems, mass matrices and natural frequency estimation | | | | |
| 5 | **Title** | **Two Dimensional Finite Element Analysis** | **CO5** | **BL** | **T, R** | **4** |
| | 5.1 | Plane stress and plane strain concepts, triangular and quadrilateral elements | | | | |
| | 5.2 | Shape functions for 2D elements, formulation of CST element stiffness matrix | | | | |
| | 5.3 | Two-dimensional stress analysis and engineering applications | | | | |
| 6 | **Title** | **Finite Element Software Applications** | **CO6** | **BL** | **T, R** | **4** |
| | 6.1 | Introduction to commercial FEA software and preprocessing techniques | | | | |
| | 6.2 | Meshing, material property assignment, loading and boundary condition applications | | | | |
| | 6.3 | Post-processing, result interpretation, validation and industrial case studies | | | | |
| Self-Study | **SS.1** | Introduction to nonlinear finite element analysis | | | | |
| | **SS.2** | Numerical methods for engineering systems | | | | |
| | **SS.3** | Finite element applications in automotive engineering | | | | |
| | **SS.4** | Thermal simulation using engineering software | | | | |
| | **SS.5** | Composite material analysis using FEM | | | | |
| | **SS.6** | Industrial case studies using ANSYS / Abaqus | | | | |

## Laboratory Component

| Sr. No. | Name of Experiment | CO | Hrs |
|---|---|---|---|
| 1 | Introduction to ANSYS/MATLAB Interface, Geometry Creation and Model Setup | CO1 | 2 |
| 2 | Mesh Generation and Mesh Convergence Study for Simple Geometries | CO1 | 2 |
| 3 | MATLAB Program for Solution of Linear Algebraic Equations using Gauss Elimination Method | CO2 | 2 |
| 4 | MATLAB Program for One-Dimensional Spring Element Analysis | CO2 | 2 |
| 5 | MATLAB Program for One-Dimensional Bar Element Analysis and Comparison with Analytical Solution | CO2 | 2 |
| 6 | ANSYS Analysis of Axially Loaded Stepped Bar and Determination of Stress Distribution | CO3 | 2 |
| 7 | ANSYS Structural Analysis of Cantilever Beam under Point Load and Validation with Beam Theory | CO3 | 2 |
| 8 | ANSYS Structural Analysis of Simply Supported Beam under Uniformly Distributed Load | CO4 | 2 |
| 9 | ANSYS Steady-State Thermal Analysis of a Plane Wall / Fin | CO4 | 2 |
| 10 | ANSYS Two-Dimensional Stress Analysis of Plate with Circular Hole | CO5 | 2 |
| 11 | ANSYS Modal Analysis of Cantilever Beam for Natural Frequency Determination | CO5 | 2 |
| 12 | ANSYS Project: Static Structural Analysis and Optimization of Mechanical Component (Bracket/Connecting Rod/Base Plate) with Report Preparation | CO6 | 4 |

# 13.6 Assessment Methodologies and Tools

## Theory Component

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | IA-1 | 1 | CAT | Paper- Pen, Pencil | Class Room Test | 15 | 15% | 1 Hrs |
| **2** | IA-2 | 1 | CAT | Paper- Pen, Pencil | Class Room Test | 15 | 15% | 1 Hrs |
| **3** | FA | 2 | CAT | #MCQ/Quiz | Online Assessment | 10 | 10% | 0.5 Hrs |
| **4** | ESE | 1 | ESE | Paper- Pen, Pencil | In Class-End Sem Exam | 60 | 60% | 2.5 Hrs |

**IA = Internal Assessment; FA = Formative Assessment;*

*IA-1 will be conducted after completion of 1-3 Modules; IA-2 will be conducted after completion of 4-6 modules*

*#MCQ/Quiz on modules wise & GATE base Questions*

## Term Work

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | Exp 1 - Exp 11 | 11 | CAT | Practicals | Journal Rubric Based | 10 | 40 | 1 Hrs |
| **2** | Mini Project | 1 | CAT | Mini Project | Rubric Based | 5 | 20 | 0.5 Hrs |
| **3** | Assignment | 2 | CAT | Attendance | Rubric Based | 5 | 20 | - |
| **4** | Attendance | 1 | - | Attendance | Records and Rubric | 5 | 20 | - |

# 13.7 Suggested CO-PO/PSO Correlation Matrix

*CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)*

| CO# | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MEBS241.1** | 3 | 2 | – | – | – | – | – | – | – | – | – | 2 | 2 |
| **MEBS241.2** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 2 |
| **MEBS241.3** | 3 | 3 | 2 | 2 | 2 | – | – | – | – | – | – | 3 | 3 |
| **MEBS241.4** | 3 | 3 | – | 2 | 2 | – | – | – | – | – | – | 3 | 3 |
| **MEBS241.5** | 3 | 3 | 2 | 2 | 3 | – | – | – | – | – | – | 3 | 3 |
| **MEBS241.6** | 3 | 3 | – | 2 | 3 | – | – | – | – | – | 2 | 3 | 3 |

## 13.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| **1** | WK2 | Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. | Used in matrix algebra, numerical methods, finite element formulations, interpolation functions, and computational engineering analysis. |
| **2** | WK3 | A systematic, theory-based formulation of fundamentals required in the engineering discipline. | Provides core engineering fundamentals necessary for structural analysis, thermal analysis, and engineering simulations. |
| **3** | WK4 | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline. | Applied in finite element modelling, computational mechanics, software-based simulations, and advanced engineering problem-solving. |
| **4** | WK5 | Knowledge including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon and similar concepts. | Supports optimization of engineering systems, lightweight structures, sustainable design practices, and efficient engineering analysis. |
| **5** | WK6 | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline. | Applied through practical usage of modern FEA software tools, engineering simulations, and industrial applications. |
| **6** | WK8 | Engagement with selected knowledge in current research literature and awareness of critical thinking and creative approaches. | Encourages analytical thinking, research orientation, software-based investigations, and exposure to emerging simulation technologies. |

## 13.9 Resources

### Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | Introduction to Finite Elements in Engineering | Latest | Tirupathi R. Chandrupatla | Pearson | 2025 |
| **T2** | A First Course in Finite Element Method | Latest | Daryl L. Logan | Cengage Learning | 2025 |
| **T3** | Concepts and Applications of Finite Element Analysis | Latest | Robert D. Cook | Wiley India | 2025 |
| **T4** | Finite Element Method | Latest | J.N. Reddy | McGraw Hill | 2025 |

## Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | Textbook of Finite Element Analysis | 4th | P. Seshu | PHI Learning | 2025 |
| **R2** | The Finite Element Method in Engineering | 10th | S.S. Rao | Elsevier | 2011 |
| **R3** | Finite Element Procedures | 2nd | K.J. Bathe | Prentice Hall | 2017 |
| **R4** | Finite Element Analysis: Theory and Application using ANSYS | Revised | Saeed Moaveni | Pearson | 2020 |
| **R5** | Introduction to Finite Element Method | Revised | Desai and Abel | CBS Publishers | 2025 |

## Web Resources / Online References

| SN | Title | Description |
|---|---|---|
| **O1** | https://nptel.ac.in/courses/112104193 | NPTEL Course on Finite Element Method by IIT Madras |
| **O2** | https://nptel.ac.in/courses/112106135 | NPTEL Course on Computational Mechanics |
| **O3** | https://nptel.ac.in/courses/112104116 | NPTEL Course on Advanced Finite Element Analysis |
| **O4** | https://nptel.ac.in/courses/105106051 | NPTEL Numerical Methods for Engineers |
| **O5** | https://www.ansys.com/academic | ANSYS Academic Learning Resources |
| **O6** | https://ocw.mit.edu | MIT OpenCourseWare – Finite Element Topics |
| **O7** | https://www.simscale.com | Cloud-Based CAE and Simulation Platform |

# *Chapter 14: Subject- Fluid Mechanics (Sem IV)*

| Overview | | | |
|---|---|---|---|
| **Course code:** | MEPC241 | Course Category: | Program Core |
| **Sem:** | IV | Syllabus & Version: | SIGCE-R25-Y2 |

## 14.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | Team work/ Self learning | Total |
|---|---|---|---|---|---|
| | L | T | P | SL | |
| **Hours/Week** | 3 | - | 2 | 3 | 8 |
| **Hours/Sem** | 45 | - | 30 | 45 | 120 |
| **Credits** | 3 | - | 1 | - | 4 |

## 14.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | 40% | 60% | 100% | 3 |
| **Labs** | 50% | 50% | 100% | 1 |

## 14.3 Course Objectives

| | |
|---|---|
| **Pre-requisite Course Codes, if any.** | Knowledge of Engineering Mechanics, Engineering Mathematics, Applied Physics |

**Course Overview:**

This course introduces fundamental concepts of fluid mechanics including fluid statics, fluid kinematics, fluid dynamics, dimensional analysis, flow through pipes, viscous flow, boundary layer theory, and flow measuring devices. The course develops analytical skills required to solve engineering problems involving fluid flow systems.

**Course Objective:**

1. To introduce the fundamental concepts and physical properties of fluids and analyze fluid behavior under static conditions.
2. To develop understanding of fluid kinematics and describe fluid motion using continuity equation, stream function, and velocity potential function.
3. To apply principles of fluid dynamics including Bernoulli's equation, Euler's equation, and momentum equation to engineering problems and flow measuring devices.
4. To study viscous flow behavior, laminar flow characteristics, and governing equations for fluid motion in pipes.
5. To analyze flow through pipes including frictional losses, pipe networks, hydraulic gradient line, and energy gradient line.

| |
|---|
| 6. To understand boundary layer theory, drag and lift phenomena, and methods for controlling boundary layer separation in engineering applications. |

## 14.4 Course Outcomes

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **MEPC241.1** | Explain properties of fluids, classify fluid flow, and evaluate hydrostatic forces on submerged surfaces. | Understand |
| **MEPC241.2** | Analyze fluid motion using continuity equation, stream function, velocity potential function, and circulation concepts | Analyze |
| **MEPC241.3** | Apply Euler's equation, Bernoulli's equation, and momentum equation to solve fluid flow and flow measurement problems. | Apply |
| **MEPC241.4** | Analyze laminar viscous flow behavior using Reynolds number, Navier–Stokes equation, and Hagen–Poiseuille equation. | Analyze |
| **MEPC241.5** | Evaluate major and minor losses in pipe flow systems and analyze flow through pipes connected in series and parallel. | Evaluate |
| **MEPC241.6** | Explain boundary layer development, drag and lift phenomena, and methods for preventing boundary layer separation. | Understand |

## 14.5 Modules / Syllabus Content

### Theory Component

| Module | Unit | Topic | CO | Blooms Level | Reference | Hrs |
|---|---|---|---|---|---|---|
| 1 | Title | Basic Concepts and Fluid Statics | CO1 | BL | T, R | 6 |
| | 1.1 | Significance of fluid mechanics ,Physical properties of fluids | | | | |
| | 1.2 | Newton's law of viscosity ,Newtonian and non-Newtonian fluids | | | | |
| | 1.3 | Pascal's law and hydrostatic law | | | | |
| | 1.4 | Hydrostatic force on submerged surfaces, (Vertical, Inclined and Curved) | | | | |
| 2 | Title | Fluid Kinematics | CO2 | BL | T, R | 6 |
| | 2.1 | Classification of fluid flow | | | | |
| | 2.2 | Streamline, path line and streak line | | | | |
| | 2.3 | Acceleration of fluid particle | | | | |
| | 2.4 | Differential equation of continuity | | | | |
| | 2.5 | Rotational flow and vortices | | | | |
| | 2.6 | Stream function, velocity potential function and circulation | | | | |
| 3 | Title | Fluid Dynamics | CO3 | BL | T, R | 8 |
| | 3.1 | Concept of control volume and control surface ,Reynolds Transport Theorem (RTT )No Numerical) | | | | |
| | 3.2 | The Euler and Bernoulli equations | | | | |
| | 3.3 | Bernoulli application venturimeter, orificemeter, Pitot tube, | | | | |
| | 3.4 | Momentum equation and its application – forces on pipe bends, moment of momentum, | | | | |
| 4 | Title | Laminar Viscous Flow | CO4 | BL | T, R | 7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 4.1 | Reynolds number and critical Reynolds number | | | | |
| | 4.2 | Navier-Stokes equation of motion | | | | |
| | 4.3 | Relationship between shear stress and pressure gradient | | | | |
| | 4.4 | Plane Poiseuille and Couette flow | | | | |
| | 4.5 | Hagen-Poiseuille flow through circular pipe | | | | |
| 5 | Title | Flow Through Pipes | CO5 | BL | T, R | 7 |
| | 5.1 | Reynolds experiment | | | | |
| | 5.2 | Darcy-Weisbach equation | | | | |
| | 5.3 | Major and minor losses in pipes | | | | |
| | 5.4 | Hydraulic gradient line and energy gradient line | | | | |
| | 5.5 | Pipes in series and parallel and equivalent pipe | | | | |
| 6 | Title | Boundary Layer Flow | CO6 | BL | T, R | 5 |
| | 6.1 | Boundary layer along thin plate and in pipe | | | | |
| | 6.2 | Boundary layer thickness, Momentum integral equation | | | | |
| | 6.3 | Drag and lift, Separation of boundary layer, | | | | |
| | 6.4 | Methods of preventing boundary layer separation. | | | | |
| Self - Study | SL1 | Applications of fluid mechanics in hydraulic systems and marine engineering | | | | |
| | SL2 | Flow visualization techniques and stream function applications | | | | |
| | SL3 | Analysis of flow measuring devices used in industries | | | | |
| | SL4 | Computational study of laminar and turbulent flow characteristics | | | | |
| | SL5 | Design considerations in industrial pipe network systems | | | | |
| | SL6 | Boundary layer applications in automobile and aerospace engineering | | | | |

## Laboratory Component (Any 10 experiments to be performed)

| SN | Title of the experiment | | Hrs |
|---|---|---|---|
| 1 | Calibration of Pressure Gauges | | 2 |
| 2 | Measurement of Hydrostatic Pressure | | 2 |
| 3 | Verification of Archimedes Principle | | 2 |
| 4 | Calibration of Venturimeter / Orificemeter / Pitot Tube | | 3 |
| 5 | Determination of Friction Factor for Pipes 2 | | 2 |
| 6 | Determination of Major and Minor Losses in Pipe Systems | | 2 |
| 7 | Verification of Bernoulli's Equation | | 2 |
| 8 | Experiment on Laminar Flow Through Pipe | | 2 |
| 9 | Calculation of Lift and Drag over Aerofoil | | 2 |
| 10 | Determination of Pressure Distribution over Aerofoil | | 3 |
| 11 | Determination of Coefficient of Discharge of Mouthpiece and Nozzle | | 2 |
| 12 | Performance Characteristics of Centrifugal Pump (Head, Discharge, Efficiency and Power) | | 2 |

# 14.6 Assessment Methodologies and Tools

## Theory Component

**IA = Internal Assessment; FA = Formative Assessment;*

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | IA-1 | 1 | CAT | Paper- Pen, Pencil | Class Room Test | 15 | 15 | 1 Hrs |
| **2** | IA-2 | 1 | CAT | Paper- Pen, Pencil | Class Room Test | 15 | 15 | 1 Hrs |
| **3** | FA | 2 | CAT | #MCQ/Quiz | Online Assessment | 10 | 10 | 0.5 Hrs |
| **4** | ESE | 1 | ESE | Paper- Pen, Pencil | In Class-End Sem Exam | 60 | 60 | 2.5 Hrs |

**IA = Internal Assessment; FA = Formative Assessment;*
*IA-1 will be conducted after completion of 1-3 Modules; IA-2 will be conducted after completion of 4-6 modules*
*#MCQ/Quiz on modules wise & GATE base Questions.*

## Lab Component

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | Exp 1 – Exp12 | 12 | CAT | Practical | Journal (Rubrics Based) | 20 | 40 | 2 Hrs |
| **2** | Class Participation | | CAT | Attendance | Record and Rubrics | 5 | 10 | 1 Hrs |
| **3** | ESE | 1 | ESE | Oral and Practical | Rubrics Based | 25 | 50 | 2 Hrs |

# 14.7 Suggested CO-PO/PSO Correlation Matrix

*CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)*

| CO # | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MEPC241.1** | 3 | 3 | – | – | – | – | – | – | – | – | – | 3 | 2 |
| **MEPC241.2** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 2 |
| **MEPC241.3** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 3 |
| **MEPC241.4** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 3 |
| **MEPC241.5** | 3 | 3 | – | – | 2 | 2 | – | – | – | – | – | 3 | 3 |
| **MEPC241.6** | 3 | 3 | – | – | 2 | 2 | – | – | – | – | – | 3 | 2 |

## 14.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK # | WK Statement | Justification of Mapping |
|---|---|---|---|
| **1** | WK1 | A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences. | Applied in understanding fluid properties and fluid behavior. |
| **2** | WK2 | Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. | Used in solving fluid flow and pressure measurement problems. |
| **3** | WK3 | A systematic, theory-based formulation of fundamentals required in the engineering discipline. | Applied in pipe system and hydraulic device analysis. |
| **4** | WK4 | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline. | Used in analysis of flow behavior and experimental fluid mechanics. |
| **5** | WK6 | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline. | Used in CFD simulations and flow visualization tools. |

## 14.9 Resources

### Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | Fluid Mechanics | 3rd | Yunus A. Cengel & John Cimbala | McGraw Hill | 2018 |
| **T2** | Fluid Mechanics and Hydraulic Machines | 1st | C.S.P. Ojha | Oxford | 2017 |
| **T3** | Fox and McDonald's Introduction to Fluid Mechanics | 9th | Pritchard & Mitchell | Wiley | 2020 |
| **T4** | Fluid Mechanics | 10th | R.K. Bansal | Laxmi | 2019 |

### Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | Fluid Mechanics | 8th | Frank M. White | McGraw Hill | 2017 |
| **R2** | Engineering Fluid Mechanics | 9th | K.L. Kumar | Eurasia Publishing House | 2016 |
| **R3** | Fluid Mechanics and Hydraulics | 2nd | Suresh Ukarande | Ane Books Pvt. Ltd. | 2018 |
| **R4** | Introduction to Fluid Mechanics | 1st | James A. Fay | MIT Press | 2015 |

### Online Resources

| SN | Title | Description |
|---|---|---|
| **O1** | https://nptel.ac.in/courses/112105171 | NPTEL course on Fluid Mechanics by IIT Professors |
| **O2** | https://ocw.mit.edu | MIT OpenCourseWare – Fluid Mechanics lecture notes |
| **O3** | https://www.learnengineering.org | Animated videos and concept explanations for fluid mechanics |
| **O4** | https://vlab.co.in | Virtual Labs by IITs for Fluid Mechanics experiments |

| | | |
|---|---|---|
| **O5** | https://www.cfd-online.com | CFD Online resources, discussions, and tutorials |
| **O6** | https://www.engineeringtoolbox.com | Fluid properties, pipe flow, and engineering calculators |
| **O7** | https://www.khanacademy.org/science/physics/fluids | Basic fluid mechanics concepts and tutorials |
| **O8** | https://www.youtube.com/@NesoAcademy | Fluid Mechanics video lectures and solved examples |
| **09** | https://www.youtube.com/@LearnChemE | Fluid flow animations and engineering applications |
| **10** | https://archive.nptel.ac.in | Archived NPTEL lectures, assignments, and notes |

# Chapter 15: *Subject- Kinematics and Control (Sem IV)*

| Overview | | | |
|---|---|---|---|
| **Course code:** | MEPC242 | Course Category: | Program Core Course |
| **Sem:** | IV | Syllabus & Version: | SIGCE-R25-Y2 |

## 15.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | Team work/ Self learning | Total |
|---|---|---|---|---|---|
| | L | T | P | SL | |
| **Hours/Week** | 3 | - | 2 | 3 | 8 |
| **Hours/Sem** | 45 | - | 30 | 45 | 120 |
| **Credits** | 3 | - | 1 | - | 4 |

## 15.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | 40% | 60% | 100% | 3 |
| **Labs** | 50% | 50% | 100% | 1 |

## 15.3 Course Objectives

| **Pre-requisite Course Codes, if any.** | Engineering Mechanics, Engineering Graphics, Applied Mathematics, Basics of Mechanical Systems |
|---|---|

**Course Overview:**

This course introduces the principles of kinematics and motion analysis of mechanisms used in mechanical systems. The course emphasizes velocity and acceleration analysis, motion transmission, cam-follower systems, governors and gyroscopic applications through analytical, graphical and simulation-based approaches. The curriculum integrates industrial applications, mechanism synthesis and modern design practices.

**Course Objective:**

1. To understand kinematic concepts and motion characteristics of mechanisms.
2. To analyze velocity and acceleration in machine elements and mechanisms.
3. To study motion transmission through belts, chains and gears.
4. To analyze cam follower mechanisms and motion characteristics.
5. To understand working principles and performance of governors.
6. To analyze gyroscopic effects in automobiles, ships and aircraft systems.

## 15.4 Course Outcomes

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **MEPC242.1** | Analyse kinematic pairs, chains and inversions of mechanisms. | Analyse |
| **MEPC242.2** | Determine velocity and acceleration in mechanisms using graphical methods. | Apply |
| **MEPC242.3** | Evaluate motion transmission characteristics in belts, chains and gears. | Analyse |
| **MEPC242.4** | Design and analyse cam follower systems for specified motion profiles. | Create |
| **MEPC242.5** | Analyse performance characteristics of governors. | Analyse |
| **MEPC242.6** | Evaluate gyroscopic effects in engineering applications. | Evaluate |

## 15.5 Modules / Syllabus Content

### Theory Component

| Module | Unit | Topic | CO | Blooms Level | Reference | Hrs |
|---|---|---|---|---|---|---|
| 1 | Title | Kinematic Pairs and Mechanisms | CO1 | BL | T,R | 06 |
| | 1.1 | Types of kinematic pairs, constrained motion and kinematic chains | | | | |
| | 1.2 | Mechanisms and inversions of four bar chain | | | | |
| | 1.3 | Single and double slider crank chain inversions | | | | |
| | 1.4 | Straight line mechanisms | | | | |
| | 1.5 | Intermittent motion mechanisms | | | | |
| 2 | Title | Velocity and Acceleration Analysis | CO2 | BL | T,R | 08 |
| | 2.1 | Relative velocity method for mechanisms | | | | |
| | 2.2 | Velocity analysis of slider crank mechanisms | | | | |
| | 2.3 | Acceleration analysis using relative acceleration method | | | | |
| | 2.4 | Coriolis component of acceleration and applications | | | | |
| 3 | Title | Power Transmission Drives | CO3 | BL | T,R | 07 |
| | 3.1 | Belt drives: velocity ratio, slip, creep and power transmission | | | | |
| | 3.2 | Flat belt and V-belt drives, centrifugal tension | | | | |
| | 3.3 | Chain drives and gear terminology | | | | |
| | 3.4 | Gear trains and velocity ratio calculations | | | | |
| 4 | Title | Cam and Followers | CO4 | BL | T,R | 05 |
| | 4.1 | Types of cams and followers, follower motions | | | | |
| | 4.2 | SHM, cycloidal and polynomial follower motions | | | | |
| | 4.3 | Displacement, velocity, acceleration and jerk diagrams | | | | |
| | 4.4 | Cam profile construction techniques | | | | |
| 5 | Title | Governors | CO5 | BL | T,R | 06 |
| | 5.1 | Types of governors and terminology | | | | |
| | 5.2 | Porter and Proell governors | | | | |
| | 5.3 | Hartnell governor and governor stability | | | | |
| | 5.4 | Isochronism, sensitiveness and hunting | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6 | Title | Gyroscope | CO6 | BL | T,R | 07 |
| | 6.1 | Gyroscopic couple and angular motion | | | | |
| | 6.2 | Gyroscopic effects in automobiles during steering | | | | |
| | 6.3 | Gyroscopic effects in ships and aircraft | | | | |
| | 6.4 | Stability and control applications | | | | |
| Self - Study | SS1 | Study of practical applications of four bar and slider crank mechanisms used in automobiles and machinery | | | | |
| | SS2 | Simulation of velocity and acceleration analysis of mechanisms using CAD/CAE software | | | | |
| | SS3 | Comparative study of belt, chain and gear drives used in industrial power transmission systems | | | | |
| | SS4 | Design and motion analysis of cam-follower mechanisms used in IC engines and automation systems | | | | |
| | SS5 | Study of electronic governors and modern speed control systems in engines and turbines | | | | |
| | SS6 | Applications of gyroscopic effects in ships, aircraft, robotics and navigation systems | | | | |

### Laboratory Component

| SN | Title of the experiment | Hrs |
|---|---|---|
| 1 | Study of kinematic pairs and mechanisms using models | 2 |
| 2 | Velocity analysis using relative velocity method | 3 |
| 3 | Acceleration analysis including Coriolis component | 3 |
| 4 | Motion analysis of Cam | 2 |
| 5 | Cam profile construction | 2 |
| 6 | Experiment on Porter governor characteristics | 3 |
| 7 | Experiment on Hartnell governor | 3 |
| 8 | Experiment on gyroscope apparatus | 2 |
| 9 | Belt drive and gear train analysis | 2 |
| 10 | Virtual simulation of mechanisms using software | 2 |
| 11 | Virtual simulation of mechanisms using software | 2 |
| 12 | Mini Project (Based on entire Syllabus, working Mechanism/Fabrication) | – |

## 15.6 Assessment Methodologies and Tools

### Theory Component

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | IA-1 | 1 | CAT | Paper- Pen, Pencil | Class Room Test | 15 | 15 | 1 Hrs |
| **2** | IA-2 | 1 | CAT | Paper- Pen, Pencil | Class Room Test | 15 | 15 | 1 Hrs |
| **3** | FA | 2 | CAT | #MCQ/Quiz | Online Assessment | 10 | 10 | 0.5 Hrs |
| **4** | ESE | 1 | ESE | Paper- Pen, Pencil | In Class-End Sem Exam | 60 | 60 | 2.5 Hrs |

**IA = Internal Assessment; FA = Formative Assessment;*

*IA-1 will be conducted after completion of 1-3 Modules; IA-2 will be conducted after completion of 4-6 modules*

*#MCQ/Quiz based on Modules & GATE based Question.*

### Lab Component

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | Exp 1 – Exp 12 | 12 | CAT | Practical | Journal (Rubrics Based) | 10 | 20 | 2 Hrs |
| **2** | FA | 1 | CAT | Mini Project | Rubrics based | 10 | 20 | 0.5 Hrs |
| **3** | Class Participation | | CAT | Attendance | Record and Rubrics | 5 | 10 | Continuous |
| **4** | ESE | | ESE | Oral and Practical | Rubrics Based | 25 | 50 | 2 Hrs |

## 15.7 Suggested CO-PO/PSO Correlation Matrix

*CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)*

| CO # | PO 1 | PO2 | PO 3 | PO 4 | PO5 | PO 6 | PO 7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MEPC206.1** | 3 | 3 | – | – | – | – | – | – | – | – | – | 3 | 2 |
| **MEPC206.2** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 2 |
| **MEPC206.3** | 3 | 3 | 2 | – | 2 | – | – | – | – | – | – | 3 | 3 |
| **MEPC206.4** | 3 | 3 | 3 | – | 2 | – | – | – | – | – | – | 3 | 3 |
| **MEPC206.5** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 2 |
| **MEPC206.6** | 3 | 3 | – | – | 2 | - | – | – | – | – | – | 3 | 2 |

## 15.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| **1** | WK2 | Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. | Used extensively in graphical and analytical analysis of mechanisms, gear trains, governors, cams and gyroscopic systems. |
| **2** | WK3 | A systematic, theory-based formulation of fundamentals required in the engineering discipline. | Provides core mechanical engineering fundamentals related to mechanisms, machine motion, kinematic analysis and power transmission systems. |
| **3** | WK4 | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline. | Applied in design and analysis of machine elements, mechanisms, automotive systems and industrial machinery. |
| **4** | WK5 | Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area. | Supports the selection and design of efficient mechanical systems and control strategies that improve performance, minimize energy consumption and enhance sustainable operation of engineering systems. |

| | | | |
|---|---|---|---|
| **4** | WK6 | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline. | Applied in practical analysis of cams, gears, belt drives, governors and gyroscopic systems used in industrial applications. |

# 15.9 Resources

## Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | Theory of Machines | 14th | R.S. Khurmi & J.K. Gupta | S. Chand | 2019 |
| **T2** | Theory of Machines | 4th | S.S. Rattan | McGraw Hill | 2020 |
| **T3** | Theory of Mechanisms and M/C | 3rd | Amitabha Ghosh & A K Mallik | East-West Press | 2018 |
| **T4** | Kinematics of Machinery | 1st | Cleghorn | Oxford | 2017 |
| **T5** | Mechanism and Machine Theory | 1st | Rao & Dukkipati | New Age | 2016 |

## Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | Theory of Machines | 3rd | Thomas Bevan | CBS Publishers | 2015 |
| **R2** | Mechanism Design | 4th | Erdman & Sandor | Pearson | 2017 |
| **R3** | Theory of Machines | 5th | Shigley & Uicker | Oxford | 2016 |
| **R4** | Kinematics and Dynamics of Machinery | 3rd | Wilson & Sadler | Pearson | 2018 |
| **R1** | Theory of Machines | 3rd | Thomas Bevan | CBS Publishers | 2015 |

## Online Resources

| SN | Title | Description |
|---|---|---|
| **O1** | NPTEL Kinematics of Mechanisms | Covers kinematic pairs, mechanisms, velocity and acceleration analysis of machines |
| **O2** | NPTEL Theory of Machines | Detailed lectures on gears, cams, governors and gyroscopic applications |
| **O3** | SWAYAM Theory of Machines | Online learning resource covering fundamentals and applications of machine kinematics |
| **O4** | MIT OpenCourseWare Mechanisms | Open educational material on mechanism dynamics and machine motion analysis |
| **O5** | NPTEL Governors and Gyroscope | Specialized resource on governors, balancing and gyroscopic effects in machines |

# *Chapter 16: Subject- Mechanical Measurement and Control (Sem IV)*

| Overview | | | |
|---|---|---|---|
| **Course code:** | MEPC243 | Course Category: | Program Core Course |
| **Sem:** | IV | Syllabus & Version: | SIGCE-R25-Y2 |

## 16.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | Team work/ Self learning | Total |
|---|---|---|---|---|---|
| | L | T | P | SL | |
| **Hours/Week** | 3 | - | - | 3 | 6 |
| **Hours/Sem** | 45 | - | - | 45 | 90 |
| **Credits** | 3 | - | - | - | 3 |

## 16.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | 40% | 60% | 100% | 3 |
| **Labs** | – | - | – | - |

## 16.3 Course Objectives

| | |
|---|---|
| **Pre-requisite Course Codes, if any.** | Engineering Mechanics, Engineering Mathematics, Basic Physics and basic electronics. |

**Course Overview:**

This course introduces students to modern mechanical measurement techniques, intelligent sensors, transducers, data acquisition systems, and control engineering fundamentals used in industrial automation and manufacturing systems. The course emphasizes measurement accuracy, signal conditioning, dynamic system modeling, and industrial process control with practical engineering applications.

**Course Objective:**

1. To introduce principles of mechanical measurements and instrumentation.
2. To develop understanding of sensors, transducers, and signal conditioning systems.
3. To impart knowledge of dimensional and process parameter measurements.
4. To study mathematical modelling and analysis of control systems.
5. To analyse transient and steady-state behaviour of engineering systems.
6. To familiarize students with modern digital instrumentation.

## 16.4 Course Outcomes

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **MEPC243.1** | Explain generalized measurement systems, standards, calibration, and measurement characteristics. | Understand |
| **MEPC243.2** | Select suitable sensors and transducers for mechanical engineering applications. | Apply |
| **MEPC243.3** | Analyze dimensional, temperature, pressure, and flow measurement systems. | Analyse |
| **MEPC243.4** | Develop mathematical models and transfer functions of engineering systems. | Create |
| **MEPC243.5** | Evaluate transient and steady-state response characteristics of control systems. | Apply |
| **MEPC243.6** | Apply digital instrumentation concepts in practical systems. | Apply |

## 16.5 Modules / Syllabus Content

### Theory Component

| Module | Unit | Topic | CO | Blooms Level | Reference | Hrs |
|---|---|---|---|---|---|---|
| 1 | Title | Fundamentals of Mechanical Measurements and Error Analysis | CO1 | BL | T, R | 6 |
| | 1.1 | Introduction to Mechanical Measurements, Standards, Calibration, Generalized Measurement System | | | | |
| | 1.2 | Static Characteristics: Accuracy, Precision, Sensitivity, Linearity, Drift, Hysteresis | | | | |
| | 1.3 | Dynamic Characteristics and Measurement Errors | | | | |
| | 1.4 | Statistical Analysis of Measured Data | | | | |
| 2 | Title | Sensors, Transducers and Smart Instrumentation | CO2 | BL | T, R | 7 |
| | 2.1 | Classification of Sensors and Transducers | | | | |
| | 2.2 | Sensors, Strain Gauges, Load Cells and Torque Sensors | | | | |
| | 2.3 | LVDT, Capacitive Sensors and Optical Encoders | | | | |
| | 2.4 | Smart Sensors and MEMS Applications | | | | |
| 3 | Title | Industrial Process and Dimensional Measurements | CO3 | BL | T, R | 6 |
| | 3.1 | Pressure and Vacuum Measurement | | | | |
| | 3.2 | Temperature Measurement using RTD, Thermistors and Thermocouples | | | | |
| | 3.3 | Flow Measurement: Venturi meter, Orifice Meter and Rotameter | | | | |
| | 3.4 | Surface Roughness and Dimensional Measurement | | | | |
| 4 | Title | Mathematical Modelling of Control Systems | CO4 | BL | T, R | 7 |
| | 4.1 | Introduction to Control Systems and Classification | | | | |
| | 4.2 | Mathematical Modelling of Mechanical and Thermal Systems | | | | |
| | 4.3 | Transfer Functions and Block Diagram Reduction | | | | |
| | 4.4 | Signal Flow Graphs and Mason's Gain Formula | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | Title | Time Response and Stability Analysis of Control Systems | CO5 | BL | T, R | 7 |
| | 5.1 | Time Response of First Order Systems | | | | |
| | 5.2 | Time Response of Second Order Systems | | | | |
| | 5.3 | Steady State Errors and Error Constants | | | | |
| | 5.4 | Stability Analysis using Routh Criterion | | | | |
| 6 | Title | Digital Instrumentation | CO6 | BL | T, R | 6 |
| | 6.1 | Signal Conditioning | | | | |
| | 6.2 | Digital Instrumentation and Data Acquisition Systems | | | | |
| Self - Study | SS. 1 | Study the latest industrial standards and calibration procedures used in modern measurement systems. | | | | |
| | SS. 2 | Explore recent applications of MEMS sensors and smart transducers in automotive and industrial automation systems. | | | | |
| | SS. 3 | Investigate advanced dimensional inspection techniques such as CMM and laser-based measurement systems used in manufacturing industries. | | | | |
| | SS. 4 | Practice modelling of real-life mechanical and thermal systems using transfer function approaches. | | | | |
| | SS. 5 | Analyze industrial case studies related to transient response and stability improvement of control systems. | | | | |
| | SS. 6 | Digital instrumentation systems used in smart manufacturing industries. | | | | |

## 16.6 Assessment Methodologies and Tools

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | IA-1 | 1 | CAT | Paper- Pen, Pencil | Class Room Test | 15 | 15 | 1 Hrs |
| **2** | IA-2 | 1 | CAT | Paper- Pen, Pencil | Class Room Test | 15 | 15 | 1 Hrs |
| **3** | FA | 2 | CAT | #MCQ/Quiz | Online Assessment | 10 | 10 | 0.5 Hrs |
| **4** | ESE | 1 | ESE | Paper- Pen, Pencil | In Class-End Sem Exam | 60 | 60 | 2.5 Hrs |

### Theory Component

**IA = Internal Assessment; FA = Formative Assessment;*

*IA-1 will be conducted after completion of 1-3 Modules; IA-2 will be conducted after completion of 4-6 modules*

*#MCQ/Quiz based on Modules & GATE based Question.*

## 16.7 Suggested CO-PO/PSO Correlation Matrix

*CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)*

| CO # | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MEPC243.1** | 3 | 2 | – | – | – | – | – | – | – | – | – | 2 | 2 |
| **MEPC243.2** | 3 | 3 | 2 | – | 2 | – | – | – | – | – | – | 3 | 3 |
| **MEPC243.3** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 3 |
| **MEPC243.4** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 2 |
| **MEPC243.5** | 3 | 3 | – | – | 2 | – | – | – | – | – | – | 3 | 2 |
| **MEPC243.6** | 3 | 2 | – | – | 3 | – | – | – | – | – | - | 2 | 3 |

## 16.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| 1 | WK1 | A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences. | The course applies principles of physics related to temperature, pressure, force, displacement, flow, and other physical quantities that form the basis of measurement systems and instrumentation. |
| 2 | WK2 | Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. | Mathematical modelling of dynamic systems, transfer function development, response analysis, signal interpretation, and performance evaluation of control systems require mathematical and analytical techniques. |
| 3 | WK3 | A systematic, theory-based formulation of fundamentals required in the engineering discipline. | The course provides fundamental knowledge of measurement systems, calibration, sensors, transducers, instrumentation, system dynamics, and control engineering essential for mechanical engineering practice. |
| 4 | WK5 | Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area. | Accurate measurements and efficient control strategies contribute to optimal resource utilization, improved energy efficiency, reduced wastage, and sustainable operation of engineering systems and industrial processes. |

| | | | |
|---|---|---|---|
| 5 | WK6 | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline. | The course involves practical applications of sensors, transducers, calibration methods, instrumentation devices, control components, and digital measurement technologies widely used in industry. |

# 16.9 Resources

## Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | Mechanical Measurements and Instrumentation | 18th | A.K. Sawhney | Dhanpat Rai Publications | 2019 |
| **T2** | Measurement Systems: Application and Design | 6th | Ernest O. Doebelin | McGraw Hill Education | 2017 |
| **T3** | Mechanical Measurements | 2nd | S.P. Venkateshan | Wiley India | 2015 |
| **T4** | Instrumentation and Control Systems | 2nd | W. Bolton | Elsevier | 2019 |
| **T5** | Control Systems Engineering | 7th | I.J. Nagrath and M. Gopal | New Age International | 2021 |
| **T6** | Modern Control Engineering | 5th | Katsuhiko Ogata | Pearson Education | 2018 |

## Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | Engineering Metrology | 3rd | R.K. Jain | Khanna Publishers | 2018 |
| **R2** | Engineering Metrology and Measurements | 2nd | N.V. Raghavendra and L. Krishnamurthy | Oxford University Press | 2018 |
| **R3** | Experimental Methods for Engineers | 8th | J.P. Holman | McGraw Hill | 2012 |
| **R4** | Instrumentation Devices and Systems | 2nd | C.S. Rangan, G.R. Sharma andV.S.V. Mani | Tata McGraw Hill | 2011 |
| **R5** | Automatic Control Systems | 10th | Benjamin C. Kuo and Farid Golnaraghi | Wiley India | 2017 |
| **R6** | Process Control Instrumentation Technology | 8th | Curtis D. Johnson | Pearson Education | 2014 |

## Online Resources

| Sr. No. | Title of Online Resource | Description |
|---|---|---|

| | | |
|---|---|---|
| **O1** | NPTEL – Principles of Mechanical Measurement | Comprehensive course covering measurement systems, calibration techniques, sensors, transducers and industrial instrumentation applications offered by Indian Institute of Technology Guwahati. |
| **O2** | NPTEL – Mechanical Measurement Systems | Detailed study material on mechanical measurements, data acquisition systems, error analysis and instrumentation methods from Indian Institute of Technology Roorkee. |
| **O3** | NPTEL – Mechanical Measurements and Metrology | Covers metrology, dimensional measurements, surface roughness, comparators and industrial inspection systems by Indian Institute of Technology Madras. |
| **O4** | NPTEL – Control Engineering | Provides fundamental and advanced concepts of transfer functions, stability analysis and time response of control systems by Indian Institute of Technology Kharagpur. |
| **O5** | MATLAB Control System Tutorials | Industrial tutorials and simulation examples for modelling and analysis of control systems using MathWorks MATLAB and Simulink tools. |
| **O6** | National Instruments – Instrumentation and DAQ Resources | Technical resources on data acquisition systems, signal conditioning and virtual instrumentation using LabVIEW from National Instruments. |
| **O7** | Automation Studio Learning Resources | Learning material for hydraulic, pneumatic and control system simulation useful for laboratory and industrial automation studies. |

# *Chapter 17: Subject- Design Thinking (Sem IV)*

| Overview | | | |
|---|---|---|---|
| **Course code:** | **IGEM242** | **Course Category:** | Vocational and Skill Enhancement Course |
| **Sem:** | **IV** | **Syllabus & Version:** | SIGCE-NEP-R25-Y2 |

## 17.1 Teaching & Learning Scheme

| Components | Classroom Instruction | | Lab instructions | | Teamwork/ Self learning | Total |
|---|---|---|---|---|---|---|
| | L | T | P | D | SL | |
| **Hours/Week** | - | - | 2 | 2 | - | 4 |
| **Hours/Sem** | - | - | 30 | 30 | - | **60** |
| **Credits** | - | - | 2 | - | - | **2** |

** L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning*

## 17.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | - | - | **-** | **-** |
| **Lab & Term Work** | 100% | - | **100%** | **2** |

## 17.3 Course Objectives

| **Pre-requisite Course / Knowledge** | |
|---|---|
| **Course Overview:**<br>This course introduces students to the principles, process, and practical application of design thinking as a human-cantered approach to problem-solving. It focuses on understanding user needs, redefining problems, and creating innovative solutions through iterative design. | |
| **Course Objective:**<br>1. To introduce learners to the fundamental concepts of Design Thinking.<br>2. To make learners understand the different stages involved in the Design Thinking process.<br>3. To acquaint learners with various tools used in Design Thinking.<br>4. To study techniques used for generating solutions to problems.<br>5. To provide exposure to different case studies related to Design Thinking.<br>6. To design, develop, and evaluate a prototype. | |

# 17.4 Modules / Syllabus Content

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **IGEM241.1** | Differentiate between traditional problem-solving methods and the Design Thinking approach and explain its core principles. | Analyze (L4) |
| **IGEM241.2** | Develop a user persona by applying empathy-based techniques. | Apply (L3) |
| **IGHS241.3** | Formulate a clear problem statement using appropriate Design Thinking tools. | Apply (L3) |
| **IGEM241.4** | Apply ideation methods to generate multiple solution options for a problem. | Apply (L3) |
| **IGEM241.5** | Build prototypes using a variety of techniques. | Create (L6) |
| **IGEM241.6** | Evaluate prototypes and collect feedback to improve and refine them. | Evaluate (L5) |

# 17.5 Modules / Syllabus Content

## Theory Component

| Module | Unit | Topic | CO | Blooms Level | Reference | Hrs |
|---|---|---|---|---|---|---|
| 1 | **Title** | **Introduction to Design Thinking** | **CO1** | **L4** | **T1, R1** | **5** |
| | 1.1 | Definition, History and need of Design Thinking | | | | |
| | 1.2 | Difference between Traditional Problem Solving and Design Thinking approach | | | | |
| | 1.3 | Key tenets of Design Thinking | | | | |
| 2 | **Title** | **Empathize** | **CO2** | **L3** | **T1, T2, R1** | **5** |
| | 2.1 | Foundation of Empathy and its purpose | | | | |
| | 2.2 | Methods for understanding user needs: Interviews, observation and immersion | | | | |
| | 2.3 | Empathy Mapping and persona development | | | | |
| 3 | **Title** | **Define – Problem Definition and Analysis** | **CO3** | **L3** | **T2, T3, R1** | **5** |
| | 3.1 | Significance of defining a problem | | | | |
| | 3.2 | Analyse research data to identify core problem | | | | |
| | 3.2 | Crafting actionable Problem Statements (Point of View - POV) | | | | |
| 4 | **Title** | **Ideate – Generating solution** | **CO4** | **L3** | **T1, T2, R2** | **5** |
| | 4.1 | Divergent vs Convergent thinking | | | | |
| | 4.2 | Brainstorming techniques: Mind mapping, SCAMPER | | | | |
| | 4.3 | Concept selection and feasibility assessment | | | | |
| 5 | **Title** | **Prototype - Making ideas tangible** | **CO5** | **L6** | **T1, T3, R1** | **3** |
| | 5.1 | Low Fidelity to High Fidelity Prototype | | | | |
| | 5.2 | Rapid Prototyping technique | | | | |
| 6 | **Title** | **Test – Iteration and Feedback** | **CO6** | **L5** | **T1, T2, R1** | **3** |
| | 6.1 | Guidelines for conducting test | | | | |

| | | |
|---|---|---|
| | 6.2 | User validation and usability testing |
| | 6.3 | Developing Feedback loops to refine the prototype based on testing |
| **Self-Study** | SS.1 | Self-Learning: Case Studies from various domains |
| | SS.2 | Self-Learning: Empathy and User Research |
| | SS.3 | Self-Learning: Creating a Persona – A Step-by-step guide with tips and examples |
| | SS.4 | Self-Learning: How to run an effective ideation workshop: A step-by-step guide |
| | SS.5 | Self-Learning: Various case studies related to prototyping |
| | SS.6 | Self-Learning: To find End Goals of test: Desirability, Feasibility and Viability |

## Laboratory Component (Suggested List of Experiments)

| SN | Title of the experiment | Description | CO | Hrs |
|---|---|---|---|---|
| **1** | Customer Journey Mapping – Visualize user interaction from discovery to usage and identify pain points | **CO2** | **2** | **1** |
| **2** | Stakeholder Mapping – Identify stakeholders and categorize them by influence and interest | **CO2** | **2** | **2** |
| **3** | How Might We Problem Framing – Convert insights into actionable problem statements | **CO3** | **2** | **3** |
| **4** | Brainstorming Session – Generate creative ideas using mind mapping and brainwriting techniques | **CO4** | **2** | **4** |
| **5** | Affinity Diagramming – Group ideas into themes to identify patterns and insights | **CO3** | **2** | **5** |
| **6** | Rapid Prototyping – Create quick, low-fidelity prototypes focusing on functionality | **CO5** | **2** | **6** |
| **7** | Wireframing – Design basic layouts for mobile/web interfaces | **CO5** | **2** | **7** |
| **8** | Role-Playing – Simulate user interactions with prototypes to gather feedback | **CO6** | **2** | **8** |
| **9** | Usability Testing – Test prototypes with users to identify issues and improvements | **CO6** | **2** | **9** |
| **10** | Feedback Loop and Iteration – Refine solutions based on user feedback and document improvements | **CO6** | **2** | **10** |

## Assignments (Suggested list of Assignments)

| SN | List of Assignments |
|---|---|
| 1 | Create an empathy map for a specific target user group. Divide it into four sections: *Says, Thinks, Feels, and Does*. Gather insights by interviewing users or researching their experiences. |
| 2 | Based on research, develop user personas that include demographics, motivations, pain points, and goals. Present the persona to the class. |
| 3 | Select three real-life products with both good and bad design aspects. Analyse them and explain why you consider their design effective or ineffective. |
| 4 | Explore any open-source design thinking tool and write a short report about it. You may Also conduct a user survey to support your findings. |

# 17.6 Assessment Methodologies and Tools

## Lab Component

| | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | Experiment | 10 | CAT | Practical Experiments | Journal (Rubrics Based) | **25** | 50 | |
| **2** | Assignment | 4 | CAT | Teacher Choice | Teacher Choice | **10** | 20 | |
| **3** | Report | 1 | CAT | Report Writing | Rubrics based | **10** | 20 | |
| **4** | Attendance | 1 | CAT | Attendance | Record based | **5** | 10 | |

Note:

1. *CAT Activity will be part of Term Work.*
2. *The final certification and acceptance of Term Work (TW) shall be granted only if the student has demonstrated satisfactory performance in laboratory work and has secured the minimum passing marks in the Term Work.*
3. *Learners will perform minimum 10 experiments at least 1 experiment from each module.*

# 17.7 Suggested CO-PO/PSO Correlation Matrix

***CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)***

| CO # | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **IGEM241.01** | 3 | 3 | - | - | 2 | - | - | 2 | 2 | - | - | 2 | 2 | |
| **IGEM241.02** | 2 | 3 | 3 | 2 | 2 | - | - | 2 | 2 | - | - | 3 | 2 | |
| **IGEM241.03** | 3 | 3 | 3 | 2 | 2 | - | - | 2 | 2 | - | - | 3 | 2 | |
| **IGEM241.04** | 2 | 2 | 2 | 2 | 2 | - | - | 2 | 2 | - | - | 3 | 2 | |
| **IGEM241.05** | 2 | 2 | 2 | 2 | 2 | - | - | 2 | 2 | - | - | 3 | 2 | |
| **IGEM241.06** | 2 | 2 | 2 | 3 | 2 | - | - | 2 | 2 | - | - | 3 | 2 | |

# 17.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| **1** | **WK2** | Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the | Design Thinking involves analytical and data-driven approaches for understanding user needs and evaluating solutions. |

| | | | |
|---|---|---|---|
| | | discipline. | |
| **2** | **WK5** | Knowledge including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts. | The subject promotes sustainable and resource-efficient solution development for real-world problems. |
| **3** | **WK7** | Knowledge of the role of engineering in society and identified issues in engineering practice including public safety and sustainable development. | Design Thinking focuses on solving societal problems with user-centric and socially responsible approaches. |
| **4** | **WK8** | Engagement with current research literature, critical thinking, and creative approaches to evaluate emerging issues. | The subject develops innovation, creativity, critical thinking, and problem-solving abilities. |

# 17.9 Resources

## Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | Design Your Thinking: The Mindsets, Toolsets, and Skill Sets for Creative Problem-Solving | 1st | Pavan Soni | Penguin Random House India Pvt. Ltd. | 2022 |
| **T2** | Design Thinking: Methodology Book | 1st | Emrah Yayici | CRC Press | 2016 |
| **T3** | Handbook of Design Thinking | 1st | Christian Mueller Roterberg | Independently Published | 2018 |

## Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School | 2nd | Idris Mootee | Wiley | 2013 |
| **R2** | Change by Design | Revised | Tim Brown | Harper Business | 2009 |

## Online Resources

| SN | Title | Description |
|---|---|---|
| **01** | Design Thinking and Innovation by Ravi Poovaiah https://onlinecourses.swayam2.ac.in/aic23_ge17/preview | SWAYAM course covering fundamentals of Design Thinking, innovation processes, user-centred design, ideation techniques, and real-world applications. |
| **02** | Introduction to Design Thinking by Dr. Rajeshwari Patil, Dr. Manisha Shukla, Dr. Deepali Raheja, Dr. Mansi Kapoor | SWAYAM course introducing Design Thinking concepts, problem-solving methodologies, empathy, ideation, prototyping, and testing techniques. |

| | | |
|---|---|---|
| | https://onlinecourses.swayam2.ac.in/imb24_mg37/preview | |
| **03** | Usability Testing<br>https://www.interaction-design.org/literature/topics/usability-testing | Online resource explaining usability testing principles, user evaluation methods, feedback collection techniques, and best practices for improving user experience and product design. |

# Chapter 18: Subject - Engineering Fundamentals and Technical Skills (Sem: IV)

| Overview | | | |
|---|---|---|---|
| **Course Code:** | **IGVS241** | **Course Category:** | Vocational and Skill Enhancement |
| **Sem:** | IV | **Syllabus & Version:** | SIGCE-NEP-R25-Y2 |

## 18.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | | Team work/ Self learning | Total |
|---|---|---|---|---|---|---|
| | L | T | P | D | SL | |
| **Hours/Week** | - | - | | 2 | - | **2** |
| **Hours/Sem** | - | - | | 30 | - | **30** |
| **Credits** | - | - | | 1 | - | **1** |

* L = Lectures; T= Tutorials; P = Practical; D = Demo; SL = Self Learning

## 18.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | - | - | **-** | **-** |
| **Labs/ Demo/ Activity** | 100% | - | **100%** | **1** |

## 18.3 Course Objectives

| **Pre-requisite Course Codes, if any.** | Programming for Problem Solving, Engineering Mathematics |
|---|---|
| **Course Overview:**<br><br>The course series provides comprehensive training in programming, problem solving, database management, and competitive coding skills required for academic excellence and industry readiness. It covers Python and Java programming fundamentals, object-oriented programming, data structures, algorithms, SQL query writing, debugging techniques, and optimization methods. The courses also focus on logical reasoning, competitive programming strategies, advanced problem-solving techniques, graph and string algorithms, and number theory concepts. Through hands-on coding practice, placement-oriented challenges, mock tests, and real-world case studies, students develop strong analytical, technical, and | |

| |
|---|
| interview preparation skills essential for software development, coding competitions, and career opportunities in the IT industry. |
| **Course Objective:**<br>1. To develop programming and logical problem-solving skills using Python fundamentals, data structures, object-oriented concepts, and placement-oriented coding techniques.<br>2. To apply Java programming concepts, object-oriented principles, and data structures for developing efficient solutions to coding and real-world programming problems.<br>3. To understand and implement SQL queries, joins, subqueries, indexing, and aggregate functions for effective database management and data retrieval.<br>4. To enhance algorithmic thinking and coding efficiency through optimization techniques, modular arithmetic, and competitive programming strategies.<br>5. To strengthen analytical reasoning, debugging abilities, and optimization skills for solving computational and logical problems efficiently.<br>6. To apply advanced algorithms, graph techniques, string algorithms, and number theory concepts in solving complex programming and real-world competitive coding challenges. |

## 18.4 Course Outcomes

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **IGVS241.1** | Apply Python programming concepts, data structures, object-oriented programming principles, and competitive coding techniques to solve logical and placement-oriented programming problems efficiently. | Apply (L3) |
| **IGVS241.2** | Develop Java-based solutions using programming fundamentals, object-oriented concepts, data structures, algorithms, and debugging techniques for software development and coding challenges. | Apply (L3) |
| **IGVS241.3** | Design and execute SQL queries using joins, subqueries, aggregate functions, indexing, and views for efficient database management and data retrieval applications. | Understand (L2) |
| **IGVS241.4** | Analyze and solve competitive programming problems using algorithmic techniques such as greedy methods, divide-and-conquer strategies, sliding window, prefix sums, and modular arithmetic. | Analyze (L4) |
| **IGVS241.5** | Demonstrate effective problem-solving abilities through optimization techniques, debugging strategies, test case validation, and analytical reasoning for computational problems. | Analyze (L4) |

| | | |
|---|---|---|
| **IGVS241.6** | Apply advanced algorithms including graph algorithms, weighted pathfinding, string matching algorithms, and number theory concepts to solve complex real-world and competitive programming challenges. | Evaluate (L5) |

# 18.5 Modules / Syllabus Content

## Demo Component

| Module | Unit | Topic | CO | Blooms Level | Reference | Hrs |
|---|---|---|---|---|---|---|
| | **Title** | **Python Programming and Problem Solving** | **CO1** | **Apply (L3)** | **T1, R1** | **5** |
| | 1.1 | Python Programming Fundamentals 1. Variables, Data Types, and Operators 2. Conditional Statements and Loops 3. Functions, Lists, and String Handling | | | | |
| | 1.2 | Data Structures using Python 1. Lists, Tuples, and Dictionaries 2. Stack and Queue Implementation 3. Searching and Sorting Techniques, Time Complexity and Optimization Techniques 2. Pattern Programming and Logical Problem Solving 3. Placement-Oriented Coding Challenges | | | | |
| | 1.3 | Object-Oriented Programming in Python 1. Classes and Objects 2. Inheritance and Polymorphism 3. Constructors and Encapsulation | | | | |
| | 1.4 | Activity: Develop Python programs to perform searching and sorting techniques such as Linear Search, Binary Search, Bubble Sort, and Selection Sort. | | | | |
| | 1.5 | Activity: Analyze the time complexity of different algorithms and implement optimized coding solutions for placement-oriented problems. | | | | |
| 2 | **Title** | **Core Java Programming and Problem Solving** | **CO2** | **Apply (L3)** | **T2, R2** | **5** |
| | 2.1 | Java Programming Fundamentals 1. Variables, Data Types, Operators, and Input/Output 2. Conditional Statements and Looping Constructs 3. Methods, Arrays, and String Handling | | | | |
| | 2.2 | Data Structures using Java 1. Arrays, ArrayList, and LinkedList 2. Stack, Queue, and HashMap Implementation 3. Searching and Sorting Algorithms, Competitive Coding using Java 1. Time Complexity and Optimization Techniques 2. Pattern Programming and Logical Coding Problems 3. Placement-Oriented Coding Challenges | | | | |
| | 2.3 | Object-Oriented Programming in Java 1. Classes, Objects, and Constructors 2. Inheritance, Polymorphism, and Abstraction 3. Encapsulation and Interface Concepts | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 2.4 | Activity: Develop Java programs to perform searching and sorting algorithms such as Linear Search, Binary Search, Bubble Sort, and Merge Sort. | | | | |
| | 2.5 | Activity: Create Java classes and objects to model real-world applications using constructors and methods. | | | | |
| 3 | **Title** | **SQL Basics and Intermediate** | **CO3** | **Apply (L3)** | **T3, r3** | **4** |
| | 3.1 | Understanding SQL Syntax, Writing Complex Queries, Advanced Joins (INNER OUTER, CROSS) | | | | |
| | 3.2 | Nested Subqueries, Indexing Techniques, Aggregate Functions (GROUP BY, HAVING) Using Views for Query Simplification | | | | |
| | 3.3 | Activity: Develop SQL queries using nested subqueries for data analysis and conditional retrieval. | | | | |
| | 3.4 | Activity: Develop a database application using views to generate summarized reports from multiple tables. | | | | |
| 4 | **Title** | **Competitive Programming Basics** | **CO4** | **Apply (L3)** | **T4, R4** | **4** |
| | 4.1 | Greedy Algorithms in Practice, Divide and Conquer Techniques, Sliding Window and Two Pointers,Prefix Sums | | | | |
| | 4.2 | Dynamic Array Usage in Problem Solving, Applying Modular Arithmetic in Coding Challenges | | | | |
| | 4.3 | Activity: Implement prefix sum algorithms to perform efficient range sum and cumulative data analysis operations. | | | | |
| | 4.4 | Activity: Solve competitive programming challenges involving modular arithmetic and large number computations efficiently. | | | | |
| 5 | **Title** | **Problem Solving Techniques** | **CO5** | **Apply (L3)** | **T5, R5** | **4** |
| | 5.1 | Understanding Problem Statements,Optimizing Solutions (Time and Space Complexity) | | | | |
| | 5.2 | Test Case Generation and Validation, Debugging Advanced Logical Errors | | | | |
| | 5.3 | Activity: Analyze different programming problem statements and identify inputs, outputs, constraints, and expected solutions. | | | | |
| | 5.4 | Activity: Develop automated test scenarios to verify the accuracy and reliability of coding solutions. | | | | |
| 6 | **Title** | **Advanced Problem Solving** | **CO6** | **Analyze (L4)** | **T6, r6** | **4** |

| | | |
|---|---|---|
| | 6.1 | Advanced Graph Problems (Dynamic Graph Queries), Pathfinding in Weighted Graphs), String Algorithms (KMP, Z Algorithm, Rabin- Karp) |
| | 6.2 | Number Theory (Primality Testing, GCD, LCM, Chinese Remainder Theorem), Real- world Case Studies in Competitive Programming |
| | 6.3 | Activity: Develop programs for dynamic graph queries and real-time pathfinding applications using graph data structures. |
| | 6.4 | Activity: Design optimized coding solutions for industry-level problem statements using advanced algorithms and data structures. |

## 18.6 Assessment Methodologies and Tools

### Lab Component

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | Activity | 12 | CAT | • Activity | • Journal (Rubrics Based) | 20 | 80 | 2 Hrs. |
| **2** | Attendance | | CAT | • Attendance<br>• Teachers Observation | • Record | 5 | 20 | 2 Hrs. |

*CAT Activity will be part of Term Work*

## 18.7 Suggested CO-PO/PSO/PEO Correlation Matrix

***CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)***

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **IGVS241.1** | - | - | - | - | - | 2 | - | 2 | 3 | 3 | - | 2 | - | - |
| **IGVS241.2** | 2 | 2 | - | - | 2 | - | - | - | 3 | 3 | - | - | 2 | - |
| **IGVS241.3** | - | - | 2 | 2 | - | - | - | - | - | - | - | - | 2 | - |
| **IGVE241.4** | 2 | 2 | - | - | - | 2 | - | 2 | 3 | - | - | 3 | - | - |
| **IGVS241.5** | - | 2 | - | - | 2 | - | - | 3 | - | 3 | 2 | - | - | - |
| **IGVS241.6** | 2 | 3 | 2 | - | 2 | 2 | - | - | 2 | 3 | 2 | 3 | 2 | 2 |

## 18.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| 1 | WK1 | A systematic, theory-based understanding of the natural sciences applicable to engineering fundamentals. | Students develop foundational knowledge of Python programming, Java programming, SQL, algorithms, and computational problem-solving concepts essential for engineering and software applications. |
| 2 | WK2 | Conceptually-based mathematics, numerical analysis, statistics, and formal aspects of computer and information science to support engineering analysis and modeling. | Competitive programming, time complexity analysis, modular arithmetic, graph algorithms, and optimization techniques strengthen analytical, mathematical, and logical reasoning abilities. |
| 3 | WK3 | A systematic, theory-based formulation of engineering fundamentals required in engineering specialization. | The course develops core understanding of data structures, object-oriented programming, database systems, searching and sorting techniques, and advanced computational methods required for computer engineering specialization. |
| 4 | WK5 | Engineering practice supported by techniques, resources, and modern engineering and IT tools necessary for engineering activities. | Practical implementation using Python, Java, SQL platforms, coding environments, debugging tools, GitHub, and online coding platforms enhances modern software engineering practices. |
| 5 | WK6 | Engineering practice informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues relevant to professional engineering practice. | Real-world case studies, debugging practices, and placement-oriented coding activities improve professional decision-making and responsible software development skills. |

## 18.9 Resources

### Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| T1 | Python Programming: An Introduction to Computer Science | 3rd | John Zelle | Franklin, Beedle & Associates | 2016 |
| T2 | Java: The Complete Reference | 11th | Herbert Schildt | McGraw Hill | 2019 |
| T3 | Learning SQL | 3rd | Alan Beaulieu | O'Reilly Media | 2020 |
| T4 | Database System Concepts | 7th | Abraham Silberschatz, Henry F. Korth, S. Sudarshan | McGraw Hill | 2019 |

| | | | | | |
|---|---|---|---|---|---|
| **T5** | *Problem Solving with Algorithms and Data Structures using Python* | 3rd | Bradley N. Miller, David L. Ranum | Franklin, Beedle & Associates | 2011 |
| **T6** | *Algorithm Design* | 1st | Jon Kleinberg, Éva Tardos | Pearson | 2005 |

## Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | Automate the Boring Stuff with Python | 2nd | Al Sweigart | No Starch Press | 2019 |
| **R2** | Introduction to Programming in Java | 2nd | Robert Sedgewick, Kevin Wayne | Addison-Wesley | 2017 |
| **R3** | SQL Practice Problems | 1st | Sylvia Moestl Vasilik | Manning Publications | 2017 |
| **R4** | Database Management Systems | 3rd | Raghu Ramakrishnan, | McGraw Hill | 2002 |
| **R5** | Guide to Competitive Programming | 1st | Antti Laaksonen | Springer | 2017 |
| **R6** | Algorithms Unlocked | 1st | Thomas H. Cormen | MIT Press | 2013 |

## Online Resources

| SN | Title | Description |
|---|---|---|
| **O1** | https://leetcode.com | A student-friendly platform to practice coding problems, data structures, and algorithms for improving programming skills and preparing for placements. |
| **O2** | https://docs.oracle.com/en/java/javase/26/ | Official Java learning resource for students to understand core Java concepts, syntax, libraries, and programming fundamentals. |
| **O3** | https://sqlzoo.net/wiki/SQL_Tutorial | Interactive SQL practice website designed for students to learn and apply database queries step-by-step. |
| **O4** | https://codeforces.com/ | Competitive programming platform for students to practice coding challenges and improve problem-solving speed and accuracy. |

| | | |
|---|---|---|
| O5 | https://www.interviewbit.com/ | Structured learning platform for students to prepare for technical interviews through coding practice and conceptual learning. |

# Chapter 19: *Subject - AI Tools (SEM IV)*

| Overview | | | |
|---|---|---|---|
| **Course code:** | **MEVS241** | **Course Category:** | Vocational & Skill Enhancement |
| **Sem:** | IV | **Syllabus & Version:** | SIGCE-NEP-R2025-Y2 |

## 19.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | | Team work/ Self learning | Total |
|---|---|---|---|---|---|---|
| | L | T | P | D | SL | |
| **Hours/Week** | - | - | 2 | 2 | - | **4** |
| **Hours/Sem** | - | - | 30 | 30 | - | **60** |
| **Credits** | - | - | 2 | | - | **2** |

** L = Lectures; T = Tutorials; P = Practical; D= Demo; SL=Self Learning*

## 19.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | - | - | - | - |
| **Labs** | 50% | 50% | **100%** | **2** |

## 19.3 Course Objectives

| **Pre-requisite Course / Knowledge** | Knowledge of any programming or algorithms is desirable |
|---|---|
| **Course Overview:**<br>This course provides hands-on exposure to modern AI-powered tools across writing, image generation, coding, research, and workflow automation. Students will learn to effectively integrate these tools into real-world academic, research, and industrial applications. | |
| **Course Objective:**<br>1 To introduce students to the landscape and capabilities of modern AI tools used in various domains.<br>2 To familiarize students with the use of AI tools for enhancing productivity in writing, coding, research, and design tasks.<br>3 To provide exposure to AI-based systems for generating and processing text, images, and code.<br>4 To impart knowledge of integrating multiple AI tools for building automated workflows.<br>5 To create awareness about ethical considerations, limitations, and responsible use of AI technologies. | |

## 19.4 Course Outcomes

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **EEVS242.1** | Use AI tools effectively for content creation and communication | Apply(L3) |
| **EEVS242.2** | Create a brand logo or product concept artwork using multiple prompt variations; evaluate image quality, consistency, and prompt effectiveness across different AI image generation tools | Evaluate(L5) |
| **EEVS242.3** | Develop a small application using AI-assisted coding; compare manually written code with AI-generated code in terms of readability, efficiency, and maintainability. | Analyze(L4) |
| **EEVS242.4** | Conduct efficient AI-supported research | Analyze(L4) |
| **EEVS242.5** | Design automated workflows integrating multiple AI tools | Create(L6) |

## 19.5 Modules / Syllabus Content

### Theory Component

| Module | Unit | Topic | CO | Blooms Level | Reference | Hrs |
|---|---|---|---|---|---|---|
| 1 | **Title** | **AI for Writing & Content Creation** | **CO1** | Apply | **T1, R2** | **7** |
| | 1.1 | AI-assisted writing fundamentals | | | | |
| | 1.2 | Prompt engineering for content generation | | | | |
| | 1.3 | Blog writing, reports, technical documentation | | | | |
| | 1.4 | Summarization and paraphrasing techniques | | | | |
| | 1.5 | Tone adaptation and multilingual writing | | | | |
| 2 | **Title** | **Image Generation Tools** | **CO2** | **Apply** | **T3** | **5** |
| | 2.1 | Basics of generative AI in image synthesis | | | | |
| | 2.2 | Prompt design for image creation | | | | |
| | 2.3 | Style transfer and artistic rendering | | | | |
| 3 | **Title** | **AI Code Assistants** | **CO3** | **Analyze** | **T3, T5, R3** | **5** |
| | 3.1 | AI-assisted programming concepts | | | | |
| | 3.2 | Code generation, debugging, and optimization | | | | |
| | 3.3 | Auto-completion and documentation generation | | | | |
| | 3.4 | Limitations and risks in AI-generated code | | | | |
| 4 | **Title** | **Research & Knowledge Tools** | **CO4** | **Analyze** | **T4, R2** | **4** |
| | 4.1 | AI in academic research | | | | |
| | 4.2 | Literature review automation | | | | |
| | 4.3 | Citation generation and validation | | | | |
| | 4.4 | Knowledge extraction and summarization | | | | |
| 5 | **Title** | **Workflow Automation** | **CO5** | **Create** | **T4, T2, R4** | **5** |
| | 5.1 | Introduction to no-code/low-code automation | | | | |

| | | | |
|---|---|---|---|
| | 5.2 | Integrating AI tools into workflows | |
| | 5.3 | Event-based automation and triggers | |
| | 5.4 | Building intelligent pipelines | |
| **Self - Study** | SS.1 | Explore AI tools for grammar correction and plagiarism detection such as Grammarly and Turnitin. | 1hr/ wk |
| | SS.2 | Explore AI video generation tools like Runway ML and Synthesia. | |
| | SS.3 | Study AI testing/debugging tools and DevOps assistants such as Tabnine and Replit. | |
| | SS.4 | Explore academic reference management tools such as Mendeley and Zotero. | |
| | SS.5 | Explore AI agent platforms and autonomous workflow systems such as AutoGPT and LangChain. | |

### Laboratory Component (Suggested List of Experiments)

| SN | Title of the experiment | CO | Hrs |
|---|---|---|---|
| 1 | Generate blog/article using Claude, ChatGPT, and Jasper; compare quality and accuracy; create technical documentation using Copy.ai | CO1 | 2 |
| 2 | Design zero-shot, few-shot, and chain-of-thought prompts; generate summaries and paraphrased outputs; experiment with tone adaptation and multilingual writing | CO1 | 2 |
| 3 | Generate images using Midjourney, DALL·E, and Stable Diffusion; compare realism vs creativity; apply negative prompts and style keywords | CO2 | 2 |
| 4 | Define a poster theme; generate visual elements using AI image tools; assemble poster using Canva; present final poster with prompt explanation | CO2 | 2 |
| 5 | Set up GitHub Copilot/Cursor; build a simple app (to-do list, calculator, or API app); use AI for code generation; validate and test | CO3 | 2 |
| 6 | Load buggy code into AI-assisted IDE; fix errors using AI suggestions; request optimization; generate inline comments and docstrings automatically | CO3 | 2 |
| 7 | Use Perplexity AI for topic exploration; use Elicit to discover research papers; use NotebookLM to extract insights; | CO4 | 2 |
| 8 | Perform manual literature review (30 min); repeat using AI tools; compare time, sources, depth, and accuracy; identify hallucinations; prepare comparison report | CO4 | 2 |
| 9 | Generate Citation and annotated bibliography and cross-check citations | CO4 | 2 |
| 10 | Build an automated workflow to generate AI-based content from form submissions. | CO5 | 2 |
| 11 | Design an end-to-end workflow for AI-generated content delivery through email. | CO5 | 2 |
| 12 | Create a complete automation pipeline | CO5 | 2 |

## 19.6 Assessment Methodologies and Tools

### Lab Component

| # | Assessment | How Many | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | Exp 1 – Exp 10 | 10 | CAT | Practical / Experiments/Tutorials | Journal (Rubrics Based) | 15 | 30 | - |
| **2** | Classroom Participation | 1 | CAT | Presentation | Rubrics Based | 5 | 10 | - |
| **3** | Attendance | | CAT | Attendance | Record Based | 5 | 10 | - |
| **4** | ESE | | ESE | Oral and Practical | Rubrics based | 25 | 50 | 2 Hrs |

*Note:*

1. *CAT Activity will be part of Term Work.*
2. *The final certification and acceptance of Term Work (TW) shall be granted only if the student has demonstrated satisfactory performance in laboratory work and has secured the minimum passing marks in the Term Work.*
3. *Learners will perform minimum 10 experiment at least 1 experiment from each module.*
4. *Presentation topics strictly based on Application of Analysis of Algorithms in various domains.*
5. *Each practical will be assessed considering **30% work of lab +10% Home work +10% attendance.***
6. *ESE will be combination of execute any one program from exp1-exp10 followed by Oral by external examiner.*

## 19.7 Suggested CO-PO/PSO/PEO Correlation Matrix

***CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)***

| CO # | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EEVS242.1** | 3 | 2 | 2 | 3 | 2 | - | 3 | - | - | - | - | 3 | 3 | 3 |
| **EEVS242.2** | 2 | 2 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | 3 | 3 | 3 |
| **EEVS242.3** | 3 | 3 | 3 | 3 | 2 | - | 3 | - | - | - | - | 3 | 3 | 3 |
| **EEVS242.4** | 3 | 3 | 2 | 3 | 2 | 2 | 3 | - | - | - | - | 3 | 3 | 3 |
| **EEVS242.5** | 2 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - | - | 3 | 3 | 3 |

## 19.8 Course to Knowledge and Attitude Profile (WK) Mapping

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| **1** | **WK1** | **Theory based understanding of the natural science applicable to the discipline** | **Applies scientific principles of data processing and computational intelligence that form the basis of modern AI tools.** |
| **2** | **WK3** | **Theory based formulation of engineering fundamentals** | **The course develops engineering fundamentals through prompt design and automation workflows.** |
| **3** | **WK4** | **Engineering specialist Knowledge** | **AI-assisted development, research automation, and intelligent workflow systems.** |
| **4** | **WK6** | **Knowledge of engineering practice** | **Practical implementation of AI tools for solving real-world engineering and productivity challenges.** |

| | | | |
|---|---|---|---|
| **5** | **Wk9** | **Professional ethics and responsibilities** | **ethical awareness regarding responsible AI usage, privacy, plagiarism** |

# 19.9 Resources

## Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | Prompt Engineering for Generative AI | 1st | James Phoenix, Mike Taylor | O'Reilly Media, | 2024 |
| **T2** | Generative AI for Software Developers | 1st | Saurabh Shrivastava et al. | Packt Publishing, | 2025 |
| **T3** | Generative AI: Techniques, Models and Applications | 1st | Rajan Gupta, Sanju Tiwari, Poonam Chaudhary | Springer | 2025 |
| **T4** | AI Tools for Everyone: Your Guide to Artificial Intelligence | 1st | Aditya Basu | | 2025 |
| **T5** | AI Prompt Engineering Absolute Beginner's Guide | 1st | Michael Miller | Pearson | 2025 |

## Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | Co-Intelligence: Living and Working with AI | - | Ethan Mollick | Portfolio/Penguin | 2024 |
| **R2** | Generative AI: How ChatGPT and Other AI Tools Will Revolutionize Business | | Tom Taulli | Apress(ISBN: 978-1-484-29922-3) | 2023 |
| **R3** | Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play | 2nd Ed | David Foster | O'Reilly MediaISBN: 978-1-098-13418-1 | 2019 |
| **R4** | Modern Generative AI with ChatGPT and OpenAI Models | 1st | Valentina Alto | Packt Publishing ISBN: 978-1-805-12366-0 | 2023 |

## Online Resources

| SN | Title | Description |
|---|---|---|
| **01** | https://docs.anthropic.com | Anthropic Claude documentation and prompt engineering guides |
| **02** | https://www.promptingguide.ai | Comprehensive prompt engineering techniques guide |
| **03** | https://platform.openai.com/docs | OpenAI API documentation for ChatGPT and DALL·E |
| **04** | https://huggingface.co | Open-source AI models, datasets, and image generation spaces |
| **05** | https://zapier.com/learn | Zapier learning hub for workflow automation tutorials |
| **06** | https://docs.n8n.io | n8n workflow automation platform documentation |
| **07** | https://elicit.com | AI research assistant for literature discovery and synthesis |
| **08** | https://learnprompting.org | Free open-source course on prompt engineering |

# Chapter 20: *Subject- Mini Project – I (Sem IV)*

| Overview | | | |
|---|---|---|---|
| **Course Code:** | MEPR241 | Course Category: | Project |
| **Sem:** | III | Syllabus & Version: | SIGCE-R25-Y2 |

## 20.1 Teaching & Learning Scheme

| Components | Class room Instruction | | Lab instructions | | Team work/ Self learning | Total |
|---|---|---|---|---|---|---|
| | L | T | P | D | SL | |
| **Hours/Week** | - | - | 2 | - | - | 2 |
| **Hours/Sem** | - | - | 30 | - | - | **30** |
| **Credits** | - | - | 1 | - | - | **1** |

## 20.2 Examination Scheme

| Component | CAT | ESE | TOTAL | CREDITS |
|---|---|---|---|---|
| **Theory** | - | - | **-** | **-** |
| **Labs** | 50% | 50% | **100%** | **1** |

** L = Lectures; T= Tutorials; P = Practical; D = Demo; SL = Self Learning*

## 20.3 Course Objectives

| | |
|---|---|
| **Pre-requisite Course Codes, if any.** | Basic engineering knowledge, problem-solving skills, teamwork, technical communication, and familiarity with relevant tools and technologies. |
| **Course Overview:** Identify real-world needs and formulate them into engineering problems. Develop collaborative problem-solving and teamwork skills. Apply fundamental engineering principles to solve practical challenges. Cultivate self-directed learning and continuous inquiry habits. | |
| **Course Objective:**<br>1. To familiarize oneself with the process of recognizing demands and transforming them into a problem.<br>2. To acclimate to the process of collaboratively resolving the issue.<br>3. To familiarize oneself with the use of fundamental engineering principles in addressing challenges.<br>4. To instill the practice of self-directed learning and inquiry | |

## 20.4 Course Outcomes

| Course Outcomes (CO): At the End of the course students will be able to | | |
|---|---|---|
| **CO #** | **CO Detail** | **Bloom's level** |
| **MEPR241.1** | Identify and formulate a simple mechanical engineering problem. | Understand |
| **MEPR241.2** | Apply engineering principles and tools to develop project solutions. | Apply |
| **MEPR241.3** | Design, fabricate, assemble, or simulate a working model/system. | Create |
| **MEPR241.4** | Analyse project performance and interpret results. | Analyse |
| **MEPR241.5** | Prepare technical documentation and present project outcomes effectively. | Understand |

## 20.5 Guidelines for Mini Project

1. Students are required to create a group of three to four students. It is prohibited to form a group with fewer than three or more than four students, as this is a group activity.
2. In consultation with the faculty supervisor, director of department, or internal committee of faculties, students should conduct surveys and identify needs. These needs will be transformed into a problem statement for micro projects.
3. Students are required to submit an implementation plan in the form of a Gantt/PERT/CPM chart that outlines the weekly activities of the micro project.
4. Each group is required to create a logbook in which they can document their weekly work progress, and the guide/supervisor can corroborate and record any notes or comments.
5. While faculty supervisors may provide students with feedback during the micro project activity, the primary objective is to encourage self-directed learning.
6. Students in a group should be able to effectively comprehend problems, propose multiple solutions, and select the most suitable solution in consultation with their guide or supervisor.
7. Students are required to transform the optimal solution into a functional model by utilizing a variety of components from their respective domains and presenting it.
8. Validation of the solution with appropriate justification and compilation of a report in the University of Mumbai's standard format.
9. Given the emphasis on self-learning, innovation, addressing societal issues, and the development of entrepreneurship quality within the students through the Mini Projects, it is advisable for all student groups to implement a single project of a suitable quality over the course of two semesters. i.e. Mini Project 1 in semesters III/IV and Mini Project 2 in semesters V/VI.
10. Nevertheless, providing that the proposed Mini Project adheres to the qualitative aspects mentioned above and is completed in the odd semester, the group may be permitted to work on the extension of the Mini Project with appropriate improvements/modifications or a completely new project idea in the even semester, based on the individual students or group capability and the mentor's recommendations. This policy may be implemented on an individual basis.

**Guidelines for Assessment of MiniProject:**

**Term Work**

The review/ progress monitoring committee shall be constituted by Head of departments of each institute. The progress of the mini project to be evaluated on a continuous basis, minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below;

| | |
|---|---|
| Marks awarded by guide/supervisor based on logbook | 10 |
| Marks awarded by review committee | 10 |
| Quality Project report | 05 |

**Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.**

**One-year project:**

The first semester requires complete theoretical solutions, including component/system selection and cost analysis. Two evaluations will be conducted based on the presentation provided by the student group.

The first step is to finalize the problem.

The second step is to finalize the suggested solution for the problem.

The second semester will involve acquiring components/systems, creating a functioning prototype, and validating outcomes from previous semesters.

The first evaluation assesses the readiness of a functional prototype.

The second evaluation will be based on a poster presentation and demonstration of a functioning model in the last month of the semester.

**Half-year project:**

During one semester, students' groups must complete projects covering all components, including identifying needs/problems.

**Proposed ultimate solution**.

Procurement of components and systems

Creating and testing prototypes.

Two reviews will be undertaken for ongoing assessment: first to finalize the problem and suggested solution, and second to execute and test the solution.

**Mini-project assessment criteria.**

Mini Project will be evaluated based on the following criteria:

1. Survey quality and need identification.
2. Clearly define the problem based on necessity.
3. Innovative solutions.
4. Assessing the feasibility of offered issue solutions and selecting the best answer.
5. Cost effectiveness.

6. Social effect.
7. Innovativeness.
8. Cost-effectiveness and social impact.
9. The functional model fully meets the given requirements.
10. Effectively applying skill sets.
11. Effective use of engineering standards.
12. Individual contributions as members or leaders.
13. Clear written and verbal communication.

In a one-year project, the first semester assessment can be based on the first six criteria, while the remaining criteria can be utilized for the second semester evaluation of students' mini-project performance.

For half-year projects, students' success in mini projects can be evaluated using all general criteria.

Guidelines for Assessing the Mini Project Practical/Oral Examination:

Follow University of Mumbai norms for preparing reports.

The Mini Project will be evaluated by a panel of internal and external examiners from industry or research organizations with over five years of experience, authorized by the institution's head. The student project group will present and demonstrate their functioning model.

Encourage students to submit papers based on their work at conferences and contests.

**The Mini Project must be graded based on the following points**:

a. Problem quality and clarity.
b. Innovative solutions.
c. Cost-effectiveness and social impact.
d. The functional model fully meets the given requirements.
e. Effective usage of skill sets.
f. Effectively use conventional engineering rules.
g. Individuals' contributions as members or leaders.
h. Clear written and verbal communication.

## 20.6 Assessment Methodologies and Tools

### Lab Component

| # | Assessment | Nos | Category | Assessment Instrument | Assessment Method | Marks | % Wt | Duration |
|---|---|---|---|---|---|---|---|---|
| **1** | Miniproject | 1 | CAT | Mini project | Synopsis/Project Report | 20 | 40 | 2 Hrs |
| **2** | Attendance Participation Mini Project | | CAT | Attendance Field Project | Rubrics Based Record and Rubrics | 5 | 10 | Continuous |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **3** | ESE | | ESE | Oral and Practical | Rubrics based | 25 | 50 | - |

*CAT Activity will be part of Term Work*

## 20.7 Suggested CO-PO/PSO/PEO Correlation Matrix

***CO-PO Correlation (3-Strong, 2-Moderate, 1-Weak Correlation)***

| CO # | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MEPR241.1** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 |
| **MEPR241.2** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | 2 |
| **MEPR241.3** | 2 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 2 |
| **MEPR241.4** | 2 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | - | 2 |
| **MEPR241.5** | 2 | 2 | 2 | 2 | 2 | 3 | - | - | - | - | - | 2 | 3 |

## 20.8 Course to Knowledge and Attitude Profile (WK)

| # | WK# | WK Statement | Justification of Mapping |
|---|---|---|---|
| **1** | **WK1** | A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences. | Applied in understanding the scientific principles and societal requirements associated with the identified problem and developing technically feasible solutions. |
| **2** | **WK2** | Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. engineering | Used for problem analysis, data collection, interpretation, modelling, performance evaluation and preparation of implementation plans such as Gantt, PERT and CPM charts. |
| **3** | **WK3** | A systematic, theory-based formulation of fundamentals required in the engineering discipline. | Provides the engineering fundamentals required for understanding the problem, generating alternative solutions and developing working models. |
| **4** | **WK4** | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline. | Applied in the design, development and validation of innovative solutions using domain-specific knowledge and emerging technologies relevant to the selected project area. |
| **5** | **WK5** | Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area. | Applied in developing sustainable, cost-effective and socially relevant engineering solutions with consideration for resource utilization and environmental impact. |
| **6** | **WK6** | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline. | Used in project planning, fabrication, testing, validation, documentation and implementation of engineering solutions using appropriate tools and technologies. |

| | | | |
|---|---|---|---|
| **7** | **WK8** | Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues. | Demonstrated through self-learning, literature survey, innovation, critical thinking, evaluation of alternatives and development of entrepreneurial approaches to solve societal problems. |

# 20.9 Resources

## Textbooks

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **T1** | Project Management for Engineering, Business and Technology | 6th | John M. Nicholas and Herman Steyn | Routledge | 2020 |
| **T2** | The Art of Project Management | 2nd | Scott Berkun | O'Reilly Media | 2008 |
| **T3** | Project Management: A Systems Approach to Planning, Scheduling, and Controlling | 12th | Harold Kerzner | Wiley | 2017 |
| **T4** | Engineering Project Management | 4th | Neil G. Siegel | Wiley | 2015 |
| **T5** | Successful Project Management | 6th | Jack Gido and James P. Clements | Cengage Learning | 2018 |

## Reference Books

| SN | Title | Edition | Authors | Publisher | Year |
|---|---|---|---|---|---|
| **R1** | Project Management: A Systems Approach to Planning, Scheduling, and Controlling | 12th | Harold Kerzner | Wiley | 2017 |
| **R2** | Engineering Design: A Project-Based Introduction | 4th | Clive L. Dym et al | Wiley | 2014 |
| **R3** | Design Thinking: Understanding How Designers Think and Work | 2nd | Nigel Cross | Bloomsbury Academic | 2021 |
| **R4** | Sustainable Engineering Practice: An Introduction | 1st | James R. Mihelcic and Julie B. Zimmerman | Wiley | 2014 |
| **R5** | Rural Technology and Community Development | 1st | S. K. Khanna | Dhanpat Rai Publications | 2005 |

## Online Resources

| SN | Title | Description |
|---|---|---|
| **O1** | https://ieeexplore.ieee.org | These references are commonly accepted for Mini Project-I, Mini Project-II, Community Engagement Projects, Innovation Projects, and Capstone Project courses in autonomous engineering colleges. |
| **O2** | https://nptel.ac.in | These references are commonly accepted for Mini Project-I, Mini Project-II, Community Engagement Projects, Innovation Projects, and Capstone Project courses in autonomous engineering colleges. |